

# DATA SHEET

## **SURFACE-MOUNT CERAMIC MULTILAYER CAPACITORS**

High-capacitance: Class 2, X5R/X7R  
(Pb Free & RoHS compliant)

6.3 V TO 25 V

56 nF to 47  $\mu$ F



## SCOPE

This specification describes high capacitance X5R/X7R series chip capacitors with lead-free terminations.

## APPLICATIONS

- PCs, hard disk, game PCs
- Power supplies
- DVDs, camcorders
- Mobile phones, PDAs

## FEATURES

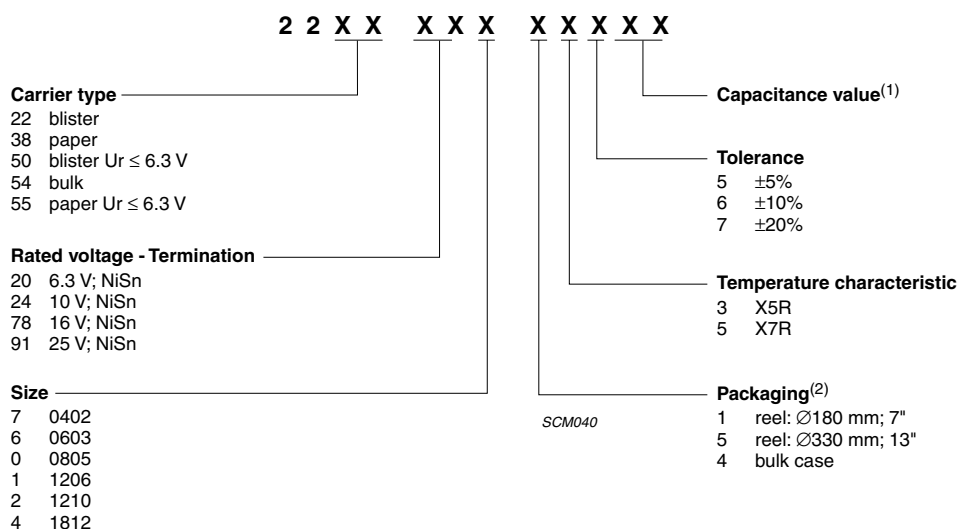
- Supplied in tape on reel
- Nickel-barrier end termination

## ORDERING INFORMATION

Components may be ordered by using either a Phycomp's unique I2NC or Phycomp clear text code.

## PHYCOMP ORDERING CODE

### I2NC CODE



(1) Refer to "Conversion table of capacitance & last 2 digits of I2NC"

(2) Quantity on reel depends on thickness classification; see section "Thickness classification and packing quantities for 6.3 V to 25 V".

**Conversion table of capacitance & last 2 digits of 12NC**

| CAP.<br>(nF) | LAST 2 DIGITS<br>OF 12NC | CAP.<br>(nF) | LAST 2 DIGITS<br>OF 12NC | CAP.<br>(nF) | LAST 2 DIGITS<br>OF 12NC | CAP.<br>(nF) | LAST 2 DIGITS<br>OF 12NC |
|--------------|--------------------------|--------------|--------------------------|--------------|--------------------------|--------------|--------------------------|
| 0.10         | 09                       | 1.8          | 26                       | 33           | 43                       | 560          | 59                       |
| 0.12         | 11                       | 2.2          | 27                       | 39           | 44                       | 680          | 61                       |
| 0.15         | 12                       | 2.7          | 28                       | 47           | 45                       | 820          | 62                       |
| 0.18         | 13                       | 3.3          | 29                       | 56           | 46                       | 1,000        | 63                       |
| 0.22         | 14                       | 3.9          | 31                       | 68           | 47                       | 1,500        | 65                       |
| 0.27         | 15                       | 4.7          | 32                       | 82           | 48                       | 2,200        | 67                       |
| 0.33         | 16                       | 5.6          | 33                       | 100          | 49                       | 3,300        | 69                       |
| 0.39         | 17                       | 6.8          | 34                       | 120          | 51                       | 4,700        | 72                       |
| 0.47         | 18                       | 8.2          | 35                       | 150          | 52                       | 6,800        | 74                       |
| 0.56         | 19                       | 10           | 36                       | 180          | 53                       | 10,000       | 76                       |
| 0.68         | 21                       | 12           | 37                       | 220          | 54                       | 22,000       | 81                       |
| 0.82         | 22                       | 15           | 38                       | 270          | 55                       | 47,000       | 85                       |
| 1.0          | 23                       | 18           | 39                       | 330          | 56                       | 100,000      | 89                       |
| 1.2          | 24                       | 22           | 41                       | 390          | 57                       |              |                          |
| 1.5          | 25                       | 27           | 42                       | 470          | 58                       |              |                          |

**NOTE**

1. This table is applied to all X5R, X7R, Y5V, and Z5U products except Y5V 50 V products.

**CTC CODE**

| Size<br>code | Temp.<br>Char. | Capacitance               | Tolerance      | Rated<br>voltage | Termination | Packing                 | Marking        | Series  |
|--------------|----------------|---------------------------|----------------|------------------|-------------|-------------------------|----------------|---------|
| 0402         | 2B = X5R       | 225 = 2,200,000 pF; the   | J = $\pm 5\%$  | 5 = 6.3 V        | B = NiSn    | 2 = 180 mm; 7" paper    | 0 = No marking | D = BNE |
| 0603         | 2R = X7R       | third digit signifies the | K = $\pm 10\%$ | 6 = 10 V         |             | 3 = 330 mm; 13" paper   |                |         |
| 0805         |                | multiplying factor:       | M = $\pm 20\%$ | 7 = 16 V         |             | B = 180 mm; 7" blister  |                |         |
| 1206         |                | 3 = $\times 1,000$        |                | 8 = 25 V         |             | F = 330 mm; 13" blister |                |         |
| 1210         |                | 4 = $\times 10,000$       |                |                  |             | P = Bulk case           |                |         |
| 1812         |                | 5 = $\times 100,000$      |                |                  |             |                         |                |         |
|              |                | 6 = $\times 1,000,000$    |                |                  |             |                         |                |         |
|              |                | 7 = $\times 10,000,000$   |                |                  |             |                         |                |         |

**Example: 06032B225M5B20D**

## 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. I.

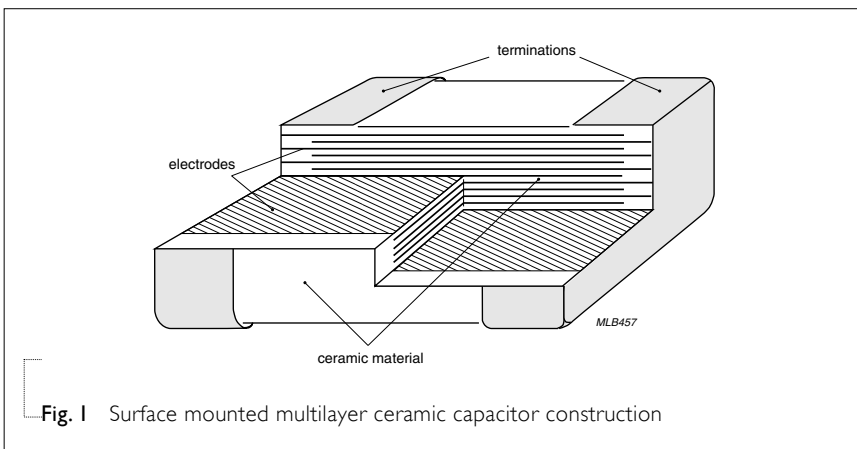


Fig. I Surface mounted multilayer ceramic capacitor construction

## DIMENSION

For dimension see Table I

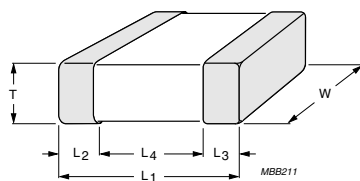


Fig. 2 Surface mounted multilayer ceramic capacitor dimension

Table I

| TYPE           | CC0402                | CC0603         | CC0805          | CC1206         | CC1210         | CC1812         |
|----------------|-----------------------|----------------|-----------------|----------------|----------------|----------------|
| $L_1$ (mm)     | $1.0 \pm 0.05$        | $1.6 \pm 0.10$ | $2.0 \pm 0.20$  | $3.2 \pm 0.20$ | $3.2 \pm 0.20$ | $4.5 \pm 0.20$ |
| $W$ (mm)       | $0.5 \pm 0.05$        | $0.8 \pm 0.07$ | $1.25 \pm 0.20$ | $1.6 \pm 0.20$ | $2.5 \pm 0.20$ | $3.2 \pm 0.20$ |
| $T$ (mm)       | Refer to table 2 to 4 |                |                 |                |                |                |
| $L_2/L_3$ (mm) | min.                  | 0.15           | 0.20            | 0.25           | 0.25           | 0.25           |
|                | max.                  | 0.30           | 0.50            | 0.75           | 0.75           | 0.75           |
| $L_4$ (mm)     | min.                  | 0.40           | 0.60            | 0.55           | 1.40           | 2.20           |

CAPACITANCE RANGE & THICKNESS FOR X5R/X7R 6.3 V

Table 2

| CAPACITANCE<br>( $\mu$ F) | 6.3 V<br>0402  | 0603           | 0805           | 1206          | 1210          |
|---------------------------|----------------|----------------|----------------|---------------|---------------|
| 0.056                     |                |                |                |               |               |
| 0.068                     |                |                |                |               |               |
| 0.082                     |                |                |                |               |               |
| 0.10                      | 0.5 $\pm$ 0.05 |                |                |               |               |
| 0.12                      |                |                |                |               |               |
| 0.15                      |                |                |                |               |               |
| 0.18                      |                |                |                |               |               |
| 0.22                      |                |                |                |               |               |
| 0.27                      |                |                |                |               |               |
| 0.33                      |                |                |                |               |               |
| 0.39                      |                |                |                |               |               |
| 0.47                      |                |                |                |               |               |
| 0.56                      |                |                |                |               |               |
| 0.68                      |                |                |                |               |               |
| 0.82                      |                |                |                |               |               |
| 1.0                       |                | 0.8 $\pm$ 0.07 |                |               |               |
| 1.5                       |                | 0.8 $\pm$ 0.1  |                |               |               |
| 2.2                       |                |                | 1.25 $\pm$ 0.1 |               |               |
| 3.3                       |                |                | 1.25 $\pm$ 0.2 |               |               |
| 4.7                       |                |                |                |               |               |
| 6.8                       |                |                |                |               |               |
| 10                        |                |                |                | 1.6 $\pm$ 0.2 |               |
| 22                        |                |                |                |               | 2.5 $\pm$ 0.2 |
| 47                        |                |                |                |               |               |

NOTE

- Values in shaded cells indicate thickness class in mm.
- X5R: ; X7R: ; both X5R and X7R: .

# CAPACITANCE RANGE & THICKNESS FOR X5R/X7R 10V

Table 3

| CAPACITANCE<br>(μF) | 10 V<br>0402 | 0603      | 0805      | 1206      | 1210     |
|---------------------|--------------|-----------|-----------|-----------|----------|
| 0.056               | 0.5 ±0.05    |           |           |           |          |
| 0.068               |              |           |           |           |          |
| 0.082               |              |           |           |           |          |
| 0.10                |              | 0.5 ±0.05 |           |           |          |
| 0.12                | 0.5 ±0.05    |           |           |           |          |
| 0.15                |              |           |           |           |          |
| 0.18                |              |           |           |           |          |
| 0.22                |              |           |           |           |          |
| 0.27                |              | 0.8 ±0.07 |           |           |          |
| 0.33                |              |           |           |           |          |
| 0.39                |              |           |           |           |          |
| 0.47                |              |           |           |           |          |
| 0.56                |              | 0.8 ±0.07 |           |           |          |
| 0.68                |              |           |           |           |          |
| 0.82                |              |           |           |           |          |
| 1.0                 |              |           |           | 1.25 ±0.1 |          |
| 1.5                 |              | 0.8 ±0.1  |           |           |          |
| 2.2                 |              |           | 1.25 ±0.1 |           |          |
| 3.3                 |              |           | 1.25 ±0.2 |           |          |
| 4.7                 |              |           |           | 1.6 ±0.2  |          |
| 6.8                 |              |           |           | 1.6 ±0.2  |          |
| 10                  |              |           |           |           | 1.9 ±0.2 |
| 22                  |              |           |           |           | 2.5 ±0.2 |

## NOTE

- Values in shaded cells indicate thickness class in mm.
- X5R:  ; X7R:  ; both X5R and X7R:  .

CAPACITANCE RANGE & THICKNESS FOR X5R/X7R 16V TO 25V

Table 4

| CAPACITANCE<br>( $\mu$ F) | 16V<br>0402    | 0603           | 0805           | 1206           | 1210          | 1812          | 25V<br>0603    | 1206          | 1210          |
|---------------------------|----------------|----------------|----------------|----------------|---------------|---------------|----------------|---------------|---------------|
| 0.056                     | 0.5 $\pm$ 0.05 |                |                |                |               |               |                |               |               |
| 0.068                     |                |                |                |                |               |               |                |               |               |
| 0.082                     |                |                |                |                |               |               |                |               |               |
| 0.10                      |                |                |                |                |               |               |                |               |               |
| 0.12                      |                | 0.8 $\pm$ 0.07 |                |                |               |               |                |               |               |
| 0.15                      |                |                |                |                |               |               |                |               |               |
| 0.18                      |                |                |                |                |               |               |                |               |               |
| 0.22                      |                |                |                |                |               |               |                |               |               |
| 0.27                      |                |                |                |                |               |               |                |               |               |
| 0.33                      |                |                |                |                |               |               | 0.8 $\pm$ 0.07 |               |               |
| 0.39                      |                |                |                |                |               |               |                |               |               |
| 0.47                      |                |                |                |                |               |               |                |               |               |
| 0.56                      |                |                | 1.25 $\pm$ 0.2 |                |               |               |                |               |               |
| 0.68                      |                |                |                |                |               |               |                |               |               |
| 0.82                      |                |                |                |                |               |               |                |               |               |
| 1.0                       |                |                |                |                |               |               |                | 1.6 $\pm$ 0.2 |               |
| 1.5                       |                |                |                |                |               |               |                |               |               |
| 2.2                       |                |                |                | 1.15 $\pm$ 0.1 |               |               |                |               |               |
| 3.3                       |                |                |                |                | 1.9 $\pm$ 0.2 |               |                |               | 1.9 $\pm$ 0.2 |
| 4.7                       |                |                |                | 1.6 $\pm$ 0.2  | 1.9 $\pm$ 0.2 |               |                |               |               |
| 6.8                       |                |                |                |                | 2.5 $\pm$ 0.2 |               |                |               | 2.5 $\pm$ 0.2 |
| 10                        |                |                |                |                |               |               |                |               |               |
| 22                        |                |                |                |                |               | 2.5 $\pm$ 0.2 |                |               |               |

NOTE

- Values in shaded cells indicate thickness class in mm.
- X5R:  ; X7R:  ; both X5R and X7R:  .

**THICKNESS CLASSES AND PACKING QUANTITY**

Table 5

| DESCRIPTION         | SIZE CODE | THICKNESS CLASSIFICATION (mm) | 8 mm TAPE WIDTH/AMOUNT PER REEL |         |              |         | 12 mm TAPE WIDTH /AMOUNT PER REEL |        | AMOUNT PER BULK CASE |
|---------------------|-----------|-------------------------------|---------------------------------|---------|--------------|---------|-----------------------------------|--------|----------------------|
|                     |           |                               | Ø180 mm, 7"                     |         | Ø330 mm, 13" |         | Ø180 mm, 7" Blister               |        |                      |
|                     |           |                               | Paper                           | Blister | Paper        | Blister |                                   |        |                      |
| Discrete capacitors | 0201      | 0.3 ±0.03                     | 15,000                          | ---     | 50,000       | ---     | ---                               | ---    |                      |
|                     | 0402      | 0.5 ±0.05                     | 10,000                          | ---     | 50,000       | ---     | ---                               | 50,000 |                      |
|                     | 0603      | 0.8 ±0.07                     | 4,000                           | ---     | 15,000       | ---     | ---                               | 15,000 |                      |
|                     | 0805      | 0.6 ±0.10                     | 4,000                           | ---     | 20,000       | ---     | ---                               | 10,000 |                      |
|                     |           | 0.85 ±0.1                     | 4,000                           | ---     | 15,000       | ---     | ---                               | 8,000  |                      |
|                     |           | 1.25 ±0.10                    | ---                             | 3,000   | ---          | 10,000  | ---                               | 5,000  |                      |
|                     | 1206      | 0.6 ±0.10                     | 4,000                           | ---     | 20,000       | ---     | ---                               | ---    |                      |
|                     |           | 0.85 ±0.10                    | 4,000                           | ---     | 15,000       | ---     | ---                               | ---    |                      |
|                     |           | 1.00 / 1.15 ±0.10             | ---                             | 3,000   | ---          | 10,000  | ---                               | ---    |                      |
|                     |           | 1.6 ±0.15                     | ---                             | 2 500   | ---          | 10,000  | ---                               | ---    |                      |
|                     |           | 1.6 ±0.20                     | ---                             | 2,000   | ---          | 10,000  | ---                               | ---    |                      |
|                     | 1210      | 0.6 / 0.7 ±0.10               | ---                             | 4,000   | ---          | 15,000  | ---                               | ---    |                      |
|                     |           | 0.85 ±0.10                    | ---                             | 4,000   | ---          | 10,000  | ---                               | ---    |                      |
|                     |           | 1.15 ±0.10                    | ---                             | 3,000   | ---          | 10,000  | ---                               | ---    |                      |
|                     |           | 1.15 ±0.15                    | ---                             | 3,000   | ---          | 10,000  | ---                               | ---    |                      |
|                     |           | 1.5 ±0.10                     | ---                             | 2,000   | ---          | ---     | ---                               | ---    |                      |
|                     |           | 1.6 / 1.9 ±0.20               | ---                             | 2,000   | ---          | ---     | ---                               | ---    |                      |
|                     |           | 2.5 ±0.20                     | ---                             | 1,000   | ---          | ---     | ---                               | ---    |                      |
|                     | 1808      | 1.15 ±0.15                    | ---                             | ---     | ---          | ---     | 1 500                             | ---    |                      |
|                     |           | 1.35 ±0.15                    | ---                             | ---     | ---          | ---     | 1,000                             | ---    |                      |
|                     |           | 1.5 ±0.10                     | ---                             | ---     | ---          | ---     | 1,000                             | ---    |                      |
|                     | 1812      | 0.6 / 0.85 ±0.10              | ---                             | ---     | ---          | ---     | 2,000                             | ---    |                      |
|                     |           | 1.15 ±0.10                    | ---                             | ---     | ---          | ---     | 1,500                             | ---    |                      |
|                     |           | 1.15 ±0.15                    | ---                             | ---     | ---          | ---     | 1,500                             | ---    |                      |
|                     |           | 1.35 ±0.15                    | ---                             | ---     | ---          | ---     | 1,000                             | ---    |                      |
|                     |           | 1.5 ±0.1                      | ---                             | ---     | ---          | ---     | 1,000                             | ---    |                      |
|                     |           | 1.6 ±0.2                      | ---                             | ---     | ---          | ---     | 1,000                             | ---    |                      |
| Low inductance      | 0306      | 0.5 ±0.10                     | 4,000                           | ---     | 15,000       | ---     | ---                               | ---    |                      |
|                     | 0508      | 0.85 ±0.10                    | 4,000                           | ---     | 15,000       | ---     | ---                               | ---    |                      |
|                     | 0612      | 0.85 ±0.10                    | 4,000                           | ---     | 15,000       | ---     | ---                               | ---    |                      |
| Arrays              | 0508      | 0.6 ±0.10                     | 4,000                           | ---     | ---          | ---     | ---                               | ---    |                      |
|                     |           | 0.85 ±0.10                    | 4,000                           | ---     | ---          | ---     | ---                               | ---    |                      |
|                     | 0612      | 0.8 ±0.10                     | 4,000                           | ---     | ---          | ---     | ---                               | ---    |                      |
|                     |           | 1.2 ±0.10                     | ---                             | 3,000   | ---          | ---     | ---                               | ---    |                      |



## ELECTRICAL CHARACTERISTICS

### CLASS 2 CAPACITORS; X5R/X7R DIELECTRIC; NISN TERMINATIONS

Unless otherwise stated all electrical values apply at an ambient temperature of  $20 \pm 1$  °C, an atmospheric pressure of 86 to 106 kPa, and a relative humidity of 63 to 67%.

Table 6

| DESCRIPTION                                                                                      | VALUE                                                                                      |
|--------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------|
| Capacitance range <sup>(1)</sup>                                                                 | 56 nF to 47 µF                                                                             |
| Capacitance tolerance <sup>(1) (2)</sup>                                                         | ±5%, ±10%, and ±20%                                                                        |
| Dissipation factor (D.F.) <sup>(1)</sup>                                                         | See table 7 - 12                                                                           |
| Insulation resistance after 1 minute at $U_r$ (DC)                                               | $R_{ins} \geq 10 \text{ G}\Omega$ or $R_{ins} \times C \geq 500$ seconds whichever is less |
| Maximum capacitance change as a function of temperature (temperature characteristic/coefficient) | ±15%                                                                                       |
| Operating temperature range:                                                                     |                                                                                            |
| X5R                                                                                              | −55 °C to +85 °C                                                                           |
| X7R                                                                                              | −55 °C to +125 °C                                                                          |

### NOTE

1.  $f=1 \text{ KHz}$  for  $C \leq 10 \text{ }\mu\text{F}$ ; measuring at voltage  $1 \text{ V}_{rms}$ ;  $f=120 \text{ Hz}$  for  $C > 10 \text{ }\mu\text{F}$ ; measuring at voltage  $0.5 \text{ V}_{rms}$ .
2. ±5% capacitance tolerance is on request for capacitance value  $< 1 \text{ }\mu\text{F}$ .

**DISSIPATION FACTOR (D.F.) FOR SIZES 0402 TO 1812**
**Table 7** For size 0402 (1005 metric)

| TC  | SIZE | CAPACITANCE<br>VALUE (μF) | CAPACITANCE<br>TOLERANCE (%) | DC RATED VOLTAGE<br>(V) | DISSIPATION FACTOR-<br>D.F. (%) | THICKNESS<br>(mm) |
|-----|------|---------------------------|------------------------------|-------------------------|---------------------------------|-------------------|
| X5R | 0402 | 0.10                      | ±10; ±20                     | 6.3                     | 7.0                             | 0.50              |
| X5R | 0402 | 0.12                      | ±10; ±20                     | 6.3                     | 7.0                             | 0.50              |
| X5R | 0402 | 0.15                      | ±10; ±20                     | 6.3                     | 7.0                             | 0.50              |
| X5R | 0402 | 0.18                      | ±10; ±20                     | 6.3                     | 7.0                             | 0.50              |
| X5R | 0402 | 0.22                      | ±10; ±20                     | 6.3                     | 7.0                             | 0.50              |
| X5R | 0402 | 0.27                      | ±10; ±20                     | 6.3                     | 10.0                            | 0.50              |
| X5R | 0402 | 0.33                      | ±10; ±20                     | 6.3                     | 10.0                            | 0.50              |
| X5R | 0402 | 0.39                      | ±10; ±20                     | 6.3                     | 10.0                            | 0.50              |
| X5R | 0402 | 0.47                      | ±10; ±20                     | 6.3                     | 10.0                            | 0.50              |
| X5R | 0402 | 0.56                      | ±10; ±20                     | 6.3                     | 10.0                            | 0.50              |
| X5R | 0402 | 0.68                      | ±10; ±20                     | 6.3                     | 10.0                            | 0.50              |
| X5R | 0402 | 0.82                      | ±10; ±20                     | 6.3                     | 10.0                            | 0.50              |
| X5R | 0402 | 1.00                      | ±10; ±20                     | 6.3                     | 10.0                            | 0.50              |
| X7R | 0402 | 0.056                     | ±10; ±20                     | 10                      | 5.0                             | 0.50              |
| X7R | 0402 | 0.068                     | ±10; ±20                     | 10                      | 5.0                             | 0.50              |
| X7R | 0402 | 0.082                     | ±10; ±20                     | 10                      | 5.0                             | 0.50              |
| X5R | 0402 | 0.10                      | ±10; ±20                     | 10                      | 5.0                             | 0.50              |
| X7R | 0402 | 0.10                      | ±10; ±20                     | 10                      | 5.0                             | 0.50              |
| X5R | 0402 | 0.12                      | ±10; ±20                     | 10                      | 7.0                             | 0.50              |
| X5R | 0402 | 0.15                      | ±10; ±20                     | 10                      | 7.0                             | 0.50              |
| X5R | 0402 | 0.18                      | ±10; ±20                     | 10                      | 7.0                             | 0.50              |
| X5R | 0402 | 0.22                      | ±10; ±20                     | 10                      | 7.0                             | 0.50              |
| X5R | 0402 | 0.056                     | ±10; ±20                     | 16                      | 5.0                             | 0.50              |
| X7R | 0402 | 0.056                     | ±10; ±20                     | 16                      | 5.0                             | 0.50              |
| X5R | 0402 | 0.068                     | ±10; ±20                     | 16                      | 5.0                             | 0.50              |
| X7R | 0402 | 0.068                     | ±10; ±20                     | 16                      | 5.0                             | 0.50              |
| X5R | 0402 | 0.082                     | ±10; ±20                     | 16                      | 5.0                             | 0.50              |
| X7R | 0402 | 0.082                     | ±10; ±20                     | 16                      | 5.0                             | 0.50              |
| X5R | 0402 | 0.10                      | ±10; ±20                     | 16                      | 5.0                             | 0.50              |
| X7R | 0402 | 0.10                      | ±10; ±20                     | 16                      | 5.0                             | 0.50              |

**Table 8** For size 0603 (1608 metric)

| TC  | SIZE | CAPACITANCE<br>VALUE (μF) | CAPACITANCE<br>TOLERANCE (%) | DC RATED VOLTAGE<br>(V) | DISSIPATION FACTOR-<br>D.F. (%) | THICKNESS<br>(mm) |
|-----|------|---------------------------|------------------------------|-------------------------|---------------------------------|-------------------|
| X5R | 0603 | 1.00                      | ±10; ±20                     | 6.3                     | 7.0                             | 0.80              |
| X5R | 0603 | 1.50                      | ±10; ±20                     | 6.3                     | 10.0                            | 0.80              |
| X5R | 0603 | 2.20                      | ±10; ±20                     | 6.3                     | 10.0                            | 0.80              |
| X5R | 0603 | 3.30                      | ±10; ±20                     | 6.3                     | 10.0                            | 0.80              |
| X5R | 0603 | 4.70                      | ±20                          | 6.3                     | 10.0                            | 0.80              |
| X7R | 0603 | 0.27                      | ±10; ±20                     | 10                      | 5.0                             | 0.80              |
| X7R | 0603 | 0.33                      | ±10; ±20                     | 10                      | 5.0                             | 0.80              |
| X7R | 0603 | 0.39                      | ±10; ±20                     | 10                      | 5.0                             | 0.80              |
| X7R | 0603 | 0.47                      | ±10; ±20                     | 10                      | 5.0                             | 0.80              |
| X5R | 0603 | 0.56                      | ±10; ±20                     | 10                      | 7.0                             | 0.80              |
| X5R | 0603 | 0.68                      | ±10; ±20                     | 10                      | 7.0                             | 0.80              |
| X5R | 0603 | 0.82                      | ±10; ±20                     | 10                      | 7.0                             | 0.80              |
| X5R | 0603 | 1.00                      | ±10; ±20                     | 10                      | 7.0                             | 0.80              |
| X5R | 0603 | 1.50                      | ±10; ±20                     | 10                      | 7.0                             | 0.80              |
| X5R | 0603 | 2.20                      | ±10; ±20                     | 10                      | 10.0                            | 0.80              |
| X7R | 0603 | 0.12                      | ±10; ±20                     | 16                      | 5.0                             | 0.80              |
| X7R | 0603 | 0.15                      | ±10; ±20                     | 16                      | 5.0                             | 0.80              |
| X7R | 0603 | 0.18                      | ±10; ±20                     | 16                      | 5.0                             | 0.80              |
| X7R | 0603 | 0.22                      | ±10; ±20                     | 16                      | 5.0                             | 0.80              |
| X7R | 0603 | 0.27                      | ±10; ±20                     | 16                      | 5.0                             | 0.80              |
| X7R | 0603 | 0.33                      | ±10; ±20                     | 16                      | 5.0                             | 0.80              |
| X7R | 0603 | 0.39                      | ±10; ±20                     | 16                      | 5.0                             | 0.80              |
| X7R | 0603 | 0.47                      | ±10; ±20                     | 16                      | 5.0                             | 0.80              |
| X5R | 0603 | 0.33                      | ±10; ±20                     | 25                      | 5.0                             | 0.80              |
| X5R | 0603 | 0.39                      | ±10; ±20                     | 25                      | 5.0                             | 0.80              |
| X5R | 0603 | 0.47                      | ±10; ±20                     | 25                      | 5.0                             | 0.80              |

**Table 9** For size 0805 (2012 metric)

| TC  | SIZE | CAPACITANCE<br>VALUE (μF) | CAPACITANCE<br>TOLERANCE (%) | DC RATED VOLTAGE<br>(V) | DISSIPATION FACTOR-<br>D.F. (%) | THICKNESS<br>(mm) |
|-----|------|---------------------------|------------------------------|-------------------------|---------------------------------|-------------------|
| X5R | 0805 | 2.20                      | ±10; ±20                     | 6.3                     | 7.0                             | 1.25              |
| X7R | 0805 | 2.20                      | ±10; ±20                     | 6.3                     | 7.0                             | 1.25              |
| X5R | 0805 | 3.30                      | ±10; ±20                     | 6.3                     | 7.0                             | 1.25              |
| X5R | 0805 | 4.70                      | ±10; ±20                     | 6.3                     | 7.0                             | 1.25              |
| X5R | 0805 | 6.80                      | ±10; ±20                     | 6.3                     | 10.0                            | 1.25              |
| X5R | 0805 | 10.00                     | ±10; ±20                     | 6.3                     | 10.0                            | 1.25              |
| X7R | 0805 | 1.00                      | ±10; ±20                     | 10                      | 5.0                             | 1.25              |
| X7R | 0805 | 1.50                      | ±10; ±20                     | 10                      | 7.0                             | 1.25              |
| X5R | 0805 | 2.20                      | ±10; ±20                     | 10                      | 7.0                             | 1.25              |
| X7R | 0805 | 2.20                      | ±10; ±20                     | 10                      | 7.0                             | 1.25              |
| X5R | 0805 | 3.30                      | ±10; ±20                     | 10                      | 7.0                             | 1.25              |
| X5R | 0805 | 4.70                      | ±10; ±20                     | 10                      | 7.0                             | 1.25              |
| X5R | 0805 | 6.80                      | ±10; ±20                     | 10                      | 10.0                            | 1.25              |
| X5R | 0805 | 10.00                     | ±10; ±20                     | 10                      | 10.0                            | 1.25              |
| X7R | 0805 | 0.56                      | ±10; ±20                     | 16                      | 5.0                             | 1.25              |
| X7R | 0805 | 0.68                      | ±10; ±20                     | 16                      | 5.0                             | 1.25              |
| X7R | 0805 | 0.82                      | ±10; ±20                     | 16                      | 5.0                             | 1.25              |
| X7R | 0805 | 1.00                      | ±10; ±20                     | 16                      | 5.0                             | 1.25              |

**Table 10** For size 1206 (3216 metric)

| TC  | SIZE | CAPACITANCE<br>VALUE (μF) | CAPACITANCE<br>TOLERANCE (%) | DC RATED VOLTAGE<br>(V) | DISSIPATION FACTOR-<br>D.F. (%) | THICKNESS<br>(mm) |
|-----|------|---------------------------|------------------------------|-------------------------|---------------------------------|-------------------|
| X5R | 1206 | 10.00                     | ±10; ±20                     | 6.3                     | 7.5                             | 1.60              |
| X5R | 1206 | 22.00                     | ±10; ±20                     | 6.3                     | 10.0                            | 1.60              |
| X5R | 1206 | 4.70                      | ±10; ±20                     | 10                      | 5.0                             | 1.60              |
| X7R | 1206 | 4.70                      | ±10; ±20                     | 10                      | 5.0                             | 1.60              |
| X5R | 1206 | 6.80                      | ±10; ±20                     | 10                      | 7.5                             | 1.60              |
| X5R | 1206 | 10.00                     | ±10; ±20                     | 10                      | 7.5                             | 1.60              |
| X7R | 1206 | 2.20                      | ±10; ±20                     | 16                      | 5.0                             | 1.15              |
| X5R | 1206 | 4.70                      | ±10; ±20                     | 16                      | 5.0                             | 1.60              |
| X7R | 1206 | 1.00                      | ±10; ±20                     | 25                      | 7.5                             | 1.60              |

**Table 11** For size 1210 (3225 metric)

| TC  | SIZE | CAPACITANCE<br>VALUE (μF) | CAPACITANCE<br>TOLERANCE (%) | DC RATED VOLTAGE<br>(V) | DISSIPATION FACTOR-<br>D.F. (%) | THICKNESS<br>(mm) |
|-----|------|---------------------------|------------------------------|-------------------------|---------------------------------|-------------------|
| X5R | 1210 | 22.00                     | ±20                          | 6.3                     | 2.5                             | 2.50              |
| X5R | 1210 | 47.00                     | ±20                          | 6.3                     | 10.0                            | 2.50              |
| X5R | 1210 | 10.00                     | ±10; ±20                     | 10                      | 3.5                             | 1.90              |
| X5R | 1210 | 22.00                     | ±20                          | 10                      | 7.0                             | 2.50              |
| X5R | 1210 | 3.30                      | ±10; ±20                     | 16                      | 3.5                             | 1.90              |
| X5R | 1210 | 4.70                      | ±10; ±20                     | 16                      | 3.5                             | 1.90              |
| X7R | 1210 | 4.70                      | ±10; ±20                     | 16                      | 3.5                             | 1.90              |
| X5R | 1210 | 6.80                      | ±10; ±20                     | 16                      | 3.5                             | 2.50              |
| X5R | 1210 | 10.00                     | ±10; ±20                     | 16                      | 3.5                             | 2.50              |
| X5R | 1210 | 3.30                      | ±10; ±20                     | 25                      | 3.5                             | 1.90              |
| X5R | 1210 | 4.70                      | ±10; ±20                     | 25                      | 3.5                             | 1.90              |
| X5R | 1210 | 6.80                      | ±10; ±20                     | 25                      | 2.5                             | 2.50              |
| X5R | 1210 | 10.00                     | ±10; ±20                     | 25                      | 2.5                             | 2.50              |

**Table 12** For size 1812 (4532 metric)

| TC  | SIZE | CAPACITANCE<br>VALUE (μF) | CAPACITANCE<br>TOLERANCE (%) | DC RATED VOLTAGE<br>(V) | DISSIPATION FACTOR-<br>D.F. (%) | THICKNESS<br>(mm) |
|-----|------|---------------------------|------------------------------|-------------------------|---------------------------------|-------------------|
| X5R | 1812 | 22.00                     | ±10; ±20                     | 16                      | 3.5                             | 2.50              |

**SOLDERING RECOMMENDATION**

Table 13

| 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 | ---         |

**TESTS AND REQUIREMENTS**

Table 14 Test condition, procedure and requirements

| TEST                                  | TEST METHOD      | PROCEDURE                                                                                                                                                                                                                                     | REQUIREMENTS                                                    |
|---------------------------------------|------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------|
| Mounting                              | IEC 60384-22 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                           | 4.5.1            | Precondition: 150 +0/−10 °C for 1 hour, then keep for 48 ± 1 hours at room temperature<br>f = 1 kHz for C ≤ 10 μF: measuring voltage 1 V <sub>rms</sub> at 20 °C<br>f = 120 Hz for C > 10 μF: measuring voltage 0.5 V <sub>rms</sub> at 20 °C | Within specified tolerance                                      |
| Dissipation factor (D.F.)             | 4.5.2            | f = 1 kHz for C ≤ 10 μF: measuring voltage 1 V <sub>rms</sub> at 20 °C<br>f = 120 Hz for C > 10 μF: measuring voltage 0.5 V <sub>rms</sub> at 20 °C                                                                                           | In accordance with specification                                |
| Insulation resistance                 | 4.5.3            | At U <sub>r</sub> (DC) for 1 minute                                                                                                                                                                                                           | In accordance with specification                                |
| Voltage proof                         | 4.5.4.2          | 2.5 × U <sub>r</sub> for 1 minute                                                                                                                                                                                                             | No breakdown or flashover                                       |
| Temperature characteristic            | 4.6              | Between minimum and maximum temperature                                                                                                                                                                                                       | In accordance with specification                                |
| Adhesion                              | 4.15             | A force applied for 10 seconds to the line joining the terminations and in a plane parallel to the substrate<br>for size ≥ 0603: a force of 5 N applied<br>for size 0402: a force of 2.5 N applied                                            | No visible damage                                               |
| Bond strength of plating on end face  | 4.8              | Mounting in accordance with IEC 60384-22 paragraph 4.3<br>Conditions: bending 1 mm at a rate of 1 mm/s, radius jig 340 mm                                                                                                                     | No visible damage<br>X5R/X7R: ΔC/CI: ≤ 10%<br>Y5V: ΔC/CI: ≤ 20% |

Table 14 Test condition, procedure and requirements (continued)

| TEST                         | TEST METHOD       | PROCEDURE                                                                                                                                                                                                                                                                                                                                                                                                                                         | REQUIREMENTS                                                                                                                                                                                                                                            |
|------------------------------|-------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Resistance to soldering heat | 4.9               | <p>Precondition: 150 +0/-10 °C for 1 hour, then keep for 24 ±1 hours at room temperature</p> <p>Preheating: for size ≤ 1206: 120 to 150 °C for 1 minute</p> <p>Preheating: for size &gt; 1206: 100 to 120 °C for 1 minute and 170 to 200 °C for 1 minute</p> <p>Solder bath temperature: 260 ±5 °C</p> <p>Dipping time: 10 ±0.5 seconds</p> <p>Recovery time: 24 ±2 hours.</p>                                                                    | <p>The termination shall be well tinned</p> <p>X5R/X7R: <math>\Delta C/C_i \leq 10\%</math></p> <p>Y5V: <math>\Delta C/C_i \leq 20\%</math></p> <p>D.F.: within initial specified value</p> <p><math>R_{ins}</math>: within initial specified value</p> |
| Solderability                | 4.10              | <p>Unmounted chips completely immersed in a solder bath at 235 ±5 °C</p> <p>Dipping time: size ≤ 1206 for 2 ±0.5 seconds; size &gt; 1206 for 4 ±0.5 seconds</p>                                                                                                                                                                                                                                                                                   | <p>The termination shall be well tinned.</p>                                                                                                                                                                                                            |
| Rapid change of temperature  | IEC 60384-22 4.11 | <p>Preconditioning; 150 +0/-10 °C for 1 hour, then keep for 24 ±1 hours at room temperature</p> <hr/> <p>5 cycles with following detail:<br/>30 minutes at lower category temperature;<br/>30 minutes at upper category temperature</p> <hr/> <p>Recovery time 24 ±2 hours.</p>                                                                                                                                                                   | <p>No visual damage</p> <p>X5R/X7R: <math>\leq 15\%</math></p> <p>Y5V: <math>\leq 20\%</math></p> <p>D.F.: within initial specified value</p> <p><math>R_{ins}</math>: within initial specified value</p>                                               |
| Damp heat steady state       | 4.13              | <p>Initial measurements; after 150 +0/-10 °C for 1 hour, then keep for 24 ±1 hours at room temperature</p> <p>Duration and conditions: 500 ±12 hours at 40 ±2 °C; 90 to 95% RH</p> <p>Final measurement: perform a heat treatment at 150 +0/-10 °C for 1 hour, final measurements shall be carried out 24 ±1 hours after recovery at room temperature without load.</p>                                                                           | <p>X5R/X7R: <math>\Delta C/C_i \pm 20\%</math></p> <p>Y5V: <math>\Delta C/C_i \pm 30\%</math></p> <p>D.F.: 2 × initial value max.</p> <p><math>R_{ins}</math>: 1,000 MΩ or <math>R_{ins} \times C_r \geq 50</math> seconds, whichever is less</p>       |
| Endurance                    | 4.14              | <p>Preconditioning;</p> <p>Initial measurements; after 150 +0/-10 °C for 1 hour, then keep for 24 ±1 hours at room temperature</p> <p>Duration and conditions: 1,000 ±12 hours at upper category temperature with 1.5 × <math>U_r</math> voltage applied</p> <p>Final measurement: perform a heat treatment at 150 +0/-10 °C for 1 hour, final measurements shall be carried out 24 ±1 hours after recovery at room temperature without load.</p> | <p>X5R/X7R: <math>\Delta C/C_i \pm 20\%</math></p> <p>Y5V: <math>\Delta C/C_i \pm 30\%</math></p> <p>D.F.: 2 × initial value max.</p> <p><math>R_{ins}</math>: 1,000 MΩ or <math>R_{ins} \times C_r \geq 50</math> seconds, whichever is less</p>       |

Table 14 Test condition, procedure and requirements (continued)

| TEST                       | TEST METHOD       | PROCEDURE                                                                                                                                                                                                                                                                                                                                                                                       | REQUIREMENTS                                                                                                                                                                                            |
|----------------------------|-------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Resistance to leaching     | IEC 60384-10 4.10 | Solder bath temperature: $260 \pm 5$ °C<br>Dipping time $30 \pm 0.5$ seconds                                                                                                                                                                                                                                                                                                                    | Using visual enlargement of $\times 10$ , dissolution of the termination shall not exceed 10%                                                                                                           |
| Damp heat, with $U_r$ load | 4.14              | Initial measurements; after $150 +0/-10$ °C for 1 hour, then keep for $24 \pm 1$ hours at room temperature<br>Duration and conditions: $500 \pm 12$ hours at $40 \pm 2$ °C; 90 to 95% RH; $U_r$ applied<br>Final measurement: perform a heat treatment at $150 +0/-10$ °C for 1 hour; final measurements shall be carried out $24 \pm 1$ hours after recovery at room temperature without load. | X5R/X7R: $\Delta C/C_i$ : $\pm 20\%$<br>Y5V: $\Delta C/C_i$ : $\pm 30\%$<br>D.F.: $2 \times$ initial value max.<br>$R_{ins}$ : $500 M\Omega$ or $R_{ins} \times C_r \geq 25$ seconds, whichever is less |



## REVISION HISTORY

| REVISION   | DATE         | CHANGE NOTIFICATION | DESCRIPTION                                                                                                                                                    |
|------------|--------------|---------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Version 10 | Feb 18, 2005 | -                   | - Capacitance range extended                                                                                                                                   |
| Version 9  | Nov 17, 2004 | -                   | - Extended capacitance 0.68 $\mu$ F and 2.2 $\mu$ F of X5R 0603 10 V                                                                                           |
| Version 8  | Sep 29, 2004 | -                   | - Revised 12NC ordering code of table 7-9                                                                                                                      |
| Version 7  | Sep 20, 2004 | -                   | - Rated voltage 6.3 V added to 0402/1210 and 25 V added to 1206<br>- Extend capacitance range: 4.7 $\mu$ F of 0603, 22 $\mu$ F of 1206, and 22 $\mu$ F of 1210 |
| Version 6  | Aug 13, 2004 | -                   | - 0603 10 V 0.47 $\mu$ F extended material with X5R                                                                                                            |
| Version 5  | 2004 Jul 06  | -                   | - Revise the dimensions of 0603 and 0805                                                                                                                       |
| Version 4  | 2004 May 10  | -                   | - Extended capacitance 4.7 $\mu$ F and 10 $\mu$ F of X5R 0805 10 V<br>- Revised 12NC ordering code and Phycomp clear text code of table 2 & 3                  |
| Version 3  | 2004 Mar 02  | -                   | - Test and requirement revised.                                                                                                                                |
| Version 2  | 2004 Feb 25  | -                   | - Test and requirement revised.                                                                                                                                |
| Version 1  | 2003 Sep 16  | -                   | - Updated company logos                                                                                                                                        |
| Version 0  | 2002 Aug 16  | -                   | -                                                                                                                                                              |