

# DATA SHEET

## SURFACE MOUNT MULTILAYER CERAMIC CAPACITORS

Automotive grade

NP0/X7R

6.3 V TO 630 V

0.2 pF to 2.2  $\mu$ F

RoHS compliant & Halogen Free



SCOPE

This specification describes Automotive grade NP0/X7R series chip capacitors with lead-free terminations and used for automotive equipments.

APPLICATIONS

All general purpose applications  
Entertainment applications  
Comfort / security applications  
Information applications

FEATURES

- AEC-Q200 qualified
- MSL class: MSL I
- AC series soldering is compliant with J-STD-020D
- Halogen free epoxy
- RoHS compliant
- Reduce environmentally hazardous waste
- High component and equipment reliability
- Save PCB space
- The capacitors are 100% performed by automatic optical inspection prior to taping.

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.

**GLOBAL PART NUMBER**

**AC XXXX X X XXX X **B** X XXX**  
(1) (2) (3) (4) (5) (6) (7)

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**(1) SIZE – INCH BASED (METRIC)**

0201 (0603) / 0402 (1005) / 0603 (1608) / 0805 (2012) / 1206 (3216) / 1210 (3225) / 0508 (1220) / 0612 (1632)

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**(2) TOLERANCE**

B = ±0.1 pF  
C = ±0.25 pF  
D = ±0.5 pF  
F = ±1%  
G = ±2%  
J = ±5%  
K = ±10%  
M = ±20%

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**(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

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**(4) TC MATERIAL**

NPO  
X7R

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**(5) RATED VOLTAGE**

5 = 6.3 V  
6 = 10 V  
7 = 16 V  
8 = 25 V  
9 = 50 V  
0 = 100 V  
A = 200 V  
Y = 250 V  
B = 500 V  
Z = 630 V

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**(6) PROCESS**

N = NPO  
B = Class 2 MLCC

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**(7) CAPACITANCE VALUE**

2 significant digits+number of zeros  
The 3rd digit signifies the multiplying factor, and letter R is decimal point  
Example: 121 = 12 × 10<sup>1</sup> = 120 pF

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**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 terminations and finally covered with a layer of plated tin (Matte Sn). The terminations are lead-free. A cross section of the structure is shown in Fig.1.



**DIMENSION**

Table 1 For outlines see fig. 2

| TYPE | L <sub>1</sub> (mm) | W (mm)     | T (MM)                    | L <sub>2</sub> / L <sub>3</sub> (mm) |      | L <sub>4</sub> (mm) |
|------|---------------------|------------|---------------------------|--------------------------------------|------|---------------------|
|      |                     |            |                           | min.                                 | max. | min.                |
| 0201 | 0.6 ±0.03           | 0.3 ±0.03  | Refer to<br>table 3 to 12 | 0.10                                 | 0.20 | 0.20                |
| 0402 | 1.0 ±0.05           | 0.5 ±0.05  |                           | 0.15                                 | 0.30 | 0.40                |
| 0603 | 1.6 ±0.10           | 0.8 ±0.10  |                           | 0.20                                 | 0.60 | 0.40                |
| 0805 | 2.0 ±0.20           | 1.25 ±0.20 |                           | 0.25                                 | 0.75 | 0.70                |
| 1206 | 3.2 ±0.30           | 1.6 ±0.20  |                           | 0.25                                 | 0.75 | 1.40                |
| 1210 | 3.2 ±0.30           | 2.5 ±0.20  |                           | 0.25                                 | 0.75 | 1.40                |
| 1812 | 4.5±0.40            | 3.2±0.40   |                           | 0.25                                 | 0.75 | 2.20                |

**OUTLINES**



**OUTLINES**

Table 2 For outlines see fig. 3

| TYPE                   | 0508<br>(4 X 0402) | 0612<br>(4 X 0603) |
|------------------------|--------------------|--------------------|
| L (mm)                 | 2.0 ±0.15          | 3.2 ±0.15          |
| W (mm)                 | 1.25 ±0.15         | 1.60 ±0.15         |
| T <sub>min.</sub> (mm) | 0.50               | 0.70               |
| T <sub>max.</sub> (mm) | 0.70               | 0.90               |
| A (mm)                 | 0.28 ±0.10         | 0.4 ±0.10          |
| B (mm)                 | 0.2 ±0.10          | 0.3 ±0.20          |
| P (mm)                 | 0.5 ±0.10          | 0.8 ±0.10          |



**CAPACITANCE RANGE & THICKNESS FOR NP0**

Table 3 Sizes from 0201 to 0805

| CAP.    | 0201        |          | 0603    |         |         | 0805    |         |         |
|---------|-------------|----------|---------|---------|---------|---------|---------|---------|
|         | 25 V / 50 V | 50 V     | 50 V    | 100 V   | 250 V   | 50 V    | 100 V   | 250V    |
| 0.2 pF  | 0.3±0.03    |          |         |         |         |         |         |         |
| 0.47 pF | 0.3±0.03    | 0.5±0.05 | 0.8±0.1 | 0.8±0.1 | 0.8±0.1 | 0.6±0.1 | 0.6±0.1 | 0.6±0.1 |
| 0.56 pF | 0.3±0.03    | 0.5±0.05 | 0.8±0.1 | 0.8±0.1 | 0.8±0.1 | 0.6±0.1 | 0.6±0.1 | 0.6±0.1 |
| 0.68 pF | 0.3±0.03    | 0.5±0.05 | 0.8±0.1 | 0.8±0.1 | 0.8±0.1 | 0.6±0.1 | 0.6±0.1 | 0.6±0.1 |
| 0.82 pF | 0.3±0.03    | 0.5±0.05 | 0.8±0.1 | 0.8±0.1 | 0.8±0.1 | 0.6±0.1 | 0.6±0.1 | 0.6±0.1 |
| 1.0 pF  | 0.3±0.03    | 0.5±0.05 | 0.8±0.1 | 0.8±0.1 | 0.8±0.1 | 0.6±0.1 | 0.6±0.1 | 0.6±0.1 |
| 1.2 pF  | 0.3±0.03    | 0.5±0.05 | 0.8±0.1 | 0.8±0.1 | 0.8±0.1 | 0.6±0.1 | 0.6±0.1 | 0.6±0.1 |
| 1.5 pF  | 0.3±0.03    | 0.5±0.05 | 0.8±0.1 | 0.8±0.1 | 0.8±0.1 | 0.6±0.1 | 0.6±0.1 | 0.6±0.1 |
| 1.8 pF  | 0.3±0.03    | 0.5±0.05 | 0.8±0.1 | 0.8±0.1 | 0.8±0.1 | 0.6±0.1 | 0.6±0.1 | 0.6±0.1 |
| 2.2 pF  | 0.3±0.03    | 0.5±0.05 | 0.8±0.1 | 0.8±0.1 | 0.8±0.1 | 0.6±0.1 | 0.6±0.1 | 0.6±0.1 |
| 2.7 pF  | 0.3±0.03    | 0.5±0.05 | 0.8±0.1 | 0.8±0.1 | 0.8±0.1 | 0.6±0.1 | 0.6±0.1 | 0.6±0.1 |
| 3.3 pF  | 0.3±0.03    | 0.5±0.05 | 0.8±0.1 | 0.8±0.1 | 0.8±0.1 | 0.6±0.1 | 0.6±0.1 | 0.6±0.1 |
| 3.9 pF  | 0.3±0.03    | 0.5±0.05 | 0.8±0.1 | 0.8±0.1 | 0.8±0.1 | 0.6±0.1 | 0.6±0.1 | 0.6±0.1 |
| 4.7 pF  | 0.3±0.03    | 0.5±0.05 | 0.8±0.1 | 0.8±0.1 | 0.8±0.1 | 0.6±0.1 | 0.6±0.1 | 0.6±0.1 |
| 5.6 pF  | 0.3±0.03    | 0.5±0.05 | 0.8±0.1 | 0.8±0.1 | 0.8±0.1 | 0.6±0.1 | 0.6±0.1 | 0.6±0.1 |
| 6.8 pF  | 0.3±0.03    | 0.5±0.05 | 0.8±0.1 | 0.8±0.1 | 0.8±0.1 | 0.6±0.1 | 0.6±0.1 | 0.6±0.1 |
| 8.2 pF  | 0.3±0.03    | 0.5±0.05 | 0.8±0.1 | 0.8±0.1 | 0.8±0.1 | 0.6±0.1 | 0.6±0.1 | 0.6±0.1 |
| 10 pF   | 0.3±0.03    | 0.5±0.05 | 0.8±0.1 | 0.8±0.1 | 0.8±0.1 | 0.6±0.1 | 0.6±0.1 | 0.6±0.1 |
| 12 pF   | 0.3±0.03    | 0.5±0.05 | 0.8±0.1 | 0.8±0.1 | 0.8±0.1 | 0.6±0.1 | 0.6±0.1 | 0.6±0.1 |
| 15 pF   | 0.3±0.03    | 0.5±0.05 | 0.8±0.1 | 0.8±0.1 | 0.8±0.1 | 0.6±0.1 | 0.6±0.1 | 0.6±0.1 |
| 18 pF   | 0.3±0.03    | 0.5±0.05 | 0.8±0.1 | 0.8±0.1 | 0.8±0.1 | 0.6±0.1 | 0.6±0.1 | 0.6±0.1 |
| 22 pF   | 0.3±0.03    | 0.5±0.05 | 0.8±0.1 | 0.8±0.1 | 0.8±0.1 | 0.6±0.1 | 0.6±0.1 | 0.6±0.1 |
| 27 pF   | 0.3±0.03    | 0.5±0.05 | 0.8±0.1 | 0.8±0.1 | 0.8±0.1 | 0.6±0.1 | 0.6±0.1 | 0.6±0.1 |
| 33 pF   | 0.3±0.03    | 0.5±0.05 | 0.8±0.1 | 0.8±0.1 | 0.8±0.1 | 0.6±0.1 | 0.6±0.1 | 0.6±0.1 |
| 39 pF   |             | 0.5±0.05 | 0.8±0.1 | 0.8±0.1 | 0.8±0.1 | 0.6±0.1 | 0.6±0.1 | 0.6±0.1 |
| 47 pF   |             | 0.5±0.05 | 0.8±0.1 | 0.8±0.1 | 0.8±0.1 | 0.6±0.1 | 0.6±0.1 | 0.6±0.1 |
| 56 pF   |             | 0.5±0.05 | 0.8±0.1 | 0.8±0.1 | 0.8±0.1 | 0.6±0.1 | 0.6±0.1 | 0.6±0.1 |
| 68 pF   |             | 0.5±0.05 | 0.8±0.1 | 0.8±0.1 | 0.8±0.1 | 0.6±0.1 | 0.6±0.1 | 0.6±0.1 |
| 82 pF   |             | 0.5±0.05 | 0.8±0.1 | 0.8±0.1 | 0.8±0.1 | 0.6±0.1 | 0.6±0.1 | 0.6±0.1 |
| 100 pF  |             | 0.5±0.05 | 0.8±0.1 | 0.8±0.1 | 0.8±0.1 | 0.6±0.1 | 0.6±0.1 | 0.6±0.1 |

**NOTE**

1. Values in shaded cells indicate thickness class in mm
2. Capacitance value of non E-12 series is on request

**CAPACITANCE RANGE & THICKNESS FOR NPO**

**Table 4** Sizes from 0402 to 0805 (continued)

| CAP.   | 0402     |         | 0603    |         | 0805     |          |          |
|--------|----------|---------|---------|---------|----------|----------|----------|
|        | 50 V     | 50 V    | 100 V   | 250 V   | 50 V     | 100 V    | 250 V    |
| 120 pF | 0.5±0.05 | 0.8±0.1 | 0.8±0.1 | 0.8±0.1 | 0.6±0.1  | 0.6±0.1  | 0.6±0.1  |
| 150 pF | 0.5±0.05 | 0.8±0.1 | 0.8±0.1 | 0.8±0.1 | 0.6±0.1  | 0.6±0.1  | 0.6±0.1  |
| 180 pF | 0.5±0.05 | 0.8±0.1 | 0.8±0.1 | 0.8±0.1 | 0.6±0.1  | 0.6±0.1  | 0.6±0.1  |
| 220 pF | 0.5±0.05 | 0.8±0.1 | 0.8±0.1 | 0.8±0.1 | 0.6±0.1  | 0.6±0.1  | 0.85±0.1 |
| 270 pF | 0.5±0.05 | 0.8±0.1 | 0.8±0.1 | 0.8±0.1 | 0.6±0.1  | 0.6±0.1  | 0.85±0.1 |
| 330 pF | 0.5±0.05 | 0.8±0.1 | 0.8±0.1 | 0.8±0.1 | 0.6±0.1  | 0.6±0.1  | 0.85±0.1 |
| 390 pF | 0.5±0.05 | 0.8±0.1 | 0.8±0.1 | 0.8±0.1 | 0.6±0.1  | 0.6±0.1  | 0.85±0.1 |
| 470 pF | 0.5±0.05 | 0.8±0.1 | 0.8±0.1 | 0.8±0.1 | 0.6±0.1  | 0.6±0.1  | 0.85±0.1 |
| 560 pF | 0.5±0.05 | 0.8±0.1 | 0.8±0.1 | 0.8±0.1 | 0.6±0.1  | 0.85±0.1 | 0.85±0.1 |
| 680 pF | 0.5±0.05 | 0.8±0.1 | 0.8±0.1 | 0.8±0.1 | 0.6±0.1  | 0.85±0.1 | 0.85±0.1 |
| 820 pF | 0.5±0.05 | 0.8±0.1 | 0.8±0.1 |         | 0.6±0.1  | 0.85±0.1 | 0.85±0.1 |
| 1.0 nF | 0.5±0.05 | 0.8±0.1 | 0.8±0.1 |         | 0.6±0.1  | 0.85±0.1 | 0.85±0.1 |
| 1.2 nF |          |         |         |         | 0.85±0.1 | 0.85±0.1 |          |
| 1.5 nF |          |         |         |         | 0.85±0.1 | 0.85±0.1 |          |
| 1.8 nF |          |         |         |         | 0.85±0.1 | 0.85±0.1 |          |
| 2.2 nF |          |         |         |         | 1.25±0.2 | 1.25±0.2 |          |
| 2.7 nF |          |         |         |         | 1.25±0.2 | 1.25±0.2 |          |
| 3.3 nF |          |         |         |         | 1.25±0.2 | 1.25±0.2 |          |
| 3.9 nF |          |         |         |         | 1.25±0.2 | 1.25±0.2 |          |
| 4.7 nF |          |         |         |         | 1.25±0.2 | 1.25±0.2 |          |
| 5.6 nF |          |         |         |         | 1.25±0.2 | 1.25±0.2 |          |
| 6.8 nF |          |         |         |         | 1.25±0.2 | 1.25±0.2 |          |
| 8.2 nF |          |         |         |         | 1.25±0.2 | 1.25±0.2 |          |
| 10 nF  |          |         |         |         | 1.25±0.2 | 1.25±0.2 |          |

**NOTE**

1. Values in shaded cells indicate thickness class in mm
2. Capacitance value of non E-12 series is on request

**CAPACITANCE RANGE & THICKNESS FOR NP0**

**Table 5** Sizes from 1206 to 1210

| CAP.   | 1206    |         |          |          |          | 1210     |          |          |          |
|--------|---------|---------|----------|----------|----------|----------|----------|----------|----------|
|        | 50 V    | 100 V   | 250 V    | 500 V    | 630 V    | 50 V     | 100 V    | 250 V    | 500 V    |
| 10 pF  | 0.6±0.1 | 0.6±0.1 | 0.6±0.1  | 0.6±0.1  | 1.25±0.2 |          |          |          |          |
| 12 pF  | 0.6±0.1 | 0.6±0.1 | 0.6±0.1  | 0.6±0.1  | 1.25±0.2 |          |          |          |          |
| 15 pF  | 0.6±0.1 | 0.6±0.1 | 0.6±0.1  | 0.6±0.1  | 1.25±0.2 |          |          |          |          |
| 18 pF  | 0.6±0.1 | 0.6±0.1 | 0.6±0.1  | 0.6±0.1  | 1.25±0.2 |          |          |          |          |
| 22 pF  | 0.6±0.1 | 0.6±0.1 | 0.6±0.1  | 0.6±0.1  | 1.25±0.2 |          |          |          |          |
| 27 pF  | 0.6±0.1 | 0.6±0.1 | 0.6±0.1  | 0.6±0.1  | 1.25±0.2 |          |          |          |          |
| 33 pF  | 0.6±0.1 | 0.6±0.1 | 0.6±0.1  | 0.6±0.1  | 1.25±0.2 |          |          |          |          |
| 39 pF  | 0.6±0.1 | 0.6±0.1 | 0.6±0.1  | 0.6±0.1  | 1.25±0.2 |          |          |          |          |
| 47 pF  | 0.6±0.1 | 0.6±0.1 | 0.6±0.1  | 0.6±0.1  | 1.25±0.2 |          |          |          |          |
| 56 pF  | 0.6±0.1 | 0.6±0.1 | 0.6±0.1  | 0.6±0.1  | 1.25±0.2 |          |          |          |          |
| 68 pF  | 0.6±0.1 | 0.6±0.1 | 0.6±0.1  | 0.6±0.1  | 1.25±0.2 |          |          |          |          |
| 82 pF  | 0.6±0.1 | 0.6±0.1 | 0.6±0.1  | 0.6±0.1  | 1.25±0.2 |          |          |          |          |
| 100 pF | 0.6±0.1 | 0.6±0.1 | 0.6±0.1  | 0.6±0.1  | 1.25±0.2 |          |          |          |          |
| 120 pF | 0.6±0.1 | 0.6±0.1 | 0.6±0.1  | 0.6±0.1  | 1.25±0.2 |          |          |          |          |
| 150 pF | 0.6±0.1 | 0.6±0.1 | 0.6±0.1  | 0.6±0.1  | 1.25±0.2 |          |          |          |          |
| 180 pF | 0.6±0.1 | 0.6±0.1 | 0.6±0.1  | 0.6±0.1  | 1.25±0.2 |          |          |          |          |
| 220 pF | 0.6±0.1 | 0.6±0.1 | 0.6±0.1  | 0.6±0.1  | 1.25±0.2 |          |          |          |          |
| 270 pF | 0.6±0.1 | 0.6±0.1 | 0.6±0.1  | 0.6±0.1  | 1.25±0.2 |          |          |          |          |
| 330 pF | 0.6±0.1 | 0.6±0.1 | 0.6±0.1  | 0.6±0.1  | 1.25±0.2 |          |          |          |          |
| 390 pF | 0.6±0.1 | 0.6±0.1 | 0.6±0.1  | 0.6±0.1  | 1.25±0.2 |          |          |          |          |
| 470 pF | 0.6±0.1 | 0.6±0.1 | 0.6±0.1  | 0.6±0.1  | 1.25±0.2 |          |          |          |          |
| 560 pF | 0.6±0.1 | 0.6±0.1 | 0.6±0.1  | 0.6±0.1  | 1.25±0.2 |          |          |          |          |
| 680 pF | 0.6±0.1 | 0.6±0.1 | 0.6±0.1  | 0.6±0.1  | 1.25±0.2 |          |          |          |          |
| 820 pF | 0.6±0.1 | 0.6±0.1 | 0.85±0.1 | 0.85±0.1 | 1.25±0.2 |          |          |          |          |
| 1.0 nF | 0.6±0.1 | 0.6±0.1 | 0.85±0.1 | 0.85±0.1 | 1.25±0.2 | 1.25±0.2 | 1.25±0.2 | 1.25±0.2 | 1.25±0.2 |
| 1.2 nF | 0.6±0.1 | 0.6±0.1 | 0.85±0.1 |          |          | 1.25±0.2 | 1.25±0.2 | 1.25±0.2 | 1.25±0.2 |
| 1.5 nF | 0.6±0.1 | 0.6±0.1 | 0.85±0.1 |          |          | 1.25±0.2 | 1.25±0.2 | 1.25±0.2 | 1.25±0.2 |
| 1.8 nF | 0.6±0.1 | 0.6±0.1 |          |          |          | 1.25±0.2 | 1.25±0.2 | 1.25±0.2 | 1.25±0.2 |
| 2.2 nF | 0.6±0.1 | 0.6±0.1 |          |          |          | 1.25±0.2 | 1.25±0.2 | 1.25±0.2 |          |
| 2.7 nF | 0.6±0.1 | 0.6±0.1 |          |          |          | 1.25±0.2 | 1.25±0.2 | 1.25±0.2 |          |

**NOTE**

1. Values in shaded cells indicate thickness class in mm
2. Capacitance value of non E-12 series is on request

**CAPACITANCE RANGE & THICKNESS FOR X7R**

**Table 6** Sizes from 0201 to 0603

| CAP.   | 0201     |          | 0402     |          |          |          | 0603     |         |         |         |         |         |
|--------|----------|----------|----------|----------|----------|----------|----------|---------|---------|---------|---------|---------|
|        | 25V      | 50 V     | 10V      | 16 V     | 25 V     | 50 V     | 100 V    | 10V     | 16 V    | 25 V    | 50 V    | 100 V   |
| 100 pF | 0.3±0.03 | 0.3±0.03 |          |          |          |          |          |         |         |         |         |         |
| 150 pF | 0.3±0.03 | 0.3±0.03 |          |          |          |          |          |         |         |         |         |         |
| 220 pF | 0.3±0.03 | 0.3±0.03 | 0.5±0.05 | 0.5±0.05 | 0.5±0.05 | 0.5±0.05 | 0.5±0.05 |         |         |         |         |         |
| 330 pF | 0.3±0.03 | 0.3±0.03 | 0.5±0.05 | 0.5±0.05 | 0.5±0.05 | 0.5±0.05 | 0.5±0.05 |         |         |         |         |         |
| 470 pF | 0.3±0.03 | 0.3±0.03 | 0.5±0.05 | 0.5±0.05 | 0.5±0.05 | 0.5±0.05 | 0.5±0.05 |         |         |         |         |         |
| 680 pF | 0.3±0.03 | 0.3±0.03 | 0.5±0.05 | 0.5±0.05 | 0.5±0.05 | 0.5±0.05 | 0.5±0.05 |         |         |         |         |         |
| 1.0 nF | 0.3±0.03 | 0.3±0.03 | 0.5±0.05 | 0.5±0.05 | 0.5±0.05 | 0.5±0.05 | 0.5±0.05 | 0.8±0.1 | 0.8±0.1 | 0.8±0.1 | 0.8±0.1 | 0.8±0.1 |
| 1.5 nF | 0.3±0.03 |          | 0.5±0.05 | 0.5±0.05 | 0.5±0.05 | 0.5±0.05 | 0.5±0.05 | 0.8±0.1 | 0.8±0.1 | 0.8±0.1 | 0.8±0.1 | 0.8±0.1 |
| 2.2 nF | 0.3±0.03 |          | 0.5±0.05 | 0.5±0.05 | 0.5±0.05 | 0.5±0.05 |          | 0.8±0.1 | 0.8±0.1 | 0.8±0.1 | 0.8±0.1 | 0.8±0.1 |
| 3.3 nF | 0.3±0.03 |          | 0.5±0.05 | 0.5±0.05 | 0.5±0.05 | 0.5±0.05 |          | 0.8±0.1 | 0.8±0.1 | 0.8±0.1 | 0.8±0.1 | 0.8±0.1 |
| 4.7 nF | 0.3±0.03 |          | 0.5±0.05 | 0.5±0.05 | 0.5±0.05 | 0.5±0.05 |          | 0.8±0.1 | 0.8±0.1 | 0.8±0.1 | 0.8±0.1 | 0.8±0.1 |
| 6.8 nF | 0.3±0.03 |          | 0.5±0.05 | 0.5±0.05 | 0.5±0.05 | 0.5±0.05 |          | 0.8±0.1 | 0.8±0.1 | 0.8±0.1 | 0.8±0.1 | 0.8±0.1 |
| 10 nF  | 0.3±0.03 |          | 0.5±0.05 | 0.5±0.05 | 0.5±0.05 | 0.5±0.05 |          | 0.8±0.1 | 0.8±0.1 | 0.8±0.1 | 0.8±0.1 | 0.8±0.1 |
| 15 nF  |          |          | 0.5±0.05 | 0.5±0.05 | 0.5±0.05 |          |          | 0.8±0.1 | 0.8±0.1 | 0.8±0.1 | 0.8±0.1 | 0.8±0.1 |
| 22 nF  |          |          | 0.5±0.05 | 0.5±0.05 | 0.5±0.05 |          |          | 0.8±0.1 | 0.8±0.1 | 0.8±0.1 | 0.8±0.1 | 0.8±0.1 |
| 33 nF  |          |          | 0.5±0.05 | 0.5±0.05 | 0.5±0.05 |          |          | 0.8±0.1 | 0.8±0.1 | 0.8±0.1 | 0.8±0.1 | 0.8±0.1 |
| 47 nF  |          |          | 0.5±0.05 | 0.5±0.05 | 0.5±0.05 |          |          | 0.8±0.1 | 0.8±0.1 | 0.8±0.1 | 0.8±0.1 | 0.8±0.1 |
| 68 nF  |          |          | 0.5±0.05 | 0.5±0.05 | 0.5±0.05 |          |          | 0.8±0.1 | 0.8±0.1 | 0.8±0.1 | 0.8±0.1 |         |
| 100 nF |          |          | 0.5±0.05 | 0.5±0.05 | 0.5±0.05 |          |          | 0.8±0.1 | 0.8±0.1 | 0.8±0.1 | 0.8±0.1 |         |
| 150 nF |          |          |          |          |          |          |          | 0.8±0.1 | 0.8±0.1 | 0.8±0.1 |         |         |
| 220 nF |          |          |          |          |          |          |          | 0.8±0.1 | 0.8±0.1 | 0.8±0.1 |         |         |
| 330 nF |          |          |          |          |          |          |          | 0.8±0.1 | 0.8±0.1 |         |         |         |
| 470 nF |          |          |          |          |          |          |          | 0.8±0.1 | 0.8±0.1 |         |         |         |
| 680 nF |          |          |          |          |          |          |          | 0.8±0.1 | 0.8±0.1 |         |         |         |
| 1 μF   |          |          |          |          |          |          |          | 0.8±0.1 | 0.8±0.1 | 0.8±0.1 |         |         |

**NOTE**

1. Values in shaded cells indicate thickness class in mm
2. Capacitance value of non E-6 series is on request

**CAPACITANCE RANGE & THICKNESS FOR X7R**

**Table 8** Size 0805

| CAP.   | 0805     |          |          |          |          |          |          |
|--------|----------|----------|----------|----------|----------|----------|----------|
|        | 10 V     | 16 V     | 25 V     | 50 V     | 100 V    | 250 V    | 500 V    |
| 1.0 nF | 0.85±0.1 | 0.85±0.1 | 0.85±0.1 | 0.85±0.1 | 0.85±0.1 | 0.85±0.1 | 0.85±0.1 |
| 1.5 nF | 0.85±0.1 | 0.85±0.1 | 0.85±0.1 | 0.85±0.1 | 0.85±0.1 | 0.85±0.1 | 0.85±0.1 |
| 2.2 nF | 0.85±0.1 | 0.85±0.1 | 0.85±0.1 | 0.85±0.1 | 0.85±0.1 | 0.85±0.1 | 0.85±0.1 |
| 3.3 nF | 0.85±0.1 | 0.85±0.1 | 0.85±0.1 | 0.85±0.1 | 0.85±0.1 | 0.85±0.1 | 0.85±0.1 |
| 4.7 nF | 0.85±0.1 | 0.85±0.1 | 0.85±0.1 | 0.85±0.1 | 0.85±0.1 | 0.85±0.1 | 0.85±0.1 |
| 6.8 nF | 0.85±0.1 | 0.85±0.1 | 0.85±0.1 | 0.85±0.1 | 0.85±0.1 | 1.25±0.2 |          |
| 10 nF  | 0.85±0.1 | 0.85±0.1 | 0.85±0.1 | 0.85±0.1 | 0.85±0.1 | 1.25±0.2 |          |
| 15 nF  | 0.85±0.1 | 0.85±0.1 | 0.85±0.1 | 0.85±0.1 | 0.85±0.1 | 1.25±0.2 |          |
| 22 nF  | 0.85±0.1 | 0.85±0.1 | 0.85±0.1 | 0.85±0.1 | 0.85±0.1 | 1.25±0.2 |          |
| 33 nF  | 0.85±0.1 | 0.85±0.1 | 0.85±0.1 | 0.85±0.1 | 1.25±0.2 |          |          |
| 47 nF  | 0.85±0.1 | 0.85±0.1 | 0.85±0.1 | 0.85±0.1 | 1.25±0.2 |          |          |
| 68 nF  | 0.85±0.1 | 0.85±0.1 | 0.85±0.1 | 0.85±0.1 | 1.25±0.2 |          |          |
| 100 nF | 0.85±0.1 | 0.85±0.1 | 0.85±0.1 | 0.85±0.1 | 1.25±0.2 |          |          |
| 150 nF | 0.85±0.1 | 0.85±0.1 | 0.85±0.1 | 1.25±0.2 |          |          |          |
| 220 nF | 0.85±0.1 | 0.85±0.1 | 0.85±0.1 | 1.25±0.2 |          |          |          |
| 330 nF | 1.25±0.2 | 1.25±0.2 | 1.25±0.2 | 1.25±0.2 |          |          |          |
| 470 nF | 1.25±0.2 | 1.25±0.2 | 1.25±0.2 | 1.25±0.2 |          |          |          |
| 680 nF | 1.25±0.2 | 1.25±0.2 | 1.25±0.2 | 1.25±0.2 |          |          |          |
| 1 µF   | 1.25±0.2 | 1.25±0.2 | 1.25±0.2 | 1.25±0.2 |          |          |          |
| 2.2 µF | 1.25±0.2 | 1.25±0.2 | 1.25±0.2 |          |          |          |          |

**NOTE**

1. Values in shaded cells indicate thickness class in mm
2. Capacitance value of non E-6 series is on request



**CAPACITANCE RANGE & THICKNESS FOR X7R**

Table 9 Size 1206

| CAP.   | 1206     |          |          |          |          |          |          |
|--------|----------|----------|----------|----------|----------|----------|----------|
|        | 6.3 V    | 10V      | 16V      | 25V      | 50 V     | 100 V    | 250 V    |
| 22 nF  | 0.85±0.1 | 0.85±0.1 | 0.85±0.1 | 0.85±0.1 | 0.85±0.1 | 0.85±0.1 | 1.25±0.2 |
| 33 nF  | 0.85±0.1 | 0.85±0.1 | 0.85±0.1 | 0.85±0.1 | 0.85±0.1 | 0.85±0.1 | 1.60±0.2 |
| 47 nF  | 0.85±0.1 | 0.85±0.1 | 0.85±0.1 | 0.85±0.1 | 0.85±0.1 | 0.85±0.1 | 1.60±0.2 |
| 68 nF  | 0.85±0.1 | 0.85±0.1 | 0.85±0.1 | 0.85±0.1 | 0.85±0.1 | 1.25±0.2 | 1.60±0.2 |
| 100 nF | 0.85±0.1 | 0.85±0.1 | 0.85±0.1 | 0.85±0.1 | 0.85±0.1 | 1.25±0.2 | 1.60±0.2 |
| 150 nF | 0.85±0.1 | 0.85±0.1 | 0.85±0.1 | 0.85±0.1 | 1.25±0.2 | 1.25±0.2 |          |
| 220 nF | 0.85±0.1 | 0.85±0.1 | 0.85±0.1 | 0.85±0.1 | 1.25±0.2 | 1.25±0.2 |          |
| 330 nF | 0.85±0.1 | 0.85±0.1 | 0.85±0.1 | 0.85±0.1 | 1.60±0.2 | 1.60±0.2 |          |
| 470 nF | 1.00±0.1 | 1.00±0.1 | 1.00±0.1 | 1.00±0.1 | 1.60±0.2 | 1.60±0.2 |          |
| 680 nF | 1.15±0.1 | 1.15±0.1 | 1.15±0.1 | 1.60±0.2 | 1.60±0.2 | 1.60±0.2 |          |
| 1 µF   | 1.15±0.1 | 1.15±0.1 | 1.15±0.1 | 1.60±0.2 | 1.60±0.2 | 1.60±0.2 |          |
| 2.2 µF | 1.60±0.2 | 1.60±0.2 | 1.60±0.2 | 1.60±0.2 | 1.60±0.2 | 1.60±0.2 |          |

**NOTE**

1. Values in shaded cells indicate thickness class in mm
2. Capacitance value of non E-6 series is on request

**CAPACITANCE RANGE & THICKNESS FOR X7R**

**Table 10** Size 1210

| CAP.   | 1210     |          |          |          |          |          | 1812     |          |          |
|--------|----------|----------|----------|----------|----------|----------|----------|----------|----------|
|        | 6.3V     | 10 V     | 16 V     | 25 V     | 50V      | 100 V    | 250 V    | 50V      | 100V     |
| 100 nF | 0.85±0.1 | 0.85±0.1 | 0.85±0.1 | 0.85±0.1 | 0.85±0.1 | 0.85±0.1 | 1.25±0.2 |          |          |
| 150 nF | 0.85±0.1 | 0.85±0.1 | 0.85±0.1 | 0.85±0.1 | 1.25±0.2 | 1.25±0.2 |          |          |          |
| 220 nF | 0.85±0.1 | 0.85±0.1 | 0.85±0.1 | 0.85±0.1 | 1.25±0.2 | 1.25±0.2 |          |          |          |
| 330 nF | 0.85±0.1 | 0.85±0.1 | 0.85±0.1 | 0.85±0.1 | 1.25±0.2 | 2.0±0.2  |          |          |          |
| 470 nF | 1.25±0.2 | 1.25±0.2 | 1.25±0.2 | 1.25±0.2 | 1.25±0.2 | 2.0±0.2  |          | 1.60±0.2 | 1.60±0.2 |
| 680 nF | 1.25±0.2 | 1.25±0.2 | 1.25±0.2 | 1.25±0.2 | 1.25±0.2 | 2.0±0.2  |          | 1.60±0.2 | 1.60±0.2 |
| 1 µF   | 1.25±0.2 | 1.25±0.2 | 1.25±0.2 | 1.25±0.2 | 1.25±0.2 | 2.0±0.2  |          | 1.60±0.2 | 1.60±0.2 |
| 2.2 µF |          |          |          |          | 2.0±0.2  | 2.0±0.2  |          |          |          |
| 4.7 µF |          |          |          |          | 2.5±0.2  |          |          |          |          |

**NOTE**

I. Values in shaded cells indicate thickness class in mm

**CAPACITANCE RANGE & THICKNESS FOR 4C-ARRAY**

Table 11 Temperature characteristic material from NP0

| CAPACITANCE | 0508 (4 x 0402) | 0612 (4 x 0603) |
|-------------|-----------------|-----------------|
|             | 50 V            | 50 V            |
| 10 pF       | 0.6±0.1         | 0.8±0.1         |
| 15 pF       | 0.6±0.1         | 0.8±0.1         |
| 18 pF       | 0.6±0.1         | 0.8±0.1         |
| 22 pF       | 0.6±0.1         | 0.8±0.1         |
| 33 pF       | 0.6±0.1         | 0.8±0.1         |
| 39 pF       | 0.6±0.1         | 0.8±0.1         |
| 47 pF       | 0.6±0.1         | 0.8±0.1         |
| 56 pF       | 0.6±0.1         | 0.8±0.1         |
| 68 pF       | 0.6±0.1         | 0.8±0.1         |
| 82 pF       | 0.6±0.1         | 0.8±0.1         |
| 100 pF      | 0.6±0.1         | 0.8±0.1         |
| 120 pF      |                 | 0.8±0.1         |
| 150 pF      |                 | 0.8±0.1         |
| 180 pF      |                 | 0.8±0.1         |
| 220 pF      |                 | 0.8±0.1         |
| 270 pF      |                 | 0.8±0.1         |
| 330 pF      |                 | 0.8±0.1         |
| 390 pF      |                 | 0.8±0.1         |
| 470 pF      |                 | 0.8±0.1         |
| 560 pF      |                 |                 |
| 680 pF      |                 |                 |
| 820 pF      |                 |                 |
| 1.0 nF      |                 |                 |

**NOTE**

Values in shaded cells indicate thickness class in mm

CAPACITANCE RANGE & THICKNESS FOR 4C-ARRAY

Table 12 Temperature characteristic material from X7R

| CAPACITANCE | 0508 (4 x 0402) |         |         | 0612 (4 x 0603) |         |         |
|-------------|-----------------|---------|---------|-----------------|---------|---------|
|             | 16 V            | 25 V    | 50 V    | 16 V            | 25 V    | 50 V    |
| 220 pF      |                 |         |         | 0.8±0.1         | 0.8±0.1 | 0.8±0.1 |
| 330 pF      |                 |         |         | 0.8±0.1         | 0.8±0.1 | 0.8±0.1 |
| 470 pF      |                 |         |         | 0.8±0.1         | 0.8±0.1 | 0.8±0.1 |
| 680 pF      |                 |         |         | 0.8±0.1         | 0.8±0.1 | 0.8±0.1 |
| 1.0 nF      | 0.6±0.1         | 0.6±0.1 | 0.6±0.1 | 0.8±0.1         | 0.8±0.1 | 0.8±0.1 |
| 1.5 nF      | 0.6±0.1         | 0.6±0.1 |         | 0.8±0.1         | 0.8±0.1 | 0.8±0.1 |
| 2.2 nF      | 0.6±0.1         | 0.6±0.1 |         | 0.8±0.1         | 0.8±0.1 | 0.8±0.1 |
| 3.3 nF      | 0.6±0.1         | 0.6±0.1 |         | 0.8±0.1         | 0.8±0.1 | 0.8±0.1 |
| 4.7 nF      | 0.6±0.1         | 0.6±0.1 |         | 0.8±0.1         | 0.8±0.1 | 0.8±0.1 |
| 6.8 nF      | 0.6±0.1         | 0.6±0.1 |         | 0.8±0.1         | 0.8±0.1 | 0.8±0.1 |
| 10 nF       | 0.6±0.1         | 0.6±0.1 |         | 0.8±0.1         | 0.8±0.1 | 0.8±0.1 |
| 15 nF       | 0.6±0.1         |         |         | 0.8±0.1         | 0.8±0.1 |         |
| 22 nF       | 0.6±0.1         |         |         | 0.8±0.1         | 0.8±0.1 |         |
| 33 nF       | 0.6±0.1         |         |         | 0.8±0.1         | 0.8±0.1 |         |
| 47 nF       | 0.6±0.1         |         |         | 0.8±0.1         | 0.8±0.1 |         |
| 68 nF       | 0.6±0.1         |         |         |                 |         |         |
| 100 nF      | 0.6±0.1         |         |         |                 |         |         |

**NOTE**

Values in shaded cells indicate thickness class in mm

**THICKNESS CLASSES AND PACKING QUANTITY**

Table 13

| SIZE CODE | THICKNESS CLASSIFICATION | TAPE WIDTH<br>QUANTITY PER REEL | Ø180 MM / 7 INCH |         | Ø330 MM / 13 INCH |         |
|-----------|--------------------------|---------------------------------|------------------|---------|-------------------|---------|
|           |                          |                                 | Paper            | Blister | Paper             | Blister |
| 0201      | 0.3 ±0.03 mm             | 8 mm                            | 15,000           | ---     | 50,000            | ---     |
| 0402      | 0.5 ±0.05 mm             | 8 mm                            | 10,000           | ---     | 50,000            | ---     |
| 0603      | 0.8 ±0.1 mm              | 8 mm                            | 4,000            | ---     | 15,000            | ---     |
| 0805/0508 | 0.6 ±0.1 mm              | 8 mm                            | 4,000            | ---     | 20,000            | ---     |
|           | 0.85 ±0.1 mm             | 8 mm                            | 4,000            | ---     | 15,000            | ---     |
|           | 1.25 ±0.2 mm             | 8 mm                            | ---              | 3,000   | ---               | 10,000  |
| 1206/0612 | 0.6 ±0.1 mm              | 8 mm                            | 4,000            | ---     | 20,000            | ---     |
|           | 0.85 ±0.1 mm             | 8 mm                            | 4,000            | ---     | 15,000            | ---     |
|           | 1.0/1.15 ±0.1 mm         | 8 mm                            | ---              | 3,000   | ---               | 10,000  |
|           | 1.25 ±0.2 mm             | 8 mm                            | ---              | 3,000   | ---               | 10,000  |
|           | 1.6 ±0.2 mm              | 8 mm                            | ---              | 2,000   | ---               | 10,000  |
| 1210      | 0.85 ±0.1 mm             | 8 mm                            | ---              | 4,000   | ---               | 10,000  |
|           | 1.15 ±0.1 mm             | 8 mm                            | ---              | 3,000   | ---               | 10,000  |
|           | 1.25 ±0.2 mm             | 8 mm                            | ---              | 3,000   | ---               | 10,000  |
| 1812      | 0.6 / 0.85±0.1 mm        | 12 mm                           | ---              | 2,000   | ---               | ---     |
|           | 1.15±0.1 mm              | 12 mm                           | ---              | 1,000   | ---               | ---     |
|           | 1.25±0.2 mm              | 12 mm                           | ---              | 1,000   | ---               | ---     |

**ELECTRICAL CHARACTERISTICS**

**NP0/X7R DIELECTRIC CAPACITORS; NI/SIN 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.

| DESCRIPTION               |           | VALUE                           |
|---------------------------|-----------|---------------------------------|
| Capacitance range         |           | 0.2 pF to 2.2 μF                |
| Capacitance tolerance     |           |                                 |
| NP0                       | C < 10 pF | ±0.1 pF, ±0.25 pF, ±0.5 pF      |
|                           | C ≥ 10 pF | ±1%, ±2%, ±5%                   |
| X7R                       |           | ±5% <sup>(1)</sup> , ±10%, ±20% |
| Dissipation factor (D.F.) |           |                                 |
| NP0                       | C < 30 pF | ≤ 1 / ( 400 + 20C )             |
|                           | C ≥ 30 pF | ≤ 0.1 %                         |

| X7R  | 0201                            | 0402   | 0603                                | 0805   | 1206                                    | 1210                             | 1812                         | 0508 (Array)  | 0612 (Array)  |                                   |
|------|---------------------------------|--|-------------------------------------|--|---|----------------------------------|------------------------------|---------------|---------------|-----------------------------------|
| ≤10V | 220pF to 100nF                  | 1nF to 1μF                                     | 1nF to 2.2μF                        | 22nF to 2.2μF                                  | 100nF to 1μF                            |                                  |                              |               |               | ≤ 5%<br>≤ 10%                     |
| 16V  | 220pF to 22nF<br>27nF to 100nF  | 1nF to 220nF<br>470nF to 1μF                   | 1nF to 470nF<br>680nF to 2.2μF      | 22nF to 1μF<br>2.2 μF                          | 100nF to 1μF                            |                                  | 1nF to 10nF<br>15nF to 100nF | 220pF to 47nF |               | ≤ 3.5%<br>≤ 5%                    |
| 25V  | 100pF to 470pF<br>560pF to 10nF | 220pF to 10nF<br>12nF to 27nF<br>47nF to 100nF | 1nF to 39nF<br>47nF to 220nF<br>1μF | 1nF to 180nF<br>220nF to 470nF<br>680nF to 1μF | 22nF to 680nF<br>100nF to 1μF<br>2.2 μF |                                  | 1nF to 10nF                  | 220pF to 47nF |               | ≤ 2.5%<br>≤ 3.5%<br>≤ 5%          |
| 50V  | 100pF to 470pF<br>560pF to 1nF  | 220pF to 10nF                                  | 1nF to 39nF<br>47nF to 100nF        | 1nF to 180nF<br>220nF to 470nF<br>680nF to 1μF | 22nF to 470nF<br>680nF to 2.2μF         | 100nF to 1μF<br>2.2μF<br>4.7μF   | 470nF to 1μF                 | 1nF           | 220pF to 10nF | ≤ 2.5%<br>≤ 3.5%<br>≤ 5%<br>≤ 10% |
| 100V |                                 | 220pF to 1.5nF<br>12nF to 47nF                 | 1nF to 10nF                         | 1nF to 100nF                                   | 22nF to 470nF<br>680nF to 2.2μF         | 100nF to 220nF<br>330nF to 2.2μF | 470nF to 1μF                 |               |               | ≤ 2.5%<br>≤ 5%                    |
| 250V |                                 |  |                                     | 1nF to 22nF                                    | 22nF to 100nF                           | 100nF                            |                              |               |               | ≤ 2.5%                            |
| 500V |                                 |  |                                     | 1nF to 4.7nF                                   |   |                                  |                              |               |               | ≤ 2.5%                            |

Insulation resistance after 1 minute at U<sub>r</sub> (DC) IR ≥ 10 GΩ or I.R × C ≥ 500 seconds whichever is less

Maximum capacitance change as a function of temperature (temperature characteristic/coefficient):

|     |            |
|-----|------------|
| NP0 | +30 ppm/°C |
| X7R | ±15%       |

Operating temperature range:

|         |                   |
|---------|-------------------|
| NP0/X7R | -55 °C to +125 °C |
|---------|-------------------|

**NOTE**

1. Capacitance tolerance ±5% doesn't available for X7R full product range, please contact local sales force before order

## SOLDERING RECOMMENDATION

Table 15

| SOLDERING METHOD | SIZE     |          |          |          |             |
|------------------|----------|----------|----------|----------|-------------|
|                  | 0402     | 0603     | 0805     | 1206     | ≥ 1210      |
| Reflow           | ≥ 0.1 μF | ≥ 1.0 μF | ≥ 2.2 μF | ≥ 4.7 μF | Reflow only |
| Reflow/Wave      | < 0.1 μF | < 1.0 μF | < 2.2 μF | < 4.7 μF | ---         |

## SOLDERING CONDITIONS

The lead free MLCCs are able to stand the reflow soldering conditions as below:

- Temperature: above 220 °C
- Endurance: 95 to 120 seconds
- Cycles: 3 times

The test of "soldering heat resistance" is carried out in accordance with the schedule of "MIL-STD-202F-method 210F", "The robust construction of chip capacitors allows them to be completely immersed in a solder bath of 270 °C for 10 seconds". Therefore, it is possible to mount MLCCs on one side of a PCB and other discrete components on the reverse (mixed PCBs). Surface Mount Capacitors are tested for solderability at 245 °C during 2 seconds. The test condition for no leaching is 260°C for 30 seconds.

## TESTS AND REQUIREMENTS

Table 16 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                |
| Capacitance               | IEC 60384-21/22 4.5.1 | Class 1:<br>At 20 °C, 24 hours after annealing<br>f = 1 MHz for C ≤ 1nF, measuring at voltage   V <sub>rms</sub> at 20 °C<br>f = 1 KHz for C > 1nF, measuring at voltage   V <sub>rms</sub> at 20 °C<br>Class 2:<br>At 20 °C, 24 hours after annealing<br>f = 1 KHz, measuring at voltage   V <sub>rms</sub> at 20 °C | Within specified tolerance       |
| Dissipation Factor (D.F.) | IEC 60384-21/22 4.5.2 | Class 1:<br>At 20 °C, 24 hours after annealing<br>f = 1 MHz for C ≤ 1nF, measuring at voltage   V <sub>rms</sub> at 20 °C<br>f = 1 KHz for C > 1nF, measuring at voltage   V <sub>rms</sub> at 20 °C<br>Class 2:<br>At 20 °C, 24 hours after annealing<br>f = 1 KHz, measuring at voltage   V <sub>rms</sub> at 20 °C | In accordance with specification |
| Insulation Resistance     | IEC 60384-21/22 4.5.3 | At U <sub>r</sub> (DC) for 1 minute   | In accordance with specification |

| TEST                      | TEST METHOD           | PROCEDURE  | REQUIREMENTS   |      |                 |   |      |   |                       |   |      |   |
|---------------------------|-----------------------|--|--|------|-----------------|---|------|---|-----------------------|---|------|---|
| Temperature coefficient   | 4.6                   | Capacitance shall be measured by the steps shown in the following table.<br>The capacitance change should be measured after 5 min at each specified temperature stage.   | <General purpose series><br>Class I:<br>$\Delta C/C: \pm 30\text{ppm}$<br><br>Class2:<br>X7R: $\Delta C/C: \pm 15\%$<br><br><High Capacitance series><br>Class2:<br>X7R/X5R: $\Delta C/C: \pm 15\%$            |      |                 |   |      |   |                       |   |      |   |
|                           |                       | <table border="1"> <thead> <tr> <th>Step</th> <th>Temperature(°C)</th> </tr> </thead> <tbody> <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> </tbody> </table> <p>(1) Class I<br/>Temperature Coefficient shall be calculated from the formula as below<br/> <math display="block">\text{Temp. Coefficient} = \frac{C2 - C1}{C1 \times \Delta T} \times 10^6 \text{ [ppm/°C]}</math>                     C1: Capacitance at step c<br/>                     C2: Capacitance at 125°C<br/> <math>\Delta T: 100^\circ\text{C}(=125^\circ\text{C}-25^\circ\text{C})</math></p> <p>(2) Class II<br/>Capacitance Change shall be calculated from the formula as below<br/> <math display="block">\Delta C = \frac{C2 - C1}{C1} \times 100\%</math>                     C1: Capacitance at step c<br/>                     C2: Capacitance at step b or d</p> |  | Step | Temperature(°C) | a | 25±2 | b | Lower temperature±3°C | c | 25±2 | d |
| Step                      | Temperature(°C)       |  |  |      |                 |   |      |   |                       |   |      |   |
| a                         | 25±2                  |  |  |      |                 |   |      |   |                       |   |      |   |
| b                         | Lower temperature±3°C |  |  |      |                 |   |      |   |                       |   |      |   |
| c                         | 25±2                  |  |  |      |                 |   |      |   |                       |   |      |   |
| d                         | Upper Temperature±2°C |  |  |      |                 |   |      |   |                       |   |      |   |
| e                         | 25±2                  |  |  |      |                 |   |      |   |                       |   |      |   |
| High Temperature Exposure | AEC-Q200 3            | Unpowered ; 1000hours @ T=150°C<br>Measurement at 24±2 hours after test conclusion.  | No visual damage<br>$\Delta C/C :$<br>Class I:<br>NP0: within ±0.5% or 0.5 pF whichever is greater<br>Class2:<br>X7R: ±10%<br>D.F.:<br>within initial specified value<br>IR:<br>within initial specified value |      |                 |   |      |   |                       |   |      |   |



| TEST                          | TEST METHOD | PROCEDURE  | REQUIREMENTS   |
|-------------------------------|-------------|--|--|
| Temperature Cycling           | AEC-Q200 4  | <p>Preconditioning:<br/>150 +0/-10 °C for 1 hour, then keep for 24 ± 1 hours at room temperature</p> <p>1000 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>ΔC/C</p> <p>Class 1:<br/>NP0: Within ±1% or 0.5pF, whichever is greater.</p> <p>Class 2:<br/>X7R: ±10%</p> <hr/> <p>D.F. meet initial specified value</p> <p>IR meet initial specified value</p>                  |
| Destructive Physical Analysis | AEC-Q200 5  | <p>10ea X 3 lots.</p> <p>Note: Only applies to SMD ceramics.<br/>Electrical test not required.</p>   |  |
| Moisture Resistance           | AEC-Q200 6  | <p>T=24 hrs/per cycle; 10 continuous cycles unpowered.<br/>Measurement at 24 ± 2 hours after test condition.</p>   | <p>No visual damage</p> <hr/> <p>ΔC/C</p> <p>NP0: Within ±3% or 3 pF, whichever is greater</p> <p>X7R: ±15%</p> <hr/> <p>D.F.</p> <p>Within initial specified value</p> <p>IR</p> <p>NP0: ≥ 10,000 MΩ</p> <p>X7R: Meet initial specified value</p> |



Fig. 4 Moisture resistant

| TEST            | TEST METHOD | PROCEDURE  | REQUIREMENTS   |
|-----------------|-------------|--|--|
| Biased Humidity | AEC-Q200 7  | <ol style="list-style-type: none"> <li>Preconditioning, class 2 only:<br/>150 +0/-10 °C /1 hour, then keep for<br/>24 ±1 hour at room temp</li> <li>Initial measure:<br/>Parameter: IR<br/>Measuring voltage: 1.5V ± 0.1 VDC<br/>Note: Series with 100 KΩ &amp; 6.8 KΩ</li> <li>Test condition:<br/>85 °C, 85% R.H. connected with 100 KΩ resistor, applied<br/>1.5V/U<sub>r</sub> for 1,000 hours.</li> <li>Recovery:<br/>Class1: 6 to 24 hours<br/>Class2: 24 ±2 hours</li> <li>Final measure: IR</li> </ol> | <p>No visual damage after recovery</p> <hr/> <p>Initial requirement:</p> <p><b>Class 1:</b></p> <ul style="list-style-type: none"> <li>- Connected to 100 KΩ:<br/>C ≤ 10 nF: I.R ≥ 10,000 MΩ<br/>or<br/>C &gt; 10 nF: (I.R-100 KΩ) × C ≥ 100s.</li> <li>- Connected to 6.8 KΩ:<br/>C ≤ 10 nF: I.R ≥ 10,000 MΩ<br/>or<br/>C &gt; 10 nF: (I.R-6.8 KΩ) × C ≥ 100s.</li> </ul> <p><b>Class2:</b></p> <ul style="list-style-type: none"> <li>- Connected to 100 KΩ:<br/>C ≤ 25 nF: I.R ≥ 4,000 MΩ or<br/>C &gt; 25 nF: (I.R-100 KΩ) × C ≥ 100s.</li> <li>- Connected to 6.8 KΩ:<br/>C ≤ 25 nF: I.R ≥ 10,000 MΩ<br/>or<br/>C &gt; 25 nF: (I.R-6.8 KΩ) × C ≥ 100s.</li> </ul> <p>Final measurement:<br/>The insulation resistance shall be greater than 0.1 time initial value.</p> |

| TEST               | TEST METHOD | PROCEDURE   | REQUIREMENTS   |
|--------------------|-------------|---|--|
| Operational Life   | AEC-Q200 8  | <ol style="list-style-type: none"> <li>1. Preconditioning, class 2 only:<br/>150 +0/-10 °C /1 hour, then keep for<br/>24 ±1 hour at room temp</li> <li>2. Initial measure:<br/>Spec: refer to initial spec C, D, IR</li> <li>3. Endurance test:<br/>Temperature: X7R: 125 °C<br/>Specified stress voltage applied for 1,000 hours:<br/>Applied 2.0 × U<sub>r</sub> for general products<br/>Applied 1.5 × U<sub>r</sub> for high cap. Products<br/>High voltage series follows with below<br/>stress condition:<br/>Applied 1.5 × U<sub>r</sub> for 200V, 250V series<br/>Applied 1.3 × U<sub>r</sub> for 500V, 630V series<br/>Applied 1.2 × U<sub>r</sub> for 1KV, 2KV, 3KV series</li> <li>4. Recovery time: 24 ±2 hours</li> <li>5. Final measure: C, D, IR</li> </ol> <p>Note: If the capacitance value is less than the minimum value permitted, then after the other measurements have been made the capacitor shall be preconditioned according to "IEC 60384 4.1" and then the requirement shall be met.</p> | <p>No visual damage</p> <hr/> <p>ΔC/C<br/>NP0: Within ±2% or 1 pF, whichever is greater<br/>X7R: ±15%</p> <hr/> <p>D.F.<br/>NP0: ≤ 2 × specified value.<br/>X7R: ≤ 16V: ≤ 7% or specified value whichever is greater<br/>≥ 25V: ≤ 5% or specified value whichever is greater</p> <p>IR<br/>NP0: ≥ 4,000 MΩ or IR × C<sub>r</sub> ≥ 40s whichever is less<br/>X7R: ≥ 1,000 MΩ or IR × C<sub>r</sub> ≥ 50s whichever is less</p> |
| External Visual    | AEC-Q200 9  | Any applicable method using × 10 magnification  | In accordance with specification   |
| Physical Dimension | AEC-Q200 10 | Verify physical dimensions to the applicable device specification.  | In accordance with specification   |
| Mechanical Shock   | AEC-Q200 13 | <p>Three shocks in each direction shall be applied along the three mutually perpendicular axes of the test specimen (18 shocks)</p> <p>Peak value: 1,500 g's<br/>Duration: 0.5 ms<br/>Velocity change: 15.4 ft/s<br/>Waveform: Half-sin</p>   | <p>ΔC/C<br/>NP0: Within ±0.5% or 0.5 pF, whichever is greater<br/>X7R: ±10%</p> <hr/> <p>D.F.<br/>Within initial specified value<br/>IR<br/>Within initial specified value</p>   |
| Vibration          | AEC-Q200 14 | <p>5 g's for 20 minutes, 12 cycles each of 3 orientations.</p> <p>Note:<br/>Use 8" × 5" PCB, 0.31" thick 7 secure points on one long side and 2 secure points at corners of opposite sides. Parts mounted within 2" from any secure point. Test from 10-2000 Hz.</p>  | <p>ΔC/C<br/>NP0: Within ±0.5% or 0.5 pF, whichever is greater<br/>X7R: ±10%</p> <hr/> <p>D.F: meet initial specified value<br/>IR meet initial specified value</p>   |

| TEST                         | TEST METHOD |    | PROCEDURE  | REQUIREMENTS  |
|------------------------------|-------------|----|--|---|
| Resistance to Soldering Heat | AEC-Q200    | 15 | Precondition: 150 +0/-10 °C for 1 hour, then keep for 24 ± 1 hours at room temperature<br>Preheating: for size ≤ 1206: 120 °C to 150 °C for 1 minute<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 ± 5 °C<br>Dipping time: 10 ± 0.5 seconds<br>Recovery time: 24 ± 2 hours   | Dissolution of the end face plating shall not exceed 25% of the length of the edge concerned<br><hr/> ΔC/C<br>Class 1:<br>NP0: Within ± 1% or 0.5 pF, whichever is greater.<br>Class 2:<br>X7R: ± 10%<br><hr/> D.F. within initial specified value<br>IR within initial specified value |
| Thermal Shock                | AEC-Q200    | 16 | 1. Preconditioning, class 2 only:<br>150 +0/-10 °C / 1 hour, then keep for 24 ± 1 hour at room temp<br>2. Initial measure:<br>Spec: refer to initial spec C, D, IR<br>3. Rapid change of temperature test:<br>NP0/X7R: -55 °C to +125 °C; 300 cycles<br>15 minutes at lower category temperature; 15 minutes at upper category temperature.<br>4. Recovery time:<br>Class 1: 6 to 24 hours<br>Class 2: 24 ± 2 hours<br>5. Final measure: C, D, IR  | No visual damage<br><hr/> ΔC/C<br>NP0: Within ± 1% or 1 pF, whichever is greater<br>X7R: ± 15%<br><hr/> D.F. meet initial specified value<br>IR meet initial specified value  |
| ESD                          | AEC-Q200    | 17 | Per AEC-Q200-002   | A component passes a voltage level if all components stressed at that voltage level pass.   |
| Solderability                | AEC-Q200    | 18 | Preheated to a 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 ± 5 °C<br>Dipping time: 2 ± 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 lead-free containing solder alloy<br>Temperature: 245 ± 5 °C<br>Dipping time: 3 ± 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  |
|-----------------------------|-------------|---|---|
| Electrical Characterization | AEC-Q200 19 | <p>Parametrically test per lot and sample size requirements, summary to show Min, Max, Mean and Standard deviation at room as well as Min and Max operating temperatures.</p> <p>Class 1:<br/>NP0: -55 °C to +125 °C<br/>Normal temperature: 20 °C</p> <p>Class 2:<br/>X7R: -55 °C to +125 °C<br/>Normal temperature: 20 °C</p> | <p><math>\Delta C/C</math></p> <p>Class 1:<br/>NP0: <math>\pm 30</math> ppm/°C</p> <p>Class 2:<br/>X7R: <math>\pm 15\%</math></p> |

|            |             |  |   |
|------------|-------------|--|---|
| Board Flex | AEC-Q200 21 | <p>Part mounted on a 100 mm X 40 mm FR4 PCB board, which is <math>1.6 \pm 0.2</math> mm thick and has a layer-thickness <math>35 \mu\text{m} \pm 10 \mu\text{m}</math>.</p> <p>Part should be mounted using the following soldering reflow profile.</p> <p>Conditions:</p> <p>Class 1:<br/>Bending 3 mm at a rate of 1 mm/s, radius jig 340 mm</p> <p>Class 2:<br/>Bending 2 mm at a rate of 1 mm/s, radius jig 340 mm</p> | <p>No visible damage</p> <p><math>\Delta C/C</math></p> <p>Class 1:<br/>NP0: Within <math>\pm 1\%</math> or 0.5 pF, whichever is greater</p> <p>Class 2:<br/>X7R: <math>\pm 10\%</math></p> |
|------------|-------------|--|---|

Test Substrate:



| Type | Dimension(mm) |     |      |
|------|---------------|-----|------|
|      | a             | b   | c    |
| 0201 | 0.3           | 0.9 | 0.3  |
| 0402 | 0.4           | 1.5 | 0.5  |
| 0603 | 1.0           | 3.0 | 1.2  |
| 0805 | 1.2           | 4.0 | 1.65 |
| 1206 | 2.2           | 5.0 | 1.65 |
| 1210 | 2.2           | 5.0 | 2.0  |
| 1808 | 3.5           | 7.0 | 3.7  |

|                   |             |   |  |
|-------------------|-------------|---|--|
| Terminal Strength | AEC-Q200 22 | <p>With the component mounted on a PCB obtained with the device to be tested, apply a 17.7N (1.8Kg) force to the side of a device being tested.</p> <p>This force shall be applied for 60+1 seconds.</p> <p>Also the force shall be applied gradually as not to apply a shock to the component being tested.</p> <p>* Apply 2N force for 0402 size.</p> | <p>Magnification of 20X or greater may be employed for inspection of the mechanical integrity of the device body, terminals and body/terminal junction.</p> <p>Before, during and after the test, the device shall comply with all electrical requirements stated in this specification.</p> |
|-------------------|-------------|---|--|

| TEST           | TEST METHOD | PROCEDURE   | REQUIREMENTS  |
|----------------|-------------|---|---|
| Beam Load Test | AEC-Q200 23 | Place the part in the beam load fixture. Apply a force until the part breaks or the minimum acceptable force level required in the user specification(s) is attained.   | ≤ 0805<br>Thickness > 0.5mm: 20N<br>Thickness ≤ 0.5mm: 8N<br>≥ 1206<br>Thickness ≥ 1.25 mm: 54N<br>Thickness < 1.25 mm: 15N |
| Voltage Proof  |             | 1. Specified stress voltage applied for 1~5 seconds<br>2. $U_r \leq 100\text{ V}$ : series applied 2.5 $U_r$<br>3. $100\text{ V} < U_r \leq 200\text{ V}$ series applied ( $1.5 U_r + 100$ )<br>4. $200\text{ V} < U_r \leq 500\text{ V}$ series applied ( $1.3 U_r + 100$ )<br>5. $U_r > 500\text{ V}$ : 1.3 $U_r$<br>6. $U_r \geq 1000\text{ V}$ : 1.2 $U_r$<br>Charge/Discharge current is less than 50 mA | No breakdown or flashover   |



**REVISION HISTORY**

| REVISION   | DATE          | CHANGE NOTIFICATION | DESCRIPTION  |
|------------|---------------|---------------------|--|
| Version 11 | Jun. 29, 2018 | -                   | - Add 0201 NPO 25V/ 50V, 0.2pF to 33pF, Add 0402 NPO 50V 270pF to 1nF, Add 0805 X7R 25V 2.2uF  |
| Version 10 | May. 2, 2018  | -                   | - Add 0603 NPO 100V 820pF to 1nF,<br>- Add 0805 NPO 50V to 100V, 1.2nF to 10nF,<br>- Add 0805 X7R 16V 2.2uF, 50V 680nF to 1uF,<br>- Add 1206 X7R 100V 330nF to 2.2uF, 250V 33nF to 100nF |
| Version 9  | Mar. 22, 2018 | -                   | - Add 0402 X7R 100nF 25~50V  |
| Version 8  | Nov. 22, 2017 | -                   | - Add X7R/0201/25V/100pF~10nF  |
| Version 7  | Jul. 7, 2017  | -                   | - Add X7R/0805/330nF to 470nF/50V, X7R/1206/10uF/6.3V  |
| Version 6  | Mar. 31, 2017 | -                   | - Add NPO/0603/1nF/50V, X7R/0603/1uF/10V, X7R/0603/470nF/16V, X7R/0603/220nF/25V   |
| Version 5  | Nov. 15, 2016 | -                   | - Add Soldering Condition  |
| Version 4  | Jun. 14, 2016 | -                   | - Add X7R/0805/2.2uF/10V and NPO/1206/1.2nF to 1.5nF/250V  |
| Version 3  | Jul. 21, 2015 | -                   | - Tests and Requirements update  |
| Version 2  | Jul. 17, 2014 | -                   | - Tests and Requirements update  |
| Version 1  | Apr. 19, 2013 | -                   | - Capacitance range update   |
| Version 0  | Dec. 25, 2012 | -                   | - New  |

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