

# DATA SHEET

## SURFACE-MOUNT CERAMIC MULTILAYER CAPACITORS

General Purpose & High Capacitance

Class 2, X7R

6.3 V TO 50 V

100 pF to 22  $\mu$ F

RoHS compliant & Halogen Free



SCOPE

This specification describes X7R series chip capacitors with lead-free terminations.

APPLICATIONS

- PCs, Hard disk, Game PCs
- DVDs, Video cameras
- Mobile phones
- Data processing

FEATURES

- Supplied in tape on reel
- Nickel-barrier end termination
- RoHS compliant
- Halogen Free compliant

ORDERING INFORMATION - GLOBAL PART NUMBER, PHYCOMP

CTC & I2NC

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

**YAGEO BRAND ordering code**

**GLOBAL PART NUMBER (PREFERRED)**

**CC** xxxx x x **X7R** x **BB** xxx  
 (1) (2) (3) (4) (5)

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**(1) SIZE – INCH BASED (METRIC)**

- 0201 (0603)
- 0402 (1005)
- 0603 (1608)
- 0805 (2012)
- 1206 (3216)
- 1210 (3225)
- 1812 (4532)

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**(2) TOLERANCE**

- J = ±5% <sup>(1)</sup>
- 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) RATED VOLTAGE**

- 5 = 6.3 V
- 6 = 10 V
- 7 = 16 V
- 8 = 25 V
- 9 = 50 V

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**(5) CAPACITANCE VALUE**

2 significant digits+number of zeros  
 The 3rd digit signifies the multiplying factor, and letter R is decimal point  
 Example: 103 = 10 × 10<sup>3</sup> = 10,000 pF = 10 nF

**NOTE**

1. Tolerance ±5% is not available for full product range, please contact local sales force before ordering

**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 (NiSn). The terminations are lead-free. A cross section of the structure is shown in Fig.1.



Fig. 1 Surface mounted multilayer ceramic capacitor construction

**DIMENSION**

Table I 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) | DIMENSION CODE |
|------|---------------------|-----------|-----------|--------------------------------------|------|---------------------|----------------|
|      |                     |           |           | min.                                 | Max. |                     |                |
| 0201 | 0.6 ±0.03           | 0.3 ±0.03 | 0.3 ±0.03 | 0.1                                  | 0.2  | 0.2                 | BA             |
| 0402 | 1.0 ±0.05           | 0.5 ±0.05 | 0.5 ±0.05 | 0.15                                 | 0.35 | 0.4                 | CA             |
|      | 1.6 ±0.1            | 0.8 ±0.1  | 0.8 ±0.1  | 0.2                                  | 0.6  | 0.4                 | DA             |
| 0603 | 1.6 ±0.15           | 0.8 ±0.15 | 0.8 ±0.15 | 0.2                                  | 0.6  | 0.4                 | DB             |
|      | 1.6 ±0.2            | 0.8 ±0.2  | 0.8 ±0.2  | 0.2                                  | 0.6  | 0.4                 | DC             |
| 0805 | 2.0 ±0.1            | 1.25 ±0.1 | 0.6 ±0.1  | 0.25                                 | 0.75 | 0.7                 | E0             |
|      | 2.0 ±0.1            | 1.25 ±0.1 | 0.85 ±0.1 | 0.25                                 | 0.75 | 0.7                 | EA             |
|      | 2.0 ±0.2            | 1.25 ±0.2 | 1.25 ±0.2 | 0.25                                 | 0.75 | 0.7                 | EB             |
| 1206 | 3.2 ±0.15           | 1.6 ±0.15 | 0.85 ±0.1 | 0.25                                 | 0.75 | 1.4                 | F0             |
|      | 3.2 ±0.2            | 1.6 ±0.2  | 1.0 ±0.1  | 0.25                                 | 0.75 | 1.4                 | F1             |
|      | 3.2 ±0.2            | 1.6 ±0.2  | 1.15 ±0.1 | 0.25                                 | 0.75 | 1.4                 | FA             |
|      | 3.2 ±0.3            | 1.6 ±0.2  | 1.6 ±0.2  | 0.25                                 | 0.8  | 1.4                 | FC             |
|      | 3.2 ±0.3            | 1.6 ±0.3  | 1.6 ±0.3  | 0.3                                  | 0.9  | 1.4                 | FD             |
| 1210 | 3.2 ±0.2            | 2.5 ±0.2  | 0.85 ±0.1 | 0.25                                 | 0.75 | 1.4                 | G0             |
|      | 3.2 ±0.4            | 2.5 ±0.3  | 1.15 ±0.1 | 0.25                                 | 0.75 | 1.4                 | G1             |
|      | 3.2 ±0.4            | 2.5 ±0.3  | 1.25 ±0.2 | 0.25                                 | 0.75 | 1.4                 | GA             |
|      | 3.2 ±0.4            | 2.5 ±0.3  | 1.6 ±0.2  | 0.25                                 | 0.75 | 1.4                 | G2             |
|      | 3.2 ±0.4            | 2.5 ±0.3  | 1.9 ±0.2  | 0.25                                 | 0.75 | 1.4                 | GB             |
|      | 3.2 ±0.4            | 2.5 ±0.3  | 2.0 ±0.2  | 0.25                                 | 0.75 | 1.4                 | G3             |
|      | 3.2 ±0.4            | 2.5 ±0.3  | 2.5 ±0.2  | 0.25                                 | 0.75 | 1.0                 | GC             |
|      | 3.2 ±0.4            | 2.5 ±0.3  | 2.5 ±0.3  | 0.25                                 | 0.75 | 1.0                 | GD             |
| 1812 | 4.5 ±0.2            | 3.2 ±0.2  | 0.85 ±0.1 | 0.25                                 | 0.75 | 2.2                 | JA             |
|      | 4.5 ±0.2            | 3.2 ±0.2  | 1.15 ±0.1 | 0.25                                 | 0.75 | 2.2                 | JB             |
|      | 4.5 ±0.4            | 3.2 ±0.4  | 1.6 ±0.2  | 0.25                                 | 0.75 | 2.2                 | JC             |

**OUTLINES**



Fig. 2 Surface mounted multilayer ceramic capacitor dimension

**CAPACITANCE RANGE & THICKNESS FOR X7R**

**Table 2** Sizes from 0201 to 0402

| CAP.   | 0201  |      |      |      |      | 0402  |      |      |      |      |
|--------|-------|------|------|------|------|-------|------|------|------|------|
|        | 6.3 V | 10 V | 16 V | 25 V | 50 V | 6.3 V | 10 V | 16 V | 25 V | 50 V |
| 100 pF | BA    | BA   | BA   | BA   | BA   | CA    | CA   | CA   | CA   | CA   |
| 150 pF | BA    | BA   | BA   | BA   | BA   | CA    | CA   | CA   | CA   | CA   |
| 220 pF | BA    | BA   | BA   | BA   | BA   | CA    | CA   | CA   | CA   | CA   |
| 330 pF | BA    | BA   | BA   | BA   | BA   | CA    | CA   | CA   | CA   | CA   |
| 470 pF | BA    | BA   | BA   | BA   | BA   | CA    | CA   | CA   | CA   | CA   |
| 680 pF | BA    | BA   | BA   | BA   | BA   | CA    | CA   | CA   | CA   | CA   |
| 1.0 nF | BA    | BA   | BA   | BA   | BA   | CA    | CA   | CA   | CA   | CA   |
| 1.5 nF | BA    | BA   | BA   | BA   |      | CA    | CA   | CA   | CA   | CA   |
| 2.2 nF | BA    | BA   | BA   | BA   |      | CA    | CA   | CA   | CA   | CA   |
| 3.3 nF | BA    | BA   | BA   | BA   |      | CA    | CA   | CA   | CA   | CA   |
| 4.7 nF | BA    | BA   | BA   | BA   |      | CA    | CA   | CA   | CA   | CA   |
| 6.8 nF | BA    | BA   | BA   | BA   |      | CA    | CA   | CA   | CA   | CA   |
| 10 nF  | BA    | BA   | BA   | BA   |      | CA    | CA   | CA   | CA   | CA   |
| 15 nF  |       |      |      |      |      | CA    | CA   | CA   | CA   | CA   |
| 22 nF  |       |      |      |      |      | CA    | CA   | CA   | CA   | CA   |
| 33 nF  |       |      |      |      |      | CA    | CA   | CA   | CA   | CA   |
| 47 nF  |       |      |      |      |      | CA    | CA   | CA   | CA   | CA   |
| 68 nF  |       |      |      |      |      | CA    | CA   | CA   | CA   |      |
| 100 nF | BA    |      |      |      |      | CA    | CA   | CA   | CA   | CA   |
| 150 nF |       |      |      |      |      |       |      |      |      |      |
| 220 nF |       |      |      |      |      | CA    | CA   | CA   |      |      |
| 330 nF |       |      |      |      |      |       |      |      |      |      |
| 470 nF |       |      |      |      |      | CA    | CA   |      |      |      |
| 680 nF |       |      |      |      |      |       |      |      |      |      |
| 1.0 µF |       |      |      |      |      | CA    |      |      |      |      |
| 2.2 µF |       |      |      |      |      |       |      |      |      |      |
| 4.7 µF |       |      |      |      |      |       |      |      |      |      |
| 10 µF  |       |      |      |      |      |       |      |      |      |      |
| 22 µF  |       |      |      |      |      |       |      |      |      |      |

**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 FOR X7R**

**Table 3** Sizes from 0603 to 0805

| CAP.   | 0603  |      |      |      |      | 0805  |      |      |      |      |
|--------|-------|------|------|------|------|-------|------|------|------|------|
|        | 6.3 V | 10 V | 16 V | 25 V | 50 V | 6.3 V | 10 V | 16 V | 25 V | 50 V |
| 100 pF | DA    | DA   | DA   | DA   | DA   |       |      |      |      |      |
| 150 pF | DA    | DA   | DA   | DA   | DA   |       |      |      |      |      |
| 220 pF | DA    | DA   | DA   | DA   | DA   | E0    | E0   | E0   | E0   | E0   |
| 330 pF | DA    | DA   | DA   | DA   | DA   | E0    | E0   | E0   | E0   | E0   |
| 470 pF | DA    | DA   | DA   | DA   | DA   | E0    | E0   | E0   | E0   | E0   |
| 680 pF | DA    | DA   | DA   | DA   | DA   | E0    | E0   | E0   | E0   | E0   |
| 1.0 nF | DA    | DA   | DA   | DA   | DA   | E0    | E0   | E0   | E0   | E0   |
| 1.5 nF | DA    | DA   | DA   | DA   | DA   | E0    | E0   | E0   | E0   | E0   |
| 2.2 nF | DA    | DA   | DA   | DA   | DA   | E0    | E0   | E0   | E0   | E0   |
| 3.3 nF | DA    | DA   | DA   | DA   | DA   | E0    | E0   | E0   | E0   | E0   |
| 4.7 nF | DA    | DA   | DA   | DA   | DA   | E0    | E0   | E0   | E0   | E0   |
| 6.8 nF | DA    | DA   | DA   | DA   | DA   | E0    | E0   | E0   | E0   | E0   |
| 10 nF  | DA    | DA   | DA   | DA   | DA   | E0    | E0   | E0   | E0   | E0   |
| 15 nF  | DA    | DA   | DA   | DA   | DA   | E0    | E0   | E0   | E0   | E0   |
| 22 nF  | DA    | DA   | DA   | DA   | DA   | E0    | E0   | E0   | E0   | E0   |
| 33 nF  | DA    | DA   | DA   | DA   | DA   | EA    | EA   | EA   | EA   | EA   |
| 47 nF  | DA    | DA   | DA   | DA   | DA   | EA    | EA   | EA   | EA   | EA   |
| 68 nF  | DA    | DA   | DA   | DA   | DA   | EA    | EA   | EA   | EA   | EA   |
| 100 nF | DA    | DA   | DA   | DA   | DA   | EA    | EA   | EA   | EA   | EA   |
| 150 nF | DA    | DA   | DA   | DA   | DA   | EA    | EA   | EA   | EA   | EA   |
| 220 nF | DA    | DA   | DA   | DA   | DA   | EA    | EA   | EA   | EA   | EB   |
| 330 nF | DA    | DA   | DA   | DA   |      | EB    | EB   | EB   | EB   | EB   |
| 470 nF | DA    | DA   | DA   | DA   | DA   | EB    | EB   | EB   | EB   | EB   |
| 680 nF | DA    | DA   | DA   | DA   |      | EB    | EB   | EB   | EB   | EB   |
| 1.0 µF | DA    | DA   | DA   | DA   | DB   | EB    | EB   | EB   | EB   | EB   |
| 2.2 µF | DA    | DA   | DC   |      |      | EB    | EB   | EB   | EB   | EB   |
| 4.7 µF | DC    |      |      |      |      | EB    | EB   | EB   | EB   |      |
| 10 µF  |       |      |      |      |      | EB    | EB   | EB   |      |      |
| 22 µF  |       |      |      |      |      |       |      |      |      |      |

**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 FOR X7R**

Table 4 Size 1206

| CAP.   | 1206  |      |      |      |      |
|--------|-------|------|------|------|------|
|        | 6.3 V | 10 V | 16 V | 25 V | 50 V |
| 100 pF |       |      |      |      |      |
| 150 pF |       |      |      |      |      |
| 220 pF | F0    | F0   | F0   | F0   | F0   |
| 330 pF | F0    | F0   | F0   | F0   | F0   |
| 470 pF | F0    | F0   | F0   | F0   | F0   |
| 680 pF | F0    | F0   | F0   | F0   | F0   |
| 1.0 nF | F0    | F0   | F0   | F0   | F0   |
| 1.5 nF | F0    | F0   | F0   | F0   | F0   |
| 2.2 nF | F0    | F0   | F0   | F0   | F0   |
| 3.3 nF | F0    | F0   | F0   | F0   | F0   |
| 4.7 nF | F0    | F0   | F0   | F0   | F0   |
| 6.8 nF | F0    | F0   | F0   | F0   | F0   |
| 10 nF  | F0    | F0   | F0   | F0   | F0   |
| 15 nF  | F0    | F0   | F0   | F0   | F0   |
| 22 nF  | F0    | F0   | F0   | F0   | F0   |
| 33 nF  | F0    | F0   | F0   | F0   | F0   |
| 47 nF  | F0    | F0   | F0   | F0   | F0   |
| 68 nF  | F0    | F0   | F0   | F0   | F0   |
| 100 nF | F0    | F0   | F0   | F0   | F0   |
| 150 nF | F0    | F0   | F0   | F0   | FA   |
| 220 nF | F0    | F0   | F0   | F0   | FA   |
| 330 nF | F0    | F0   | F0   | F0   | F0   |
| 470 nF | F0    | F0   | F0   | F0   | FI   |
| 680 nF | FA    | FA   | FA   | FA   | FC   |
| 1.0 μF | FA    | FA   | FA   | FA   | FC   |
| 2.2 μF | FA    | FA   | FA   | FA   | FC   |
| 4.7 μF | FC    | FC   | FC   | FC   | FC   |
| 10 μF  | FC    | FC   | FC   | FC   |      |
| 22 μF  | FC    | FC   | FD   |      |      |
| 47 μF  |       |      |      |      |      |

**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
4. Please contact local sales force for special ordering code before ordering

**CAPACITANCE RANGE & THICKNESS FOR X7R**

Table 5 Sizes from 1210 to 1812

| CAP.   | 1210  |      | 16 V |      |      | 50 V |      | 1812 |
|--------|-------|------|------|------|------|------|------|------|
|        | 6.3 V | 10 V | 16 V | 25 V | 50 V | 50 V | 50 V |      |
| 100 pF |       |      |      |      |      |      |      |      |
| 150 pF |       |      |      |      |      |      |      |      |
| 220 pF |       |      |      |      |      |      |      |      |
| 330 pF |       |      |      |      |      |      |      |      |
| 470 pF |       |      |      |      |      |      |      |      |
| 680 pF |       |      |      |      |      |      |      |      |
| 1.0 nF |       |      |      |      |      |      |      |      |
| 1.5 nF |       |      |      |      |      |      |      |      |
| 2.2 nF | G0    | G0   | G0   | G0   | G0   | G0   |      |      |
| 3.3 nF | G0    | G0   | G0   | G0   | G0   | G0   |      |      |
| 4.7 nF | G0    | G0   | G0   | G0   | G0   | G0   | JA   |      |
| 6.8 nF | G0    | G0   | G0   | G0   | G0   | G0   | JA   |      |
| 10 nF  | G0    | G0   | G0   | G0   | G0   | G0   | JA   |      |
| 15 nF  | G0    | G0   | G0   | G0   | G0   | G0   | JA   |      |
| 22 nF  | G0    | G0   | G0   | G0   | G0   | G0   | JA   |      |
| 33 nF  | G0    | G0   | G0   | G0   | G0   | G0   | JA   |      |
| 47 nF  | G0    | G0   | G0   | G0   | G0   | G0   | JA   |      |
| 68 nF  | G0    | G0   | G0   | G0   | G0   | G0   | JA   |      |
| 100 nF | G0    | G0   | G0   | G0   | G0   | G0   | JB   |      |
| 150 nF | G0    | G0   | G0   | G0   | G0   | G1   | JB   |      |
| 220 nF | G0    | G0   | G0   | G0   | G0   | G1   | JB   |      |
| 330 nF | G0    | G0   | G0   | G0   | G0   | G1   | JB   |      |
| 470 nF | G1    | G1   | G1   | G1   | G1   | GA   | JB   |      |
| 680 nF | G1    | G1   | G1   | G1   | G1   | GA   | JC   |      |
| 1.0 µF | GA    | GA   | GA   | GA   | GA   | GA   | JC   |      |
| 2.2 µF | G3    | G3   | G3   | G3   | G3   | G3   |      |      |
| 4.7 µF | GB    | GB   | GB   | GB   | GB   | GD   |      |      |
| 10 µF  | GB    | GB   | GB   | GB   | GB   | GD   |      |      |
| 22 µF  | GC    | GC   | GC   | GC   | GC   |      |      |      |
| 47 µF  | GC    | GC   |      |      |      |      |      |      |

**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
4. Please contact local sales force for special ordering code before ordering

**THICKNESS CLASSES AND PACKING QUANTITY**

Table 6

| SIZE CODE | THICKNESS CLASSIFICATION | TAPE WIDTH<br>QUANTITY PER REEL | Ø180 MM / 7 INCH |                | Ø330 MM / 13 INCH |         | QUANTITY PER BULK CASE |
|-----------|--------------------------|---------------------------------|------------------|----------------|-------------------|---------|------------------------|
|           |                          |                                 | 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            | ---     | 50,000                 |
| 0603      | 0.8 ±0.1 mm              | 8 mm                            | 4,000            | ---            | 15,000            | ---     | 15,000                 |
| 0805      | 0.6 ±0.1 mm              | 8 mm                            | 4,000            | ---            | 20,000            | ---     | 10,000                 |
|           | 0.85 ±0.1 mm             | 8 mm                            | 4,000            | ---            | 15,000            | ---     | 8,000                  |
|           | 1.25 ±0.2 mm             | 8 mm                            | ---              | 3,000          | ---               | 10,000  | 5,000                  |
| 1206      | 0.6 ±0.1 mm              | 8 mm                            | 4,000            | ---            | 20,000            | ---     | ---                    |
|           | 0.85 ±0.1 mm             | 8 mm                            | 4,000            | ---            | 15,000            | ---     | ---                    |
|           | 1.00 / 1.15 ±0.1 mm      | 8 mm                            | ---              | 3,000          | ---               | 10,000  | ---                    |
|           | 1.25 ±0.2 mm             | 8 mm                            | ---              | 3,000          | ---               | 10,000  | ---                    |
|           | 1.6 ±0.15 mm             | 8 mm                            | ---              | 2,500          | ---               | 10,000  | ---                    |
|           | 1.6 ±0.2 mm              | 8 mm                            | ---              | 2,000          | ---               | 8,000   | ---                    |
| 1210      | 0.6 / 0.7 ±0.1 mm        | 8 mm                            | ---              | 4,000          | ---               | 15,000  | ---                    |
|           | 0.85 ±0.1 mm             | 8 mm                            | ---              | 4,000          | ---               | 10,000  | ---                    |
|           | 1.15 ±0.1 mm             | 8 mm                            | ---              | 3,000          | ---               | 10,000  | ---                    |
|           | 1.15 ±0.15 mm            | 8 mm                            | ---              | 3,000          | ---               | 10,000  | ---                    |
|           | 1.25 ±0.2 mm             | 8 mm                            | ---              | 3,000          | ---               | ---     | ---                    |
|           | 1.5 ±0.1 mm              | 8 mm                            | ---              | 2,000          | ---               | ---     | ---                    |
|           | 1.6 / 1.9 ±0.2 mm        | 8 mm                            | ---              | 2,000          | ---               | ---     | ---                    |
|           | 2.0 ±0.2 mm              | 8 mm                            | ---              | 2,000<br>1,000 | ---               | ---     | ---                    |
| 1808      | 1.15 ±0.15 mm            | 12 mm                           | ---              | 3,000          | ---               | ---     | ---                    |
|           | 1.25 ±0.2 mm             | 12 mm                           | ---              | 3,000          | ---               | ---     | ---                    |
|           | 1.35 ±0.15 mm            | 12 mm                           | ---              | 2,000          | ---               | ---     | ---                    |
|           | 1.5 ±0.1 mm              | 12 mm                           | ---              | 2,000          | ---               | ---     | ---                    |
|           | 1.6 ±0.2 mm              | 12 mm                           | ---              | 2,000          | ---               | 8,000   | ---                    |
|           | 2.0 ±0.2 mm              | 12 mm                           | ---              | 2,000          | ---               | ---     | ---                    |
| 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          | ---               | ---     | ---                    |
|           | 1.5 ±0.1 mm              | 12 mm                           | ---              | 1,000          | ---               | ---     | ---                    |
|           | 1.6 ±0.2 mm              | 12 mm                           | ---              | 1,000          | ---               | ---     | ---                    |
|           | 2.0 ±0.2 mm              | 12 mm                           | ---              | 1,000          | ---               | ---     | ---                    |
|           | 2.5 ±0.2 mm              | 12 mm                           | ---              | 500            | ---               | ---     | ---                    |



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 7

| DESCRIPTION   |                                 |   |  |  |  |  |      | VALUE   |
|---|---------------------------------|---|--|--|--|--|------|---|
| Capacitance range   |                                 |   |  |  |  |  |      | 100 pF to 47 μF   |
| Capacitance tolerance   |                                 |   |  |  |  |  |      | ±5%, ±10%, ±20%   |
| Dissipation factor (D.F.)   |                                 |   |  |  |  |  |      |   |
| X7R   |                                 | 0201  | 0402   | 0603   | 0805   | 1206                                   | 1210 |   |
| ≤10V  | 100pF to 10nF                   | 100pF to 100nF<br>100nF 220nF to 470nF          | 100pF to 1μF<br>2.2μF to 4.7μF<br>1 μF               | 150pF to 2.2μF<br>4.7μF to 10μF                                    | 220pF to 2.2μF<br>4.7μF to 22μF                  | 2.2nF to 2.2μF<br>4.7μF to 47μF        |      | ≤5%<br>≤10%<br>≤12.5%   |
| 16V   | 100pF to 1.2nF<br>1.5nF to 10nF | 100pF to 22nF<br>27nF to 100nF<br>220nF         | 100pF to 220nF<br>470nF to 1.0μF<br>2.2μF            | 150pF to 470nF<br>680 nF to 2.2μF<br>4.7μF to 10μF                 | 220pF to 1μF<br>2.2μF<br>4.7μF to 22μF           | 2.2nF to 1μF<br>2.2μF<br>4.7μF to 22μF |      | ≤ 3.5%<br>≤ 5%<br>≤10%  |
| 25V   | 100pF to 470pF<br>560pF to 10nF | 100pF to 10nF<br>12 nF to 47nF<br>56nF to 100nF | 100pF to 39nF<br>47nF to 220nF<br>270nF to 1μF       | 150pF to 180nF<br>220nF to 470nF<br>680nF to 1μF<br>2.2μF to 4.7μF | 220pF to 680nF<br>1 μF<br>2.2μF to 22μF          | 2.2nF to 1μF<br>2.2μF<br>4.7μF to 22μF |      | ≤ 2.5%<br>≤ 3.5%<br>≤ 5%<br>≤10%  |
| 50V   | 100pF to 1nF                    | 100pF to 10nF<br>12 nF to 47nF                  | 100pF to 39nF<br>47nF to 220nF<br>100nF 470nF to 1μF | 150pF to 180nF<br>220nF to 470nF<br>680nF<br>1 μF to 2.2μF         | 220pF to 470nF<br>680nF to 1μF<br>2.2μF to 4.7μF | 2.2nF to 1μF<br>2.2μF to 10μF          |      | ≤2.5%<br>≤ 3.5%<br>≤ 5%<br>≤10%   |
| Insulation resistance after 1 minute at U <sub>r</sub> (DC)                                       |                                 |   |  |  |  |  |      | R <sub>ins</sub> ≥ 10 GΩ or R <sub>ins</sub> × C <sub>r</sub> ≥ 500/100/50* seconds whichever is less |
| Maximum capacitance change as a function of temperature (temperature characteristic/coefficient): |                                 |   |  |  |  |  |      | ±15%  |
| Operating temperature range:  |                                 |   |  |  |  |  |      | -55 °C to +125 °C   |

**NOTE**

\* R<sub>ins</sub> ≥ 10 GΩ or R<sub>ins</sub> × C<sub>r</sub> ≥ 500Ω.F:

- 0201 : 100pF to 10nF
- 0402 : 100pF to 220nF
- 0603 : 100pF to 1uF
- 0805 : 220pF to 1uF, 2.2uF/6.3V to 16V
- 1206/1210 : 220pF to 1uF, 2.2uF/6.3V to 25V, 4.7uF/6.3V to 16V
- 1812 : 4.7nF to 1uF

\* R<sub>ins</sub> × C<sub>r</sub> ≥ 100Ω.F:

- 0201 : 100nF/6.3V
- 0402 : 470nF/6.3V to 10V
- 0603 : 2.2uF/6.3V to 16V
- 0805 : 2.2uF/25V to 50V, 4.7uF/6.3V to 25V  
10uF/6.3V to 16V
- 1206 : 2.2uF/50V, 4.7uF/25V to 50V, 10uF/6.3V to 25V, 22uF/6.3V to 16V
- 1210 : 2.2uF/50V, 4.7uF/25V to 50V, 10uF/6.3V to 50V, 22uF/6.3V to 16V, 47uF/6.3V to 10V

\* R<sub>ins</sub> × C<sub>r</sub> ≥ 50Ω.F:

- 0402 : 1uF/6.3V
- 0603 : 4.7uF/6.3V



**Fig. 3** Typical capacitance change as a function of temperature

Size 0201 10 nF / 16 V  
Solid lines: Impedance / Dotted lines: ESR



**Fig. 4** Impedance ESR vs. frequency characteristics for multilayer chip capacitors

Size 0402 100 nF / 16 V  
Solid lines: Impedance / Dotted lines: ESR



**Fig. 5** Impedance ESR vs. frequency characteristics for multilayer chip capacitors

Size 0603 1  $\mu$ F / 16 V  
Solid lines: Impedance / Dotted lines: ESR



**Fig. 6** Impedance ESR vs. frequency characteristics for multilayer chip capacitors

Size 0805 1  $\mu$ F / 16 V  
Solid lines: Impedance / Dotted lines: ESR



**Fig. 7** Impedance ESR vs. frequency characteristics for multilayer chip capacitors

Size 1206 1  $\mu$ F / 25 V  
Solid lines: Impedance / Dotted lines: ESR



**Fig. 8** Impedance ESR vs. frequency characteristics for multilayer chip capacitors

Size 1206 10  $\mu$ F / 10 V  
Solid lines: Impedance / Dotted lines: ESR



**Fig. 9** Impedance ESR vs. frequency characteristics for multilayer chip capacitors

**SOLDERING RECOMMENDATION**

Table 8

| SOLDERING METHOD | SIZE        |          |        |          |          |             |
|------------------|-------------|----------|--------|----------|----------|-------------|
|                  | 0201        | 0402     | 0603   | 0805     | 1206     | ≥ 1210      |
| Reflow           | Reflow only | > 100 nF | > 1 μF | > 2.2 μF | > 4.7 μF | Reflow only |
| Reflow/Wave      |             | ≤ 100 nF | ≤ 1 μF | ≤ 2.2 μF | ≤ 4.7 μF | ---         |

**TESTS AND REQUIREMENTS**

Table 9 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 × 10 magnification   | In accordance with specification |
| Capacitance <sup>(1)</sup>               | 4.5.1           | Class 2:   | Within specified tolerance       |
| Dissipation Factor (D.F.) <sup>(1)</sup> | 4.5.2           | At 20 °C, 24 hrs after annealing<br>Cap ≤ 1 μF, f = 1 KHz, measuring at voltage 1 Vrms at 20 °C<br>Cap > 1 μF, f = 1 KHz for C ≤ 10 μF, rated voltage > 6.3 V, measuring at voltage 1 Vrms at 20 °C<br>f = 1 KHz, for C ≤ 10 μF, rated voltage ≤ 6.3 V, measuring at voltage 0.5 Vrms at 20 °C<br>f = 120 Hz for C > 10 μF, measuring at voltage 0.5 Vrms at 20 °C |                                  |
| Insulation Resistance                    | 4.5.3           | At U <sub>r</sub> (DC) for 1 minute  | In accordance with specification |

**NOTE:**

I. For individual product specification, please contact local sales.

| 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 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</p> <p>Temperature Coefficient shall be calculated from the formula as below</p> $\text{Temp. Coefficient} = \frac{C2 - C1}{C1 \times \Delta T} \times 10^6 \text{ [ppm/°C]}$ <p>C1: Capacitance at step c<br/>                     C2: Capacitance at 125°C<br/>                     ΔT: 100°C(=125°C-25°C)</p> <p>(2) Class II</p> <p>Capacitance Change shall be calculated from the formula as below</p> $\Delta C = \frac{C2 - C1}{C1} \times 100\%$ <p>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 | Upper Temperature±2°C | e | 25±2 | <p>&lt;General purpose series&gt;</p> <p>Class1:<br/>                     Δ C/C: ±30ppm</p> <p>Class2:<br/>                     X7R: Δ C/C: ±15%<br/>                     Y5V: Δ C/C: 22~-82%</p> <p>&lt;High Capacitance series&gt;</p> <p>Class2:<br/>                     X7R/X5R: Δ C/C: ±15%<br/>                     Y5V: Δ C/C: 22~-82%</p> |
| Step                       | Temperature(°C)       |   |   |                 |   |      |   |                       |   |      |   |                       |   |      |  |
| a                          | 25±2                  |   |   |                 |   |      |   |                       |   |      |   |                       |   |      |  |
| b                          | Lower temperature±3°C |   |   |                 |   |      |   |                       |   |      |   |                       |   |      |  |
| c                          | 25±2                  |   |   |                 |   |      |   |                       |   |      |   |                       |   |      |  |
| d                          | Upper Temperature±2°C |   |   |                 |   |      |   |                       |   |      |   |                       |   |      |  |
| e                          | 25±2                  |   |   |                 |   |      |   |                       |   |      |   |                       |   |      |  |
| Adhesion                   | 4.7                   | <p>A force applied for 10 seconds to the line joining the terminations and in a plane parallel to the substrate</p>   | <p>Force</p> <p>size ≥ 0603: 5N<br/>                     size = 0402: 2.5N<br/>                     size = 0201: 1N</p> |                 |   |      |   |                       |   |      |   |                       |   |      |  |

| TEST | TEST METHOD | PROCEDURE | REQUIREMENTS |
|------|-------------|-----------|--------------|
|------|-------------|-----------|--------------|

|               |     |  |                   |
|---------------|-----|--|-------------------|
| Bond Strength | 4.8 | Mounting in accordance with IEC 60384-22 paragraph 4.3 | No visible damage |
|---------------|-----|--|-------------------|

Conditions: bending 1 mm at a rate of 1 mm/s, radius jig 5 mm

Test Substrate:



$\Delta C/C$   
 Class2:  
 <General purpose series>  
 X7R:  $\pm 10\%$   
 <High Capacitance series>  
 X7R:  $\pm 12.5\%$

| 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  |

|                              |     |  |  |
|------------------------------|-----|--|--|
| 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>Preheating: for size $\leq$ 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 $\pm 5$ °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 |
|------------------------------|-----|--|--|

$\Delta C/C$   
 Class2:  
 X7R:  $\pm 10\%$

D.F. within initial specified value  
 $R_{THS}$  within initial specified value



| TEST                        | TEST METHOD          | PROCEDURE   | REQUIREMENTS  |
|-----------------------------|----------------------|---|---|
| Solderability               | IEC 60384-21/22 4.10 | <p>Preheated to a temperature of 80 °C to 140 °C and maintained for 30 seconds to 60 seconds.</p> <p>1. Temperature: 235±5°C / Dipping time: 2 ±0.5 s</p> <p>2. Temperature: 245±5°C / Dipping time: 3 ±0.5 s (lead free)</p> <p>Depth of immersion: 10mm</p>         | The solder should cover over 95% of the critical area of each termination   |
| 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><br/>Class2:<br/>X7R: ±15%</p> <hr/> <p>D.F. meet initial specified value<br/><math>R_{ins}</math> meet initial specified value</p> |

| TEST                               | TEST METHOD          | PROCEDURE  | REQUIREMENTS  |
|------------------------------------|----------------------|--|---|
| Damp Heat with U <sub>r</sub> Load | IEC 60384-21/22 4.13 | <ol style="list-style-type: none"> <li>Preconditioning, class 2 only:<br/>150 +0/-10 °C /1 hour, then keep for 24 ± 1 hour at room temp</li> <li>Initial measure:<br/>Spec: refer to initial spec C, D, IR</li> <li>Damp heat test:<br/>500 ± 12 hours at 40 ± 2 °C;<br/>90 to 95% R.H. 1.0 U<sub>r</sub> applied</li> <li>Recovery:<br/>Class 2: 24 ± 2 hours</li> <li>Final measure: C, D, IR</li> </ol> <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 preconditioned according to "IEC 60384 4.1" and then the requirement shall be met.</p> | <p>No visual damage after recovery</p> <hr/> <p>&lt;General Purpose series&gt;</p> <p>ΔC/C<br/>Class2:<br/>X7R: ±15%<br/>D.F.<br/>Class2:<br/>X7R: ≤ 16V: ≤ 7%<br/>          ≥ 25V: ≤ 5%</p> <p>R<sub>ins</sub><br/>Class2:<br/>X7R: ≥ 500 MΩ or R<sub>ins</sub> × C<sub>r</sub> ≥ 25s<br/>whichever is less</p> <p>&lt;High Capacitance series(≥ 1uF) and CC0402xRX7R9BB104&gt;</p> <p>ΔC/C<br/>Class2:<br/>X7R: ±20%<br/>D.F.<br/>Class2:<br/>X7R: 2 × initial value max</p> <p>R<sub>ins</sub><br/>Class2:<br/>X7R: 500 MΩ or R<sub>ins</sub> × C<sub>r</sub> ≥ 5s<br/>whichever is less</p> |

| TEST          | TEST METHOD              | PROCEDURE  | REQUIREMENTS  |
|---------------|--------------------------|--|---|
| Endurance     | IEC 60384- 4.14<br>21/22 | <p>1. Preconditioning, class 2 only:<br/>150 +0/-10 °C /1 hour, then keep for<br/>24 ±1 hour at room temp</p> <p>2. Initial measure:<br/>Spec: refer to initial spec C, D, IR</p> <p>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*</p> <p>4. Recovery time: 24 ±2 hours</p> <p>5. Final measure: C, D, IR</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 preconditioned according to "IEC 60384 4.1" and then the requirement shall be met.</p> <p>* General product (Applied 2.0 × U<sub>r</sub>):<br/>0201 ≤ 10nF<br/>0402 ≤ 100nF<br/>0603 ≤ 470nF<br/>0805, 1206, 1210 ≤ 1uF;</p> <p>* High cap product (Applied 1.5 × U<sub>r</sub>):<br/>0201 &gt; 10nF<br/>0402 &gt; 100nF<br/>0603 &gt; 470nF<br/>0805, 1206, 1210 &gt; 1uF;</p> | <p>No visual damage</p> <hr/> <p>&lt;General Purpose series&gt;<br/>ΔC/C<br/>Class2:<br/>X7R: ±15%<br/>D.F.<br/>Class2:<br/>X7R: ≤ 16V: ≤ 7%<br/>≥ 25V: ≤ 5%</p> <p>R<sub>ins</sub><br/>Class2:<br/>X7R: ≥ 1,000 MΩ or R<sub>ins</sub> × C<sub>r</sub> ≥ 50s<br/>whichever is less</p> <p>&lt;High Capacitance series&gt;<br/>ΔC/C<br/>Class 2:<br/>X7R: ±20%<br/>D.F.<br/>Class 2:<br/>X7R: 2 × initial value max</p> <p>R<sub>ins</sub><br/>Class 2:<br/>X7R: 1,000 MΩ or R<sub>ins</sub> × C<sub>r</sub> ≥ 10s<br/>whichever is less</p> |
| Voltage Proof | IEC 60384- 4.6<br>1      | <p>Specified stress voltage applied for 1~5 seconds<br/>U<sub>r</sub> ≤ 100 V: series applied 2.5 U<sub>r</sub><br/>Charge/Discharge current is less than 50 mA</p>  | No breakdown or flashover   |

**REVISION HISTORY**

| REVISION   | DATE            | CHANGE NOTIFICATION | DESCRIPTION   |
|------------|-----------------|---------------------|---|
| Version 18 | May. 11th, 2017 |                     | - Add 1210/10uF/50V   |
| Version 17 | Mar. 7th, 2017  | -                   | - 0805 L4 spec updated<br>- Dimension updated   |
| Version 16 | Dec. 7th, 2016  | -                   | - Dimension updated   |
| Version 15 | Oct. 3rd, 2016  | -                   | - Dimension updated, Soldering recommendation updated   |
| Version 14 | May 31st, 2016  | -                   | - Dimension updated   |
| Version 13 | Dec. 30, 2015   | -                   | - Dimension on 0603 and 1206 case size updated  |
| Version 12 | May 26, 2015    | -                   | - 1210, 25V dissipation factor updated  |
| Version 11 | Jan. 06, 2015   | -                   | - 0402, 100nF, 50V Dissipation factor (D.F.) updated.   |
| Version 10 | Jul. 08, 2014   | -                   | - Dimension updated   |
| Version 9  | Aug. 19, 2013   | -                   | - Dimension updated   |
| Version 8  | Oct. 13, 2011   | -                   | - Dimension updated<br>- 50V Dissipation factor(D.F) updated  |
| Version 7  | Jan. 13, 2011   | -                   | - Dimension updated   |
| Version 6  | Oct. 13, 2010   | -                   | - Rated voltage of 0201 extend to 50 V<br>- Capacitance range of 0201 X7R 6.3V to 16V extend to 100 pF<br>- Capacitance range of 0805 X7R 10V extend to 10 μF<br>- Capacitance range of 0805 X7R 50V extend to 1 μF<br>- Capacitance range of 1210 X7R 10V extend to 22 μF<br>- Figures of impedance ESR updated  |
| Version 5  | Jul 27, 2010    | -                   | - Dimension on 0603 and 1206 case size updated<br>- 16V to 25V Dissipation factor(D.F) updated  |
| Version 4  | Apr 21, 2010    | -                   | - The statement of "Halogen Free" on the cover added<br>- Dimension updated   |
| Version 3  | Oct 26, 2009    | -                   | - Capacitance range of 0402 X7R 25 V extend to 100 nF<br>- 16V Dissipation factor updated   |
| Version 2  | May 11, 2009    | -                   | - Product range updated   |
| Version 1  | Apr 24, 2009    | -                   | - Ordering code updated   |
| Version 0  | Apr 15, 2009    | -                   | - New datasheet for general purpose and high capacitance X7R series with RoHS compliant<br><br>- Replace the "6.3V to 50V" part of pdf files: X7R_10V_9, X7R_16V-to-100V_9, X7R_16-to-500V_9, UP-X5R_X7R_HighCaps_6.3-to-25V_11, UY-X5R_X7R_HighCaps_6.3-to-25V_11<br><br>- Combine 0201 from pdf files: UP-NP0X5RX7RY5V_0201_6.3-to-50V_2 and UY-NPOX5RX7RY5V_0201_6.3-to-50V_2<br><br>- Define global part number<br><br>- Description of "Halogen Free compliant" added<br><br>- Test method and procedure updated |

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