

# DATA SHEET

## SURFACE-MOUNT CERAMIC MULTILAYER CAPACITORS

Soft termination

NPO and X7R

16V TO 3KV

0.47pF to 2.2 uF

RoHS compliant & Halogen Free



**SCOPE**

This specification describes X7R series chip capacitors with Flexible leadfree terminations.

**APPLICATIONS**

High flexure stress circuit boards  
Switch power supplies  
Telecom base station

**FEATURES**

- Supplied in tape on reel
- Flexible termination system
- Lead-free termination meet RoHS requirements
- Improved resistance to thermal stresses
- Increased mechanical performance

**ORDERING INFORMATION-GLOBAL PART NUMBER**

All part numbers are identified by the series, size, tolerance, TC material, packing style, voltage, process code, termination and capacitance value.

**YAGEO ordering code****GLOBAL PART NUMBER (PREFERRED)**

**CS**   XXXX   X   X   **X7R**   X   **BX**   XXX  
           (1)    (2) (3)                    (4) (5)    (6)

**(1) SIZE – INCH BASED (METRIC)**

|             |             |
|-------------|-------------|
| 0402 (1005) | 1206 (3216) |
| 0603 (1608) | 1210 (3225) |
| 0805 (2012) | 1808 (4520) |
|             | 1812 (4532) |

**(2) TOLERANCE**

G =  $\pm 2\%$  (1)  
 J =  $\pm 5\%$  (2)  
 K =  $\pm 10\%$   
 M =  $\pm 20\%$

**(3) PACKING STYLE**

R = Paper/PE taping reel; Reel 7 inch  
 K = Blister taping reel; Reel 7 inch  
 P = Paper/PE taping reel; Reel 13 inch  
 F = Blister taping reel; Reel 13 inch

**(4) RATED VOLTAGE**

|           |           |
|-----------|-----------|
| 7 = 16 V  | Y = 250 V |
| 8 = 25 V  | B = 500 V |
| 9 = 50 V  | Z = 630 V |
| 0 = 100 V | C = 1 kV  |
| A = 200 V | D = 2 kV  |
|           | E = 3 kV  |

**(5) PROCESS**

N = NPO  
 B = Class 2 MLCC

**(6) CAPACITANCE VALUE**

2 significant digits+number of zeros  
 The 3rd digit signifies the multiplying factor, and letter R is decimal point  
 Example: 103 =  $10 \times 10^3 = 10,000 \text{ pF} = 10 \text{ nF}$

**NOTE**

1. Tolerance  $\pm 2\%$  doesn't available for full NPO product range, please contact local sales force before order.
2. Tolerance  $\pm 5\%$  doesn't available for full X7R product range, please contact local sales force before order.

## CONSTRUCTION

The capacitor consists of a rectangular block of ceramic dielectric in which a number of interleaved metal electrodes are contained. This structure gives rise to a high capacitance per unit volume.

The inner electrodes are connected to the two end flexible terminations and finally covered with a layer of plated tin (NiSn).

The terminations are lead-free. A cross section of the structure is shown in Fig.1 and Fig.2.

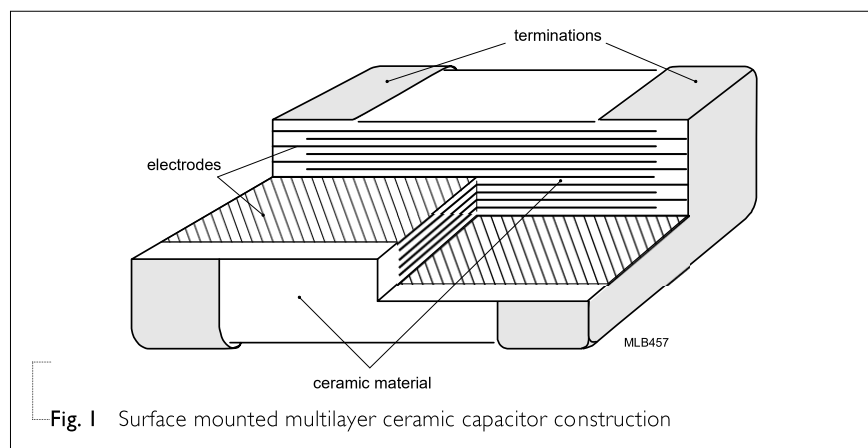


Fig. 1 Surface mounted multilayer ceramic capacitor construction

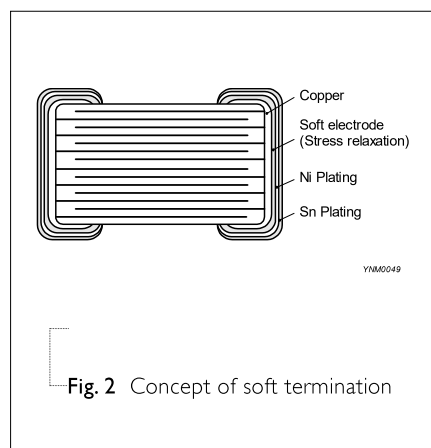


Fig. 2 Concept of soft termination

## DIMENSION

Table I For outlines see fig. 3

| TYPE | LI (mm)      | W (mm)     | T (mm)      | L2/L3(mm)<br>min | L2/L3(mm)<br>max | L4(mm)<br>min | Dimension<br>code |
|------|--------------|------------|-------------|------------------|------------------|---------------|-------------------|
| 0402 | 1.0 ± 0.15   | 0.5 ± 0.15 | 0.50 ± 0.15 | 0.10             | 0.35             | 0.30          | CA                |
| 0603 | 1.6 ± 0.20   | 0.8 ± 0.15 | 0.80 ± 0.15 | 0.20             | 0.65             | 0.50          | DA                |
|      | 1.6 ± 0.25   | 0.8 ± 0.25 | 0.80 ± 0.25 | 0.20             | 0.85             | 0.20          | DB                |
| 0805 | 2.0 ± 0.3    | 1.25 ± 0.2 | 0.60 ± 0.15 | 0.25             | 0.75             | 0.70          | EA                |
|      |              |            | 0.85 ± 0.15 |                  |                  |               | EB                |
|      |              |            | 1.25 ± 0.20 |                  |                  |               | EC                |
|      |              |            | 1.25 ± 0.25 |                  |                  |               | ED                |
|      |              |            | 0.60 ± 0.15 |                  |                  |               | FA                |
| 1206 | 3.2 ± 0.4    | 1.6 ± 0.2  | 0.85 ± 0.15 | 0.25             | 0.85             | 1.50          | FB                |
|      |              |            | 1.15 ± 0.20 |                  |                  |               | FC                |
|      |              |            | 1.25 ± 0.20 |                  |                  |               | FD                |
|      |              |            | 1.60 ± 0.20 |                  |                  |               | FE                |
|      |              |            | 1.6 ± 0.3   |                  |                  |               | FF                |
| 1210 | 3.2 ± 0.5    | 2.5 ± 0.3  | 0.85 ± 0.20 | 0.25             | 0.85             | 1.40          | GA                |
|      |              |            | 1.15 ± 0.30 |                  |                  |               | GB                |
|      |              |            | 1.25 ± 0.20 |                  |                  |               | GC                |
|      |              |            | 1.25 ± 0.30 |                  |                  |               | GD                |
|      |              |            | 1.60 ± 0.30 |                  |                  |               | GE                |
|      |              |            | 2.00 ± 0.30 |                  |                  |               | GF                |
|      |              |            | 2.5 ± 0.3   |                  |                  |               | GG                |
|      |              |            | 2.5 ± 0.2   |                  |                  |               | GH                |
|      |              |            | 1.25 ± 0.20 |                  |                  |               | HA                |
|      |              |            | 1.35 ± 0.40 |                  |                  |               | HB                |
| 1808 | 4.5+0.6/-0.4 | 2.0 ± 0.4  | 1.60 ± 0.20 | 0.25             | 0.85             | 2.20          | HC                |
|      |              |            | 1.60 ± 0.40 |                  |                  |               | HD                |
|      |              |            | 2.00 ± 0.40 |                  |                  |               | HE                |
|      |              |            | 0.85 ± 0.30 |                  |                  |               | IA                |
| 1812 | 4.5+0.6/-0.4 | 3.2 ± 0.4  | 1.15 ± 0.40 | 0.25             | 0.85             | 2.20          | IB                |
|      |              |            | 1.25 ± 0.20 |                  |                  |               | IC                |
|      |              |            | 1.25 ± 0.40 |                  |                  |               | ID                |
|      |              |            | 1.35 ± 0.40 |                  |                  |               | IE                |
|      |              |            | 1.60 ± 0.40 |                  |                  |               | IF                |

## OUTLINES

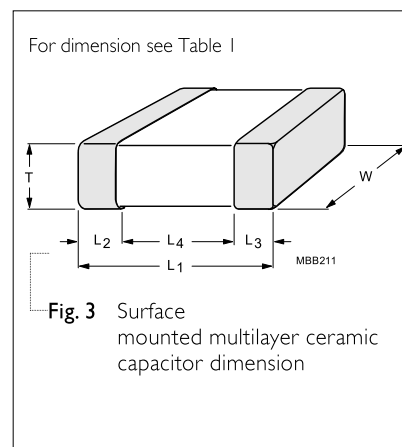


Fig. 3 Surface mounted multilayer ceramic capacitor dimension

**CAPACITANCE RANGE & THICKNESS**

Table 2 NPO / 0402 to 0805

| CAP.    | 0402 |      | 0603 |      | 0805 |     |      |      |      |      |       |
|---------|------|------|------|------|------|-----|------|------|------|------|-------|
|         | 50V  | 100V | 50V  | 100V | 250V | 50V | 100V | 250V | 500V | 630V | 1000V |
| 0.47 pF | CA   | CA   | DA   | DA   | DA   | EA  | EA   | EA   | EA   |      |       |
| 0.56 pF | CA   | CA   | DA   | DA   | DA   | EA  | EA   | EA   | EA   |      |       |
| 0.68 pF | CA   | CA   | DA   | DA   | DA   | EA  | EA   | EA   | EA   |      |       |
| 0.82 pF | CA   | CA   | DA   | DA   | DA   | EA  | EA   | EA   | EA   |      |       |
| 1 pF    | CA   | CA   | DA   | DA   | DA   | EA  | EA   | EA   | EA   |      |       |
| 1.2 pF  | CA   | CA   | DA   | DA   | DA   | EA  | EA   | EA   | EA   |      |       |
| 1.5 pF  | CA   | CA   | DA   | DA   | DA   | EA  | EA   | EA   | EA   |      |       |
| 1.8 pF  | CA   | CA   | DA   | DA   | DA   | EA  | EA   | EA   | EA   |      |       |
| 2.2 pF  | CA   | CA   | DA   | DA   | DA   | EA  | EA   | EA   | EA   |      |       |
| 2.7 pF  | CA   | CA   | DA   | DA   | DA   | EA  | EA   | EA   | EA   |      |       |
| 3.3 pF  | CA   | CA   | DA   | DA   | DA   | EA  | EA   | EA   | EA   |      |       |
| 3.9 pF  | CA   | CA   | DA   | DA   | DA   | EA  | EA   | EA   | EA   |      |       |
| 4.7 pF  | CA   | CA   | DA   | DA   | DA   | EA  | EA   | EA   | EA   |      |       |
| 5.6 pF  | CA   | CA   | DA   | DA   | DA   | EA  | EA   | EA   | EA   |      |       |
| 6.8 pF  | CA   | CA   | DA   | DA   | DA   | EA  | EA   | EA   | EA   |      |       |
| 8.2 pF  | CA   | CA   | DA   | DA   | DA   | EA  | EA   | EA   | EA   |      |       |
| 10 pF   | CA   | CA   | DA   | DA   | DA   | EA  | EA   | EA   | EA   | EA   | EB    |
| 12 pF   | CA   | CA   | DA   | DA   | DA   | EA  | EA   | EA   | EA   | EA   | EB    |
| 15 pF   | CA   | CA   | DA   | DA   | DA   | EA  | EA   | EA   | EA   | EA   | EB    |
| 18 pF   | CA   | CA   | DA   | DA   | DA   | EA  | EA   | EA   | EA   | EA   | EB    |
| 22 pF   | CA   | CA   | DA   | DA   | DA   | EA  | EA   | EA   | EA   | EA   | EB    |
| 27 pF   | CA   | CA   | DA   | DA   | DA   | EA  | EA   | EA   | EA   | EA   | EB    |
| 33 pF   | CA   | CA   | DA   | DA   | DA   | EA  | EA   | EA   | EA   | EA   | EB    |
| 39 pF   | CA   | CA   | DA   | DA   | DA   | EA  | EA   | EA   | EA   | EA   | EB    |
| 47 pF   | CA   | CA   | DA   | DA   | DA   | EA  | EA   | EA   | EA   | EA   | EB    |
| 56 pF   | CA   | CA   | DA   | DA   | DA   | EA  | EA   | EA   | EA   | EA   | EC    |
| 68 pF   | CA   | CA   | DA   | DA   | DA   | EA  | EA   | EA   | EA   | EA   | EC    |
| 82 pF   | CA   | CA   | DA   | DA   | DA   | EA  | EA   | EA   | EA   | EA   | EC    |
| 100 pF  | CA   | CA   | DA   | DA   | DA   | EA  | EA   | EA   | EA   | EA   |       |

Tape width

8 mm

**NOTE**

1. Values in shaded cells indicate thickness class in mm
2. Capacitance value of non E-12 series is on request
3. For product with 2% tolerance, please contact local sales force before ordering



**CAPACITANCE RANGE & THICKNESS**

Table 3 NPO / 0402 to 0805

| CAP.       | 0402 |      | 0603 |      |      | 0805 |      |      |      |      |       |
|------------|------|------|------|------|------|------|------|------|------|------|-------|
|            | 50V  | 100V | 50V  | 100V | 250V | 50V  | 100V | 250V | 500V | 630V | 1000V |
| 120 pF     | CA   | CA   | DA   | DA   | DA   | EA   | EA   | EA   | EA   | EA   |       |
| 150 pF     | CA   | CA   | DA   | DA   | DA   | EA   | EA   | EA   | EA   | EA   |       |
| 180 pF     | CA   |      | DA   | DA   | DA   | EA   | EA   | EA   | EA   | EA   |       |
| 220 pF     | CA   |      | DA   | DA   | DA   | EA   | EA   | EB   | EB   | EB   |       |
| 270 pF     | CA   |      | DA   | DA   | DA   | EA   | EA   | EB   | EB   | EB   |       |
| 330 pF     | CA   |      | DA   | DA   | DA   | EA   | EA   | EB   | EB   | EB   |       |
| 390 pF     | CA   |      | DA   | DA   | DA   | EA   | EA   | EB   | EB   | EB   |       |
| 470 pF     | CA   |      | DA   | DA   | DA   | EA   | EA   | EB   | EB   | EB   |       |
| 560 pF     |      |      | DA   | DA   | DA   | EA   | EA   | EB   | EC   | EC   |       |
| 680 pF     |      |      | DA   | DA   | DA   | EA   | EA   | EB   | EC   | EC   |       |
| 820 pF     |      |      | DA   | DA   |      | EA   | EA   | EB   | EC   | EC   |       |
| 1.0 nF     |      |      | DA   | DA   |      | EA   | EA   | EB   | EC   | EC   |       |
| 1.2 nF     |      |      | DA   |      |      | EB   | EB   | EC   |      |      |       |
| 1.5 nF     |      |      | DA   |      |      | EB   | EB   | EC   |      |      |       |
| 1.8 nF     |      |      | DA   |      |      | EB   | EB   | EC   |      |      |       |
| 2.2 nF     |      |      | DA   |      |      | EC   | EC   | EC   |      |      |       |
| 2.7 nF     |      |      | DA   |      |      | EC   | EC   | EC   |      |      |       |
| 3.3 nF     |      |      | DA   |      |      | EC   | EC   | EC   |      |      |       |
| 3.9 nF     |      |      |      |      |      | EC   | EC   | EC   |      |      |       |
| 4.7 nF     |      |      |      |      |      | EC   | EC   | EC   |      |      |       |
| 5.6 nF     |      |      |      |      |      | EC   | EC   |      |      |      |       |
| 6.8 nF     |      |      |      |      |      | EC   | EC   |      |      |      |       |
| 8.2 nF     |      |      |      |      |      | EC   | EC   |      |      |      |       |
| 10 nF      |      |      |      |      |      | EC   | EC   |      |      |      |       |
| Tape width |      |      |      |      |      | 8 mm |      |      |      |      |       |

**NOTE**

1. Values in shaded cells indicate thickness class in mm
2. Capacitance value of non E-12 series is on request
3. For product with 2% tolerance, please contact local sales force before ordering

CAPACITANCE RANGE & THICKNESS

Table 4 NPO / I206 to I210

| CAP.    | I206 |      |      |      | I210 |       |       |       |     |      |      |      |      |       |       |  |
|---------|------|------|------|------|------|-------|-------|-------|-----|------|------|------|------|-------|-------|--|
|         | 50V  | 100V | 250V | 500V | 630V | 1000V | 2000V | 3000V | 50V | 100V | 250V | 500V | 630V | 1000V | 2000V |  |
| 0.47 pF | FA   | FA   | FA   |      |      |       |       |       |     |      |      |      |      |       |       |  |
| 0.56 pF | FA   | FA   | FA   |      |      |       |       |       |     |      |      |      |      |       |       |  |
| 0.68 pF | FA   | FA   | FA   |      |      |       |       |       |     |      |      |      |      |       |       |  |
| 0.82 pF | FA   | FA   | FA   |      |      |       |       |       |     |      |      |      |      |       |       |  |
| 1 pF    | FA   | FA   | FA   |      |      |       |       |       |     |      |      |      |      |       |       |  |
| 1.2 pF  | FA   | FA   | FA   |      |      |       |       |       |     |      |      |      |      |       |       |  |
| 1.5 pF  | FA   | FA   | FA   |      |      |       |       |       |     |      |      |      |      |       |       |  |
| 1.8 pF  | FA   | FA   | FA   |      |      |       |       |       |     |      |      |      |      |       |       |  |
| 2.2 pF  | FA   | FA   | FA   | FA   |      |       |       |       |     |      |      |      |      |       |       |  |
| 2.7 pF  | FA   | FA   | FA   | FA   |      |       |       |       |     |      |      |      |      |       |       |  |
| 3.3 pF  | FA   | FA   | FA   | FA   |      |       |       |       |     |      |      |      |      |       |       |  |
| 3.9 pF  | FA   | FA   | FA   | FA   |      |       |       |       |     |      |      |      |      |       |       |  |
| 4.7 pF  | FA   | FA   | FA   | FA   |      |       |       |       |     |      |      |      |      |       |       |  |
| 5.6 pF  | FA   | FA   | FA   | FA   |      |       |       |       |     |      |      |      |      |       |       |  |
| 6.8 pF  | FA   | FA   | FA   | FA   |      |       |       |       |     |      |      |      |      |       |       |  |
| 8.2 pF  | FA   | FA   | FA   | FA   |      |       |       |       |     |      |      |      |      |       |       |  |
| 10 pF   | FA   | FA   | FA   | FA   | FD   | FD    | FD    | FD    |     |      |      |      |      |       |       |  |
| 12 pF   | FA   | FA   | FA   | FA   | FD   | FD    | FD    | FD    |     |      |      |      |      |       |       |  |
| 15 pF   | FA   | FA   | FA   | FA   | FD   | FD    | FD    | FD    |     |      |      |      |      |       |       |  |
| 18 pF   | FA   | FA   | FA   | FA   | FD   | FD    | FD    | FD    |     |      |      |      |      |       |       |  |
| 22 pF   | FA   | FA   | FA   | FA   | FD   | FD    | FD    | FD    |     |      |      |      |      |       |       |  |
| 27 pF   | FA   | FA   | FA   | FA   | FD   | FD    | FD    | FD    |     |      |      |      |      |       |       |  |
| 33 pF   | FA   | FA   | FA   | FA   | FD   | FD    | FD    | FD    |     |      |      |      | GC   | GC    | GC    |  |
| 39 pF   | FA   | FA   | FA   | FA   | FD   | FD    | FD    | FD    |     |      |      |      | GC   | GC    | GC    |  |
| 47 pF   | FA   | FA   | FA   | FA   | FD   | FD    | FD    | FD    | GC  | GC   | GC   | GC   | GC   | GC    | GC    |  |
| 56 pF   | FA   | FA   | FA   | FA   | FD   | FD    | FD    |       | GC  | GC   | GC   | GC   | GC   | GC    | GC    |  |
| 68 pF   | FA   | FA   | FA   | FA   | FD   | FD    | FD    |       | GC  | GC   | GC   | GC   | GC   | GC    | GC    |  |
| 82 pF   | FA   | FA   | FA   | FA   | FD   | FD    | FD    |       | GC  | GC   | GC   | GC   | GC   | GC    | GC    |  |
| 100 pF  | FA   | FA   | FA   | FA   | FD   | FD    | FD    |       | GC  | GC   | GC   | GC   | GC   | GC    | GC    |  |

Tape width

**CAPACITANCE RANGE & THICKNESS**

Table 5 NPO / I206 to I210

| CAP.   | I206 |      |      |      |      |       |       | I210 |      |      |      |      |       |       |
|--------|------|------|------|------|------|-------|-------|------|------|------|------|------|-------|-------|
|        | 50V  | 100V | 250V | 500V | 630V | 1000V | 2000V | 50V  | 100V | 250V | 500V | 630V | 1000V | 2000V |
| 120 pF | FA   | FA   | FA   | FA   | FD   | FD    | FD    | GC   | GC   | GC   | GC   | GC   | GC    | GC    |
| 150 pF | FA   | FA   | FA   | FA   | FD   | FD    | FD    | GC   | GC   | GC   | GC   | GC   | GC    | GC    |
| 180 pF | FA   | FA   | FA   | FA   | FD   | FD    | FD    | GC   | GC   | GC   | GC   | GC   | GC    | GC    |
| 220 pF | FA   | FA   | FA   | FA   | FD   | FD    | FD    | GC   | GC   | GC   | GC   | GC   | GC    | GC    |
| 270 pF | FA   | FA   | FA   | FA   | FD   | FD    |       | GC   | GC   | GC   | GC   | GC   | GC    |       |
| 330 pF | FA   | FA   | FA   | FA   | FD   | FD    |       | GC   | GC   | GC   | GC   | GC   | GC    |       |
| 390 pF | FA   | FA   | FA   | FA   | FD   | FD    |       | GC   | GC   | GC   | GC   | GC   | GC    |       |
| 470 pF | FA   | FA   | FA   | FA   | FD   | FD    |       | GC   | GC   | GC   | GC   | GC   | GC    |       |
| 560 pF | FA   | FA   | FA   | FA   | FD   | FD    |       | GC   | GC   | GC   | GC   | GC   | GC    |       |
| 680 pF | FA   | FA   | FA   | FA   | FD   | FD    |       | GC   | GC   | GC   | GC   | GC   | GC    |       |
| 820 pF | FA   | FA   | FB   | FB   | FD   | FD    |       | GC   | GC   | GC   | GC   | GC   | GC    |       |
| 1.0 nF | FA   | FA   | FB   | FB   | FD   | FD    |       | GC   | GC   | GC   | GC   | GC   | GC    |       |
| 1.2 nF | FA   | FA   | FB   | FB   | FD   |       |       | GC   | GC   | GC   | GC   |      |       |       |
| 1.5 nF | FA   | FA   | FB   | FB   | FD   |       |       | GC   | GC   | GC   | GC   |      |       |       |
| 1.8 nF | FA   | FA   | FD   | FD   | FD   |       |       | GC   | GC   | GC   | GC   |      |       |       |
| 2.2 nF | FA   | FA   | FD   | FD   | FD   |       |       | GC   | GC   | GC   | GC   |      |       |       |
| 2.7 nF | FA   | FA   | FD   |      |      |       |       | GC   | GC   | GC   | GC   |      |       |       |
| 3.3 nF | FB   | FB   | FD   |      |      |       |       | GC   | GC   | GC   | GC   |      |       |       |
| 3.9 nF | FB   | FB   | FD   |      |      |       |       | GC   | GC   | GC   | GC   |      |       |       |
| 4.7 nF | FB   | FB   |      |      |      |       |       | GC   | GC   | GC   | GC   |      |       |       |
| 5.6 nF | FB   | FB   |      |      |      |       |       | GC   | GC   |      |      |      |       |       |
| 6.8 nF | FB   | FB   |      |      |      |       |       | GC   | GC   |      |      |      |       |       |
| 8.2 nF | FD   | FD   |      |      |      |       |       | GC   | GC   |      |      |      |       |       |
| 10 nF  | FD   | FD   |      |      |      |       |       | GC   | GC   |      |      |      |       |       |

Tape width

8 mm

**CAPACITANCE RANGE & THICKNESS**

Table 6 NPO / I808 to I812

| CAP.       | I808  |       |       | I812 |       |      |      |       |       |       |
|------------|-------|-------|-------|------|-------|------|------|-------|-------|-------|
|            | 1000V | 2000V | 3000V | 100V | 250V  | 500V | 630V | 1000V | 2000V | 3000V |
| 10 pF      |       |       | HC    |      |       |      |      | IC    | IC    | IC    |
| 12 pF      |       |       | HC    |      |       |      |      | IC    | IC    | IC    |
| 15 pF      |       |       | HC    |      |       |      |      | IC    | IC    | IC    |
| 18 pF      |       |       | HC    |      |       |      |      | IC    | IC    | IC    |
| 22 pF      |       |       | HC    |      |       |      |      | IC    | IC    | IC    |
| 27 pF      |       |       | HC    |      |       |      |      | IC    | IC    | IC    |
| 33 pF      | HA    | HA    | HC    |      |       |      |      | IC    | IC    | IC    |
| 39 pF      | HA    | HA    | HC    |      |       |      |      | IC    | IC    | IC    |
| 47 pF      | HA    | HA    | HC    |      |       |      |      | IC    | IC    | IC    |
| 56 pF      | HA    | HA    | HC    | IC   | IC    | IC   | IC   | IC    | IC    | IC    |
| 68 pF      | HA    | HA    | HC    | IC   | IC    | IC   | IC   | IC    | IC    | IC    |
| 82 pF      | HA    | HA    | HC    | IC   | IC    | IC   | IC   | IC    | IC    | IC    |
| 100 pF     | HA    | HA    | HC    | IC   | IC    | IC   | IC   | IC    | IC    | IC    |
| 120 pF     | HA    | HA    |       | IC   | IC    | IC   | IC   | IC    | IC    | IC    |
| 150 pF     | HA    | HA    |       | IC   | IC    | IC   | IC   | IC    | IC    | IC    |
| 180 pF     | HA    | HA    |       | IC   | IC    | IC   | IC   | IC    | IC    | IC    |
| 220 pF     | HA    | HA    |       | IC   | IC    | IC   | IC   | IC    | IC    | IC    |
| 270 pF     | HA    | HA    |       | IC   | IC    | IC   | IC   | IC    | IC    |       |
| 330 pF     | HA    | HA    |       | IC   | IC    | IC   | IC   | IC    | IC    |       |
| 390 pF     | HA    | HA    |       | IC   | IC    | IC   | IC   | IC    | IC    |       |
| 470 pF     | HA    | HA    |       | IC   | IC    | IC   | IC   | IC    |       |       |
| 560 pF     | HA    | HA    |       | IC   | IC    | IC   | IC   | IC    |       |       |
| 680 pF     |       |       |       | IC   | IC    | IC   | IC   | IC    |       |       |
| 820 pF     |       |       |       | IC   | IC    | IC   | IC   | IC    |       |       |
| 1.0 nF     |       |       |       | IC   | IC    | IC   | IC   | IC    |       |       |
| 1.2 nF     |       |       |       | IC   | IC    | IC   | IC   | IC    |       |       |
| 1.5 nF     |       |       |       | IC   | IC    | IC   | IC   | IC    |       |       |
| 1.8 nF     |       |       |       | IC   | IC    | IC   |      |       |       |       |
| 2.2 nF     |       |       |       | IC   | IC    | IC   |      |       |       |       |
| 2.7 nF     |       |       |       | IC   | IC    | IC   |      |       |       |       |
| 3.3 nF     |       |       |       | IC   | IC    | IC   |      |       |       |       |
| 3.9 nF     |       |       |       | IC   | IC    | IC   |      |       |       |       |
| 4.7 nF     |       |       |       | IC   | IC    | IC   |      |       |       |       |
| 5.6 nF     |       |       |       | IC   |       |      |      |       |       |       |
| 6.8 nF     |       |       |       | IC   |       |      |      |       |       |       |
| 8.2 nF     |       |       |       | IC   |       |      |      |       |       |       |
| 10 nF      |       |       |       | IC   |       |      |      |       |       |       |
| 12 nF      |       |       |       | IC   |       |      |      |       |       |       |
| 15 nF      |       |       |       | IC   |       |      |      |       |       |       |
| 18 nF      |       |       |       | IC   |       |      |      |       |       |       |
| 22 nF      |       |       |       | IC   |       |      |      |       |       |       |
| 27 nF      |       |       |       |      |       |      |      |       |       |       |
| 33 nF      |       |       |       |      |       |      |      |       |       |       |
| Tape Width |       |       |       |      | 12 mm |      |      |       |       |       |

**NOTE**

1. Values in shaded cells indicate thickness class in mm
2. Capacitance value of non E-I2 series is on request
3. For product with 2% tolerance, please contact local sales force before ordering



**CAPACITANCE RANGE & THICKNESS**

Table 7 X7R / 0402 to 0805

| CAP.    | 0402 |     |     |      | 0603 |     |     |      | 0805 |     |     |     |      |      |      |      |       |  |  |  |  |
|---------|------|-----|-----|------|------|-----|-----|------|------|-----|-----|-----|------|------|------|------|-------|--|--|--|--|
|         | 16V  | 25V | 50V | 100V | 16V  | 25V | 50V | 100V | 250V | 16V | 25V | 50V | 100V | 250V | 500V | 630V | 1000V |  |  |  |  |
| 100 pF  | CA   | CA  | CA  | CA   | DA   | DA  | DA  | DA   | DA   |     |     |     |      |      |      |      |       |  |  |  |  |
| 150 pF  | CA   | CA  | CA  | CA   | DA   | DA  | DA  | DA   | DA   | EA  | EA  | EA  | EA   | EB   | EB   | EB   | EB    |  |  |  |  |
| 220 pF  | CA   | CA  | CA  | CA   | DA   | DA  | DA  | DA   | DA   | EA  | EA  | EA  | EA   | EB   | EB   | EB   | EB    |  |  |  |  |
| 330 pF  | CA   | CA  | CA  | CA   | DA   | DA  | DA  | DA   | DA   | EA  | EA  | EA  | EA   | EB   | EB   | EB   | EB    |  |  |  |  |
| 470 pF  | CA   | CA  | CA  | CA   | DA   | DA  | DA  | DA   | DA   | EA  | EA  | EA  | EA   | EB   | EB   | EB   | EB    |  |  |  |  |
| 680 pF  | CA   | CA  | CA  | CA   | DA   | DA  | DA  | DA   | DA   | EA  | EA  | EA  | EA   | EB   | EB   | EB   | EB    |  |  |  |  |
| 1.0 nF  | CA   | CA  | CA  | CA   | DA   | DA  | DA  | DA   | DA   | EA  | EA  | EA  | EA   | EB   | EB   | EB   | EB    |  |  |  |  |
| 1.5 nF  | CA   | CA  | CA  | CA   | DA   | DA  | DA  | DA   | DA   | EA  | EA  | EA  | EA   | EB   | EB   | EB   |       |  |  |  |  |
| 2.2 nF  | CA   | CA  | CA  | CA   | DA   | DA  | DA  | DA   | DA   | EA  | EA  | EA  | EA   | EB   | EB   | EB   |       |  |  |  |  |
| 3.3 nF  | CA   | CA  | CA  | CA   | DA   | DA  | DA  | DA   |      | EA  | EA  | EA  | EA   | EB   | EB   | EB   |       |  |  |  |  |
| 4.7 nF  | CA   | CA  | CA  | CA   | DA   | DA  | DA  | DA   |      | EA  | EA  | EA  | EA   | EB   | EB   | EB   |       |  |  |  |  |
| 6.8 nF  | CA   | CA  | CA  | CA   | DA   | DA  | DA  | DA   |      | EA  | EA  | EA  | EA   | EC   | EB   | EB   |       |  |  |  |  |
| 10 nF   | CA   | CA  | CA  | CA   | DA   | DA  | DA  | DA   |      | EA  | EA  | EA  | EA   | EC   | EC   | EC   |       |  |  |  |  |
| 15 nF   | CA   | CA  | CA  |      | DA   | DA  | DA  | DA   |      | EA  | EA  | EA  | EB   | EC   | EC   |      |       |  |  |  |  |
| 22 nF   | CA   | CA  | CA  |      | DA   | DA  | DA  | DA   |      | EA  | EA  | EA  | EB   | EC   | EC   |      |       |  |  |  |  |
| 33 nF   | CA   | CA  | CA  |      | DA   | DA  | DA  | DA   |      | EB  | EB  | EB  | EC   |      |      |      |       |  |  |  |  |
| 47 nF   | CA   | CA  | CA  |      | DA   | DA  | DA  | DA   |      | EB  | EB  | EB  | EC   |      |      |      |       |  |  |  |  |
| 68 nF   | CA   | CA  |     |      | DA   | DA  | DA  | DA   |      | EB  | EB  | EB  | EC   |      |      |      |       |  |  |  |  |
| 100 nF  | CA   | CA  |     |      | DA   | DA  | DA  | DA   |      | EB  | EB  | EB  | EC   |      |      |      |       |  |  |  |  |
| 150 nF  |      |     |     |      | DA   | DA  | DA  |      |      | EC  | EC  | EC  |      |      |      |      |       |  |  |  |  |
| 220 nF  |      |     |     |      | DA   | DA  | DA  |      |      | EC  | EC  | EC  |      |      |      |      |       |  |  |  |  |
| 330 nF  |      |     |     |      | DA   | DA  |     |      |      | EC  | EC  | EC  |      |      |      |      |       |  |  |  |  |
| 470 nF  |      |     |     |      | DA   | DA  |     |      |      | EC  | EC  | EC  |      |      |      |      |       |  |  |  |  |
| 680 nF  |      |     |     |      | DA   |     |     |      |      | EC  | EC  | EC  |      |      |      |      |       |  |  |  |  |
| 1000 nF |      |     |     |      | DA   | DA  |     |      |      | EC  | EC  | EC  |      |      |      |      |       |  |  |  |  |
| 2.2 μF  |      |     |     |      |      |     |     |      |      | EC  | ED  |     |      |      |      |      |       |  |  |  |  |
| 4.7 μF  |      |     |     |      |      |     |     |      |      | ED  |     |     |      |      |      |      |       |  |  |  |  |

Tape width

8 mm

**NOTE**

1. Values in shaded cells indicate thickness class in mm
2. Capacitance value of non E-6 series is on request
3. For product with 5% tolerance, please contact local sales force before ordering

**CAPACITANCE RANGE & THICKNESS**

Table 8 X7R / I206 to I210

| CAP.       | I206 |     |     |      |          |      |      |       |       | I210 |     |     |      |      |      |      |       |       |
|------------|------|-----|-----|------|----------|------|------|-------|-------|------|-----|-----|------|------|------|------|-------|-------|
|            | 16V  | 25V | 50V | 100V | 200/250V | 500V | 630V | 1000V | 2000V | 16V  | 25V | 50V | 100V | 250V | 500V | 630V | 1000V | 2000V |
| 100 pF     |      |     |     |      |          |      |      |       |       |      |     |     |      |      |      |      |       |       |
| 150 pF     |      |     |     |      |          |      |      |       |       |      |     |     |      |      |      |      |       |       |
| 220 pF     | FB   | FB  | FB  | FB   | FB       | FD   | FD   | FD    | FD    |      |     |     |      |      |      |      |       |       |
| 330 pF     | FB   | FB  | FB  | FB   | FB       | FD   | FD   | FD    | FD    |      |     |     |      |      |      |      |       |       |
| 470 pF     | FB   | FB  | FB  | FB   | FB       | FD   | FD   | FD    | FD    |      |     |     |      |      |      |      | GD    | GD    |
| 680 pF     | FB   | FB  | FB  | FB   | FB       | FD   | FD   | FD    | FD    |      |     |     |      |      |      |      | GD    | GD    |
| 1.0 nF     | FB   | FB  | FB  | FB   | FB       | FD   | FD   | FD    | FD    |      |     |     |      |      |      |      | GD    | GD    |
| 1.5 nF     | FB   | FB  | FB  | FB   | FB       | FD   | FD   | FD    | FD    |      |     |     |      |      |      |      | GD    | GD    |
| 2.2 nF     | FB   | FB  | FB  | FB   | FB       | FD   | FD   | FD    |       | GA   | GA  | GA  | GA   | GA   |      |      | GD    | GE    |
| 3.3 nF     | FB   | FB  | FB  | FB   | FB       | FD   | FD   | FD    |       | GA   | GA  | GA  | GA   | GA   | GD   | GD   | GD    |       |
| 4.7 nF     | FB   | FB  | FB  | FB   | FB       | FD   | FD   | FD    |       | GA   | GA  | GA  | GA   | GA   | GD   | GD   | GD    |       |
| 6.8 nF     | FB   | FB  | FB  | FB   | FB       | FD   | FD   | FD    |       | GA   | GA  | GA  | GA   | GA   | GD   | GD   | GD    |       |
| 10 nF      | FB   | FB  | FB  | FB   | FB       | FD   | FD   | FD    |       | GA   | GA  | GA  | GA   | GA   | GD   | GD   | GD    |       |
| 15 nF      | FB   | FB  | FB  | FB   | FB       | FD   | FD   |       |       | GA   | GA  | GA  | GA   | GA   | GD   | GD   | GD    |       |
| 22 nF      | FB   | FB  | FB  | FB   | FD       | FE   | FE   |       |       | GA   | GA  | GA  | GA   | GD   | GD   | GE   | GE    |       |
| 33 nF      | FB   | FB  | FB  | FB   | FD       | FE   | FE   |       |       | GA   | GA  | GA  | GA   | GD   | GD   |      |       |       |
| 47 nF      | FB   | FB  | FB  | FB   | FD       |      |      |       |       | GA   | GA  | GA  | GA   | GD   | GD   |      |       |       |
| 68 nF      | FB   | FB  | FB  | FD   | FD       |      |      |       |       | GA   | GA  | GA  | GA   | GD   |      |      |       |       |
| 100 nF     | FB   | FB  | FB  | FD   | FE       |      |      |       |       | GA   | GA  | GA  | GA   | GD   |      |      |       |       |
| 150 nF     | FB   | FB  | FC  | FD   |          |      |      |       |       | GA   | GA  | GB  | GD   | GD   |      |      |       |       |
| 220 nF     | FB   | FB  | FC  | FD   |          |      |      |       |       | GA   | GA  | GB  | GD   | GD   |      |      |       |       |
| 330 nF     | FE   | FE  | FE  | FE   |          |      |      |       |       | GA   | GA  | GB  | GD   |      |      |      |       |       |
| 470 nF     | FE   | FE  | FE  | FE   |          |      |      |       |       | GB   | GB  | GD  | GD   |      |      |      |       |       |
| 680 nF     | FC   | FC  | FF  | FF   |          |      |      |       |       | GB   | GB  | GD  | GF   |      |      |      |       |       |
| 1000 nF    | FC   | FC  | FF  | FF   |          |      |      |       |       | GD   | GD  | GD  | GF   |      |      |      |       |       |
| 2.2 μF     | FC   | FC  | FF  | FF   |          |      |      |       |       | GG   | GG  | GG  | GH   |      |      |      |       |       |
| 4.7 μF     | FF   | FF  |     |      |          |      |      |       |       | GG   | GG  | GG  |      |      |      |      |       |       |
| 10 μF      | FF   | FF  |     |      |          |      |      |       |       | GG   | GG  | GG  |      |      |      |      |       |       |
| Tape width |      |     |     |      |          |      |      |       |       | 8 mm |     |     |      |      |      |      |       |       |

**NOTE**

1. Values in shaded cells indicate thickness class in mm
2. Capacitance value of non E-6 series is on request
3. For product with 5% tolerance, please contact local sales force before ordering

**CAPACITANCE RANGE & THICKNESS**

Table 9 X7R / 1808 to 1812

| CAP.        | 1808  |       |       | 1812 |       |      |      |      |       |       |
|-------------|-------|-------|-------|------|-------|------|------|------|-------|-------|
|             | 1000V | 2000V | 3000V | 50V  | 100V  | 250V | 500V | 630V | 1000V | 2000V |
| 100 pF      |       |       |       |      |       |      |      |      |       |       |
| 150 pF      |       |       |       |      |       |      |      |      |       |       |
| 220 pF      |       |       |       |      |       |      |      |      |       |       |
| 330 pF      | HB    | HB    | HD    |      |       |      |      |      |       |       |
| 470 pF      | HB    | HB    | HD    |      |       |      |      |      |       |       |
| 680 pF      | HB    | HB    | HD    |      |       |      |      |      |       |       |
| 1.0 nF      | HB    | HB    | HE    |      |       |      |      |      |       |       |
| 1.5 nF      | HB    | HB    | HE    |      |       |      |      |      |       |       |
| 2.2 nF      | HB    | HD    |       | IA   | IA    | IA   | ID   | IE   | IE    | IE    |
| 3.3 nF      | HB    |       |       | IA   | IA    | IA   | ID   | IE   | IE    | IE    |
| 4.7 nF      | HB    |       |       | IA   | IA    | IA   | ID   | IE   | IE    | IE    |
| 6.8 nF      | HD    |       |       | IA   | IA    | IA   | ID   | IE   | IE    |       |
| 10 nF       | HD    |       |       | IA   | IA    | IA   | ID   | IE   | IE    |       |
| 15 nF       |       |       |       | IA   | IA    | IA   | ID   | IE   | IE    |       |
| 22 nF       |       |       |       | IA   | IA    | IA   | ID   | IE   | IE    |       |
| 33 nF       |       |       |       | IA   | IA    | IA   | ID   | IF   | IF    |       |
| 47 nF       |       |       |       | IA   | IA    | ID   | ID   |      |       |       |
| 68 nF       |       |       |       | IA   | IA    | ID   | ID   |      |       |       |
| 100 nF      |       |       |       | IB   | ID    | ID   | IF   |      |       |       |
| 150 nF      |       |       |       | IB   | ID    | ID   |      |      |       |       |
| 220 nF      |       |       |       | IB   | ID    | IF   |      |      |       |       |
| 330 nF      |       |       |       | IB   | ID    | IF   |      |      |       |       |
| 470 nF      |       |       |       | IB   | IF    | IF   |      |      |       |       |
| 680 nF      |       |       |       | IF   | IF    |      |      |      |       |       |
| 1000 nF     |       |       |       | IF   | IF    |      |      |      |       |       |
| 2.2 $\mu$ F |       |       |       |      |       |      |      |      |       |       |
| Tape width  |       |       |       |      | 12 mm |      |      |      |       |       |

**NOTE**

1. Values in shaded cells indicate thickness class in mm
2. Capacitance value of non E-6 series is on request
3. For product with 5% tolerance, please contact local sales force before ordering

**THICKNESS CLASSES AND PACKING QUANTITY**

Table 10

| SIZE CODE | THICKNESS CLASSIFICATION | TAPE WIDTH<br>QUANTITY PER REEL | Ø180 MM / 7 INCH |         | Ø180 MM / 13 INCH |         |
|-----------|--------------------------|---------------------------------|------------------|---------|-------------------|---------|
|           |                          |                                 | PAPER            | BLISTER | PAPER             | BLISTER |
| 0402      | 0.50 ± 0.15              | 8mm                             | 10,000           | --      | 50,000            | --      |
| 0603      | 0.80 ± 0.15              | 8mm                             | 4,000            | --      | 15,000            | --      |
| 0805      | 0.60 ± 0.15              | 8mm                             | 4,000            | --      | 20,000            | --      |
|           | 0.85 ± 0.15              | 8mm                             | 4,000            | --      | 15,000            | --      |
|           | 1.25 ± 0.20              | 8mm                             | --               | 3,000   | --                | 10,000  |
| 1206      | 0.60 ± 0.15              | 8mm                             | 4,000            | --      | 20,000            | --      |
|           | 0.85 ± 0.15              | 8mm                             | 4,000            | --      | 15,000            | --      |
|           | 1.15 ± 0.20              | 8mm                             | --               | 3,000   | --                | 10,000  |
|           | 1.25 ± 0.20              | 8mm                             | --               | 3,000   | --                | 10,000  |
|           | 1.60 ± 0.20              | 8mm                             | --               | 2,000   | --                | 8,000   |
| 1210      | 1.60 ± 0.30              | 8mm                             | --               | 2,000   | --                | 8,000   |
|           | 0.85 ± 0.20              | 8mm                             | --               | 4,000   | --                | 10,000  |
|           | 1.15 ± 0.30              | 8mm                             | --               | 3,000   | --                | 10,000  |
|           | 1.25 ± 0.20              | 8mm                             | --               | 3,000   | --                | 10,000  |
|           | 1.25 ± 0.30              | 8mm                             | --               | 3,000   | --                | 10,000  |
|           | 1.60 ± 0.30              | 8mm                             | --               | 2,000   | --                | 5,000   |
|           | 2.00 ± 0.30              | 8mm                             | --               | 2,000   | --                | --      |
| 1808      | 2.50 ± 0.20              | 8mm                             | --               | 1,000   | --                | --      |
|           | 1.25 ± 0.20              | 12mm                            | --               | 2,000   | --                | --      |
|           | 1.35 ± 0.40              | 12mm                            | --               | 2,000   | --                | --      |
|           | 1.60 ± 0.20              | 12mm                            | --               | 2,000   | --                | --      |
|           | 1.60 ± 0.40              | 12mm                            | --               | 2,000   | --                | --      |
| 1812      | 2.00 ± 0.40              | 12mm                            | --               | 2,000   | --                | --      |
|           | 0.85 ± 0.30              | 12mm                            | --               | 2,000   | --                | --      |
|           | 1.15 ± 0.40              | 12mm                            | --               | 1,000   | --                | --      |
|           | 1.25 ± 0.20              | 12mm                            | --               | 1,000   | --                | --      |
|           | 1.25 ± 0.40              | 12mm                            | --               | 1,000   | --                | --      |
|           | 1.35 ± 0.40              | 12mm                            | --               | 1,000   | --                | --      |
|           | 1.60 ± 0.40              | 12mm                            | --               | 1,000   | --                | --      |

**ELECTRICAL CHARACTERISTICS****X7R DIELECTRIC CAPACITORS; NISN TERMINATIONS**

Unless otherwise specified, all test and measurements shall be made under standard atmospheric conditions for testing as given in 5.3 of IEC 60068-1:

- Temperature: 15 ° C to 35 ° C
- Relative humidity: 25% to 75%
- Air pressure: 86 kPa to 106 kPa

Before the measurements are made, the capacitor shall be stored at the measuring temperature for a time sufficient to allow the entire capacitor to reach this temperature.

The period as prescribed for recovery at the end of a test is normally sufficient for this purpose.

Table 11

| DESCRIPTION                                             |               |                |                 |                |                |              | VALUE             |
|---------------------------------------------------------|---------------|----------------|-----------------|----------------|----------------|--------------|-------------------|
| Capacitance range                                       |               |                |                 |                |                |              | 100 pF to 2.2μF   |
| Dissipation factor (D.F.)                               |               |                |                 |                |                |              |                   |
| NPO                                                     | C < 30 pF     |                |                 |                |                |              | ≤ 1 / (400 + 20C) |
|                                                         | C ≥ 30 pF     |                |                 |                |                |              | ≤ 0.1 %           |
| X7R                                                     | 0402          | 0603           | 0805            | 1206           | 1210           | 1808         | 1812              |
| 16V                                                     | 100pF to 22nF | 100pF to 220nF | 150pF to 470nF  | 220pF to 1μF   | 2.2nF to 1μF   |              | ≤ 3.5%            |
|                                                         | 27nF to 100nF |                | 680 nF to 2.2μF | 2.2μF          |                |              | ≤ 5%              |
|                                                         |               | 330nF to 1μF   | 4.7μF           | 4.7μF to 10μF  | 2.2μF to 10μF  |              | ≤ 10%             |
| 25V                                                     | 100pF to 10nF | 100pF to 39nF  | 150pF to 180nF  | 220pF to 680nF | 2.2nF to 1μF   |              | ≤ 2.5%            |
|                                                         | 12 nF to 47nF | 47nF to 220nF  | 220nF to 470nF  | 1μF            |                |              | ≤ 3.5%            |
|                                                         | 56nF to 100nF |                | 680nF to 1μF    | 2.2μF          |                |              | ≤ 5%              |
|                                                         |               | 330nF to 1μF   | 2.2μF           | 4.7μF to 10μF  | 2.2μF to 10μF  |              | ≤ 10%             |
| 50V                                                     | 100pF to 10nF | 100pF to 39nF  | 150pF to 180nF  | 220pF to 470nF | 2.2nF to 1μF   | 2.2nF to 1μF | ≤ 2.5%            |
|                                                         | 12 nF to 47nF | 47nF to 220nF  | 220nF to 470nF  | 680nF to 1μF   |                |              | ≤ 3.5%            |
|                                                         |               |                | 680nF           | 2.2μF          |                |              | ≤ 5%              |
|                                                         |               |                | 1μF             |                | 2.2μF to 10μF  |              | ≤ 10%             |
| 100V                                                    | All           | 100pF to 10nF  | All             | 220pF to 680nF | 2.2nF to 680nF | All          | ≤ 2.5%            |
|                                                         |               |                |                 | 1μF            | 1μF            |              | ≤ 3.5%            |
|                                                         |               | 12nF to 100nF  |                 | 2.2μF          | 2.2μF          |              | ≤ 5%              |
| 250V to 3KV                                             |               | All            | All             | All            | All            | All          | ≤ 2.5%            |
| I.R. ≥ 10 GΩ or R × C ≥ 500 seconds whichever is less   |               |                |                 |                |                |              |                   |
| R × C ≥ 100 seconds :                                   |               |                |                 |                |                |              |                   |
| X7R/0603/1μF/16V to 25V                                 |               |                |                 |                |                |              |                   |
| X7R/0805/2.2μF/25V                                      |               |                |                 |                |                |              |                   |
| X7R/0805/4.7μF/16V                                      |               |                |                 |                |                |              |                   |
| X7R/1206/4.7μF to 10μF/16V to 25V                       |               |                |                 |                |                |              |                   |
| X7R/1210/2.2μF to 10μF/16V to 50V, X7R/1210/2.2μF/100V  |               |                |                 |                |                |              |                   |
| Maximum capacitance change as a function of temperature |               |                |                 |                |                |              | NPO: ±30ppm       |
| (temperature characteristic/coefficient):               |               |                |                 |                |                |              | X7R: ±15%         |
| Operating temperature range:                            |               |                |                 |                |                |              | -55 °C to +125 °C |

Table 12

**SOLDERING RECOMMENDATION**

| SOLDERING METHOD | SIZE        | 0402 | 0603     | 0805     | 1206     | ≥ 1210      |
|------------------|-------------|------|----------|----------|----------|-------------|
| Reflow           | Reflow only |      | > 1.0 μF | > 2.2 μF | > 2.2 μF | Reflow only |
| Reflow/Wave      |             |      | ≤ 1.0 μF | ≤ 2.2 μF | ≤ 2.2 μF | ---         |

## TESTS AND REQUIREMENTS

Table 13 Test procedures and requirements

| TEST                                  | TEST METHOD     | PROCEDURE                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | REQUIREMENTS                     |
|---------------------------------------|-----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------|
| Mounting                              | IEC 60384-21/22 | 4.3 The capacitors may be mounted on printed-circuit boards or ceramic substrates                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | No visible damage                |
| Visual Inspection and Dimension Check |                 | 4.4 Any applicable method using $\times 10$ magnification                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | In accordance with specification |
| Capacitance                           |                 | 4.5.1 Class I:<br>$f = 1 \text{ MHz}$ for $C \leq 1 \text{ nF}$ , measuring at voltage $1 \text{ V}_{\text{rms}}$ at $20^\circ\text{C}$<br>$f = 1 \text{ KHz}$ for $C > 1 \text{ nF}$ , measuring at voltage $1 \text{ V}_{\text{rms}}$ at $20^\circ\text{C}$<br><br>Class II:<br>At $20^\circ\text{C}$ , 24 hrs after annealing<br>$f = 1 \text{ KHz}$ for $C \leq 10 \mu\text{F}$ , measuring at voltage $1 \text{ V}_{\text{rms}}$ at $20^\circ\text{C}$<br>$f = 120\text{Hz}$ for $C > 10 \mu\text{F}$ , measuring at voltage $0.5 \text{ V}_{\text{rms}}$ at $20^\circ\text{C}$ | Within specified tolerance       |
| Dissipation Factor (D.F.)             |                 | 4.5.2 Class I:<br>$f = 1 \text{ MHz}$ for $C \leq 1 \text{ nF}$ , measuring at voltage $1 \text{ V}_{\text{rms}}$ at $20^\circ\text{C}$<br>$f = 1 \text{ KHz}$ for $C > 1 \text{ nF}$ , measuring at voltage $1 \text{ V}_{\text{rms}}$ at $20^\circ\text{C}$<br><br>Class II:<br>At $20^\circ\text{C}$ , 24 hrs after annealing<br>$f = 1 \text{ KHz}$ for $C \leq 10 \mu\text{F}$ , measuring at voltage $1 \text{ V}_{\text{rms}}$ at $20^\circ\text{C}$<br>$f = 120\text{Hz}$ for $C > 10 \mu\text{F}$ , measuring at voltage $0.5 \text{ V}_{\text{rms}}$ at $20^\circ\text{C}$ | In accordance with specification |
| Insulation Resistance                 |                 | 4.5.3 $U_r \leq 500 \text{ V}$ : At $U_r$ for 1 minute<br>$U_r > 500 \text{ V}$ : At $500 \text{ V}$ for 1 minute                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | In accordance with specification |

| TEST                       | TEST METHOD           | PROCEDURE                                                                                                                                                                                                                                                                                                                                                                                                                                         | REQUIREMENTS |                 |   |      |   |                       |   |      |   |                       |   |      |                                                                         |
|----------------------------|-----------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|-----------------|---|------|---|-----------------------|---|------|---|-----------------------|---|------|-------------------------------------------------------------------------|
| Temperature Characteristic | IEC 60384-21/22 4.6   | <p>Capacitance shall be measured by the steps shown in the following table.</p> <p>The capacitance change should be measured after 5 min at each specified temperature stage.</p> <table><tr><td>Step</td><td>Temperature(°C)</td></tr><tr><td>a</td><td>25±2</td></tr><tr><td>b</td><td>Lower temperature±3°C</td></tr><tr><td>c</td><td>25±2</td></tr><tr><td>d</td><td>Upper Temperature±2°C</td></tr><tr><td>e</td><td>25±2</td></tr></table> | Step         | Temperature(°C) | a | 25±2 | b | Lower temperature±3°C | c | 25±2 | d | Upper Temperature±2°C | e | 25±2 | <p>Class I:<br/>Δ C/C: ±30ppm</p> <p>Class II:<br/>X7R: Δ C/C: ±15%</p> |
| Step                       | Temperature(°C)       |                                                                                                                                                                                                                                                                                                                                                                                                                                                   |              |                 |   |      |   |                       |   |      |   |                       |   |      |                                                                         |
| a                          | 25±2                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                   |              |                 |   |      |   |                       |   |      |   |                       |   |      |                                                                         |
| b                          | Lower temperature±3°C |                                                                                                                                                                                                                                                                                                                                                                                                                                                   |              |                 |   |      |   |                       |   |      |   |                       |   |      |                                                                         |
| c                          | 25±2                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                   |              |                 |   |      |   |                       |   |      |   |                       |   |      |                                                                         |
| d                          | Upper Temperature±2°C |                                                                                                                                                                                                                                                                                                                                                                                                                                                   |              |                 |   |      |   |                       |   |      |   |                       |   |      |                                                                         |
| e                          | 25±2                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                   |              |                 |   |      |   |                       |   |      |   |                       |   |      |                                                                         |

(1) Class I

Temperature Coefficient shall be calculated from the formula as below

Temp, Coefficient =  $\frac{C_2-C_1}{C_1 \times \Delta T} \times 10^6$  [ppm/°C]

C1: Capacitance at step c

C2: Capacitance at 125°C

ΔT: 100°C (=125°C-25°C)

(2) Class II

Capacitance Change shall be calculated from the formula as below

ΔC =  $\frac{C_2-C_1}{C_1} \times 100\%$

C1: Capacitance at step c

C2: Capacitance at step b or d

| TEST                         | TEST METHOD          | PROCEDURE                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | REQUIREMENTS                                                                                                                                                                                                                                                                                              |
|------------------------------|----------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Adhesion                     | 4.7                  | A force applied for 10 seconds to the line joining the terminations and in a plane parallel to the substrate                                                                                                                                                                                                                                                                                                                                                                                                                         | Force<br>size $\geq$ 0603: 5N<br>size = 0402: 2.5N<br>size = 0201: 1N                                                                                                                                                                                                                                     |
| Bending Strength             | 4.8                  | Mounting in accordance with IEC 60384-22 paragraph 4.3<br><br>Conditions: bending at a rate of 1 mm/s, radius jig 5 mm<br>NPO: 5 mm<br>X7R/0402 to 0603: 5 mm<br>X7R/0805 to 1812: 3 mm                                                                                                                                                                                                                                                                                                                                              | No visible damage<br><br>$\Delta C/C$<br>Class I:<br>NPO: within $\pm 1\%$ or 0.5 pF, whichever is greater<br>Class II:<br>X7R: $\pm 10\%$                                                                                                                                                                |
| Resistance to Soldering Heat | 4.9                  | Precondition: 150 $\pm 0/-10$ °C for 1 hour, then keep for 24 $\pm 1$ hours at room temperature<br><br>Preheating: for size $\leq$ 1206: 120 °C to 150 °C for 1 minute<br><br>Preheating: for size $>$ 1206: 100 °C to 120 °C for 1 minute and 170 °C to 200 °C for 1 minute<br>Solder bath temperature: 260 $\pm 5$ °C<br>Dipping time: 10 $\pm 0.5$ seconds<br>Recovery time: 24 $\pm 2$ hours                                                                                                                                     | Dissolution of the end face plating shall not exceed 25% of the length of the edge concerned<br><br>$\Delta C/C$<br>Class I:<br>NPO: within $\pm 0.5\%$ or 0.5 pF, whichever is greater<br>Class II:<br>X7R: $\pm 10\%$<br><br>D.F. within initial specified value<br>I.R. within initial specified value |
| Solderability                | IEC 60384-21/22 4.10 | Preheated the temperature of 80 °C to 140 °C and maintained for 30 seconds to 60 seconds.<br><br>Test conditions for lead containing solder alloy<br>Temperature: 235 $\pm 5$ °C<br>Dipping time: 2 $\pm 0.2$ seconds<br>Depth of immersion: 10 mm<br>Alloy Composition: 60/40 Sn/Pb<br>Number of immersions: 1<br><br>Test conditions for leadfree containing solder alloy<br>Temperature: 245 $\pm 5$ °C<br>Dipping time: 3 $\pm 0.3$ seconds<br>Depth of immersion: 10 mm<br>Alloy Composition: SAC305<br>Number of immersions: 1 | The solder should cover over 95% of the critical area of each termination                                                                                                                                                                                                                                 |

| TEST                        | TEST METHOD          | PROCEDURE                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | REQUIREMENTS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|-----------------------------|----------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Rapid Change of Temperature | 4.11                 | <p>Preconditioning:<br/>150 +0/-10 °C for 1 hour, then keep for 24 ± 1 hours at room temperature</p> <p>5 cycles with following detail:<br/>30 minutes at lower category temperature<br/>30 minutes at upper category temperature</p> <p>Recovery time 24 ± 2 hours</p>                                                                                                                                                                                                                                                                                                                                              | <p>No visual damage</p> <hr/> <p><math>\Delta C/C</math></p> <p>Class I:<br/>NP0: within ±1% or 1 pF, whichever is greater</p> <p>Class II:<br/>X7R: ±15%</p> <hr/> <p>D.F. meet initial specified value<br/>I.R. meet initial specified value</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Damp Heat with $U_r$ Load   | IEC 60384-21/22 4.13 | <p>1. Preconditioning, class II only:<br/>150 +0/-10 °C / 1 hour, then keep for 24 ± 1 hour at room temp</p> <p>2. Initial measure:<br/>Spec: refer initial spec C, D, I.R.</p> <p>3. Damp heat test:<br/>500 ± 12 hours at 40 ± 2 °C;<br/>90 to 95% R.H. 1.0 <math>U_r</math> applied</p> <p>4. Recovery:<br/>Class 2: 24 ± 2 hours</p> <p>5. Final measure: C, D, I.R.</p> <p>P.S. If the capacitance value is less than the minimum value permitted, then after the other measurements have been made the capacitor shall be precondition according to "IEC 60384 4.1" and then the requirement shall be met.</p> | <p>No visual damage after recovery</p> <hr/> <p><math>\Delta C/C</math></p> <p>Class I:<br/>NP0: within ±2% or 1 pF, whichever is greater</p> <p>Class II:<br/>X7R: ±15%</p> <hr/> <p>D.F.<br/>Class I:<br/>NP0: ≤ 2 × specified value</p> <p>Class II:<br/>X7R: ≤ 2 × specified value</p> <hr/> <p>I.R.<br/>Class I:<br/>NP0: ≥ 2,500 MΩ or<br/><math>R \times C \geq 25 \Omega \cdot F</math> whichever is less</p> <p>Class II:<br/>X7R: ≥ 500 MΩ or<br/><math>R \times C \geq 25 \Omega \cdot F</math> whichever is less</p> <hr/> <p>X7R/0603/1 μF/16V to 25V<br/>X7R/0805/4.7 μF/16V<br/>X7R/1206/10 μF/16V to 25V<br/>X7R/1210/2.2 μF/16V to 50V<br/>X7R/1210/2.2 μF/100V</p> <p><math>\Delta C/C</math><br/>±20%<br/>D.F.<br/>≤ 2 × specified value<br/>I.R.<br/><math>R \times C \geq 5 \Omega \cdot F</math></p> |

| TEST          | TEST METHOD     | PROCEDURE | REQUIREMENTS                                                                                                                                                                                                                     |                                                    |
|---------------|-----------------|-----------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------|
| Endurance     | IEC 60384-21/22 | 4.14      | 1. Preconditioning, class II only: 150 +0/-10 °C /1 hour, then keep for 24 ±1 hour at room temp                                                                                                                                  | No visual damage                                   |
|               |                 |           | 2. Initial measure: Spec: refer initial spec C, D, I.R.                                                                                                                                                                          | ΔC/C                                               |
|               |                 |           | 3. Endurance test: Temperature: NPO/X7R: 125 °C Specified stress voltage applied for 1,000 hours:                                                                                                                                | Class I:                                           |
|               |                 |           | 4. High voltage series follows with below stress condition:                                                                                                                                                                      | NPO: within ±2% or 1 pF, whichever is greater      |
|               |                 |           |                                                                                                                                                                                                                                  | Class II:                                          |
|               |                 |           |                                                                                                                                                                                                                                  | X7R: ±15%                                          |
|               |                 |           |                                                                                                                                                                                                                                  | D.F.                                               |
|               |                 |           |                                                                                                                                                                                                                                  | Class I:                                           |
|               |                 |           |                                                                                                                                                                                                                                  | NPO: ≤ 2 × specified value                         |
|               |                 |           |                                                                                                                                                                                                                                  | Class II:                                          |
|               |                 |           |                                                                                                                                                                                                                                  | X7R: ≤ 2 × specified value                         |
|               |                 |           | 5. Recovery time: 24 ±2 hours                                                                                                                                                                                                    | I.R.                                               |
|               |                 |           | 6. Final measure: C, D, I.R.                                                                                                                                                                                                     | Class I:                                           |
|               |                 |           | P.S. If the capacitance value is less than the minimum value permitted, then after the other measurements have been made the capacitor shall be precondition according to "IEC 60384 4.1" and then the requirement shall be met. | NPO: ≥ 4,000 MΩ or R × C ≥ 40Ω.F whichever is less |
|               |                 |           |                                                                                                                                                                                                                                  | Class II:                                          |
|               |                 |           |                                                                                                                                                                                                                                  | X7R: ≥ 1,000 MΩ or R × C ≥ 50Ω.F whichever is less |
|               |                 |           | * Apply 1.5 × Ur for below items                                                                                                                                                                                                 | ΔC/C                                               |
|               |                 |           | X7R/0603/1uF/16V to 25V                                                                                                                                                                                                          | ±20%                                               |
|               |                 |           | X7R/0805/4.7μF/16V                                                                                                                                                                                                               | D.F.                                               |
|               |                 |           | X7R/1206/10μF/16V to 25V                                                                                                                                                                                                         | ≤ 2 × specified value                              |
|               |                 |           | X7R/1210/2.2μF to 10μF/16V to 50V                                                                                                                                                                                                | I.R.                                               |
|               |                 |           | X7R/1210/2.2μF/100V                                                                                                                                                                                                              | R × C ≥ 10 Ω.F                                     |
| Voltage Proof | IEC 60384-1     | 4.6       | Specified stress voltage applied for 1~5 seconds                                                                                                                                                                                 | No breakdown or flashover                          |
|               |                 |           | Ur ≤ 100 V: series applied 2.5 Ur                                                                                                                                                                                                |                                                    |
|               |                 |           | 100 V < Ur ≤ 200 V series applied (1.5 Ur + 100)                                                                                                                                                                                 |                                                    |
|               |                 |           | 200 V < Ur ≤ 500 V series applied (1.3 Ur + 100)                                                                                                                                                                                 |                                                    |
|               |                 |           | Ur > 500 V: 1.3 Ur                                                                                                                                                                                                               |                                                    |
|               |                 |           | Ur ≥ 1000 V: 1.2 Ur                                                                                                                                                                                                              |                                                    |
|               |                 |           | Charge/Discharge current is less than 50 mA                                                                                                                                                                                      |                                                    |

REVISION HISTORY

| REVISION  | DATE          | CHANGE<br>NOTIFICATION | DESCRIPTION                                                                    |
|-----------|---------------|------------------------|--------------------------------------------------------------------------------|
| Version 8 | Mar. 25, 2021 | -                      | - Modify X7R, 1206, 330nF to 470nF, 100V thickness to 1.6+/-0.2mm              |
| Version 7 | Oct. 05, 2020 | -                      | - Add X7R, 0603, 1uF, 25V and modify X7R, 1210, 2.2uF, 100V thickness to 2.5mm |
| Version 6 | Feb. 18, 2020 | -                      | - Modify X7R, 1206, 22nF, 500V thickness to 1.6mm                              |
| Version 5 | May 23, 2019  | -                      | - Product range changed                                                        |
| Version 4 | Jun.19, 2017  | -                      | - Product range updated                                                        |
| Version 3 | Jan. 26, 2017 | -                      | - Global part number coding rule update                                        |
| Version 2 | Dec. 30, 2016 | -                      | - Dimension updated                                                            |
| Version 1 | Dec. 16, 2016 | -                      | - Product range updated                                                        |
| Version 0 | May 20, 2016  | -                      | - New datasheet for soft termination NPO & X7R series with RoHS compliant      |