Innovative Service Around the Globe YAGEO

# DATA SHEET

## SURFACE MOUNT MULTILAYER CERAMIC CAPACITORS

Embedded Capacitance

Class 2, X5R

4 V TO 25 V

**10 nF to 220 nF**

**RoHS compliant & Halogen free**

YAGEO

Product Specification – May 24, 2024 V.0

## SCOPE

The thickness and termination dimension can be customized for the purpose of embedded the MLCCs into substrates under the ICs.

## APPLICATIONS

IC design

Module

## FEATURES

- To save space for module assembly.
- To reduce parasitic inductance.
- To ensure good electrical bonging with advanced.
- Cu termination technologies.

## 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)**

| CE | XX | XX | X | X | X5R | X | XB | XXX |
|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | | (5) | (6) | (7) |

### (1) SIZE – INCH BASED (METRIC)

01 : 0201 (0603)

02 : 0402 (1005)

### (2) THICKNESS

1B = 0.13 ±0.02mm

2B = 0.2 ±0.02mm

### (3) TOLERANCE

K = ±10%

M = ±20%

### (4) PACKING STYLE

R = Paper taping reel; Reel 7 inch

A = Paper taping reel; Reel 7 inch (Packing unit: 1000 pcs)

### (5) RATED VOLTAGE

4 = 4 V

5 = 6.3 V

6 = 10 V

7 = 16 V

8 = 25 V

### (6) TERMINALS

S = Cu Terminal

B = Sn Terminal

### (7) CAPACITANCE VALUE

2 significant digits+number of zeros

The 3rd digit signifies the multiplying factor, and letter R is decimal point

Example: 103 = $10 \times 10^3$ = 10,000 pF = 10 nF

## 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 copper. A cross section of the structure is shown in Fig.1.

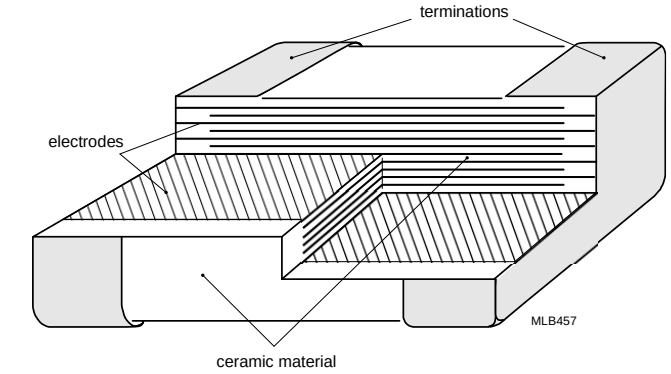


Fig. 1 Surface mount multilayer ceramic capacitor construction

## DIMENSION

Table 1 For outlines see fig. 2

| TYPE | $L_1$ (mm) | W (mm) | T (mm) | $L_2$ / $L_3$ (mm) | | $L_4$ (mm) |
|---|---|---|---|---|---|---|
| | | | | min. | max. | min. |
| 0201 | 0.6 ±0.09 | 0.3 ±0.09 | Refer to Table 2 | 0.1 | 0.25 | 0.2 |
| 0402 | 1.0 ±0.2 | 0.5 ±0.2 | | 0.15 | 0.35 | 0.3 |

## OUTLINES

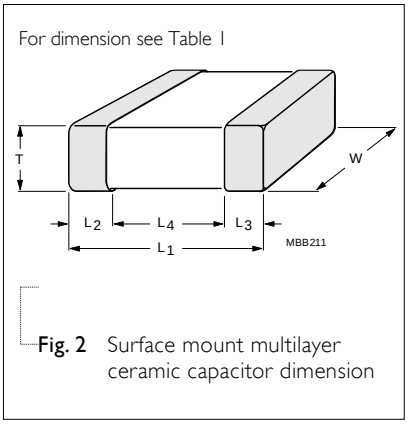


Fig. 2 Surface mount multilayer ceramic capacitor dimension

## CAPACITANCE RANGE & THICKNESS FOR X5R

Table 2 Sizes from 0201 to 0402

| CAP. | 0201 | | | | | 0402 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 4 V | 6.3 V | 10 V | 16 V | 25 V | 4 V | 6.3 V | 10 V | 16 V | 25 V |
| 10 nF | | | | | 0.13±0.02 | | | | | |
| 100 nF | | 0.2±0.02 | 0.2±0.02 | | | | | | | 0.13±0.02 |
| 220 nF | | | | | | | | 0.2±0.02 | | |

**NOTE**

1. Values in shaded cells indicate thickness class in mm

## THICKNESS CLASSES AND PACKING QUANTITY

Table 3

| SIZE CODE | THICKNESS CLASSIFICATION | TAPE WIDTH QUANTITY PER REEL | Ø180 MM / 7 INCH | | Ø330 MM / 13 INCH | | QUANTITY PER BULK CASE |
|---|---|---|---|---|---|---|---|
| | | | Paper | Blister | Paper | Blister | |
| 0201 | 0.15 mm max<br>0.22 mm max | 8 mm | 15,000 | --- | 50,000 | --- | --- |
| 0402 | 0.15 mm max<br>0.22 mm max | 8 mm | 10,000 | --- | 50,000 | --- | --- |

## ELECTRICAL CHARACTERISTICS

### X5R DIELECTRIC CAPACITORS; NISN TERMINATIONS

Unless otherwise specified, all tests 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 4

| DESCRIPTION | VALUE |
|---|---|
| Capacitance range | 10 nF to 220 nF |
| Capacitance tolerance | ±10% and ±20% |
| Dissipation factor (D.F.) | ≤10% |
| Insulation resistance after 1 minute at Ur (DC) | Rins ≥ 10 GΩ or Rins × Cr ≥ 50 seconds whichever is less |
| Maximum capacitances change as a function of temperature (temperature characteristic/coefficient): | ±15% |
| Operating temperature range: | –55 °C to +85 °C |

## TESTS AND REQUIREMENTS

Table 5 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 (1) | | 4.5.1 | Class 2: | Within specified tolerance |
| Dissipation Factor (D.F.) (1) | | 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 > 1uF, 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 $U_r$ (DC) for 1 minute | In accordance with specification |

**NOTE**

1. The figure indicates typical inspection. Please refer to individual specifications.

| TEST | TEST METHOD | PROCEDURE | REQUIREMENTS |
|---|---|---|---|
| Temperature Characteristic | 4.6 | Capacitance shall be measured by the steps shown in the following table.<br>The capacitance change should be measured after 5 min at each specified temperature stage.<br>Step / Temperature(°C): a 25±2; b Lower temperature±3°C; c 25±2; d Upper Temperature±2°C; e 25±2<br>(1) Class I<br>Temperature Coefficient shall be calculated from the formula as below<br>Temp, Coefficient = $\frac{C2-C1}{C1\times\Delta T}\times10^6$ [ppm/°C]<br>C1: Capacitance at step c<br>C2: Capacitance at 125°C<br>ΔT: 100°C (=125°C -25°C)<br>(2) Class II<br>Capacitance Change shall be calculated from the formula as below<br>$\Delta C = \frac{C2-C1}{C1}\times100\%$<br>C1: Capacitance at step c<br>C2: Capacitance at step b or d | Class2:<br>X5R: Δ C/C: ±15%<br>Measurement Voltage: Less than 1.0Vrms |
| Adhesion | 4.7 | A force applied for 10 seconds to the line joining the terminations and in a plane parallel to the substrate | Force<br>size ≥ 0603: 5N<br>size = 0402: 2.5N<br>size = 0201: 1N |
| Rapid Change of Temperature | IEC 60384-21/22 4.11 | Preconditioning;<br>150 +0/–10 °C for 1 hour, then keep for 24 ±1 hours at room temperature<br>5 cycles with following detail:<br>30 minutes at lower category temperature<br>30 minutes at upper category temperature<br>Recovery time 24 ±2 hours | No visual damage<br>ΔC/C<br>Class2:<br>X5R: ±15%<br>D.F. meet initial specified value<br>$R_{ins}$ meet initial specified value |

| TEST | TEST METHOD | PROCEDURE | REQUIREMENTS |
|---|---|---|---|
| Voltage Proof | IEC 60384-1 4.6 | 1. Specified stress voltage applied for 1~5 seconds<br>2. Ur ≤ 100 V: series applied 2.5 Ur<br>3. 100 V < Ur ≤ 200 V series applied (1.5 Ur + 100)<br>4. 200 V < Ur ≤ 500 V series applied (1.3 Ur + 100)<br>Charge/Discharge current is less than 50 mA | No breakdown or flashover |
| Endurance | 4.14 | 1. Preconditioning, class 2 only:<br>150 +0/-10 °C /1 hour, then keep for 24 ±1 hour at room temp<br>2. Initial measure:<br>Spec: refer to initial spec C, D, IR<br>3. Endurance test:<br>Temperature: X5R: 85 °C<br>Specified stress voltage applied 1.5 x Ur for 1,000 hours<br>4. Recovery time: 24 ±2 hours<br>5. Final measure: C, D, IR<br>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 requirements shall be met. | No visual damage<br>ΔC/C<br>Class2:<br>X5R: ±15%<br>D.F.<br>Class2:<br>X5R:<br>2 x initial value<br>$R_{ins}$<br>Class2:<br>Rins x Cr ≥ 10s whichever is less |

## REVISION HISTORY

| REVISION | DATE | CHANGE NOTIFICATION | DESCRIPTION |
|---|---|---|---|
| Version 0 | May 24, 2024 | - | - New datasheet for embedded capacitance X5R series with RoHS compliant |

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