

# DATA SHEET

## SURFACE-MOUNT CERAMIC MULTILAYER CAPACITORS

Low-Inductance

X5R / X7R

6.3 V TO 50 V

10 nF to 1  $\mu$ F

RoHS compliant & Halogen Free



SCOPE

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

APPLICATIONS

High speed IC packages  
 Processor package decoupling  
 AC noise reduction in multi-chip modules.

FEATURES

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

ORDERING INFORMATION - GLOBAL PART NUMBER, PHYCOMP

CTC

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)**

**CL** XXXX X X XXX X **BB** XXX  
 (1) (2) (3) (4) (5) (6)

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**(1) SIZE – INCH BASED (METRIC)**

- 0204(0510)
- 0306(0816)
- 0508(1220)
- 0612(1632)

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**(2) TOLERANCE**

- K = ±10%
- M = ±20%

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**(3) PACKING STYLE**

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

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**(4) TC MATERIAL**

X5R / X7R

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**(5) RATED VOLTAGE**

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

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**(6) CAPACITANCE VALUE**

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

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**CONSTRUCTION**

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

The inner electrodes are connected to the two end terminations and finally covered with a layer of plated tin (NiSn). The terminations are lead-free. A cross section of the structure is shown in Fig.1.

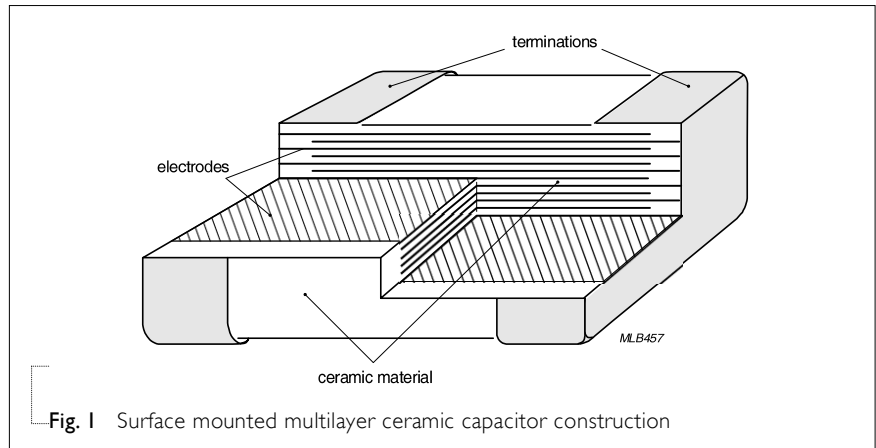


Fig. 1 Surface mounted multilayer ceramic capacitor construction

**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) |
|-------|---------------------|----------|-----------|--------------------------------------|------|---------------------|
|       |                     |          |           | min.                                 | max. | min.                |
| 0204  | 0.5 ±0.1            | 1.0 ±0.1 | 0.3 ±0.1  | 0.1                                  | 0.3  | 0.1                 |
| 0306  | 0.8 ±0.15           | 1.6 ±0.2 | 0.5 ±0.1  | 0.1                                  | 0.3  | 0.2                 |
| 0508  | 1.25 ±0.2           | 2.0 ±0.2 | 0.85 ±0.1 | 0.13                                 | 0.46 | 0.38                |
| 0612  | 1.6 ±0.2            | 3.2 ±0.2 | 0.85 ±0.1 | 0.13                                 | 0.46 | 0.50                |
| 0612* | 1.6 ±0.2            | 3.2 ±0.2 | 1.15 ±0.1 | 0.13                                 | 0.46 | 0.50                |

0612\*: 1uF/16V, 470nF~1uF/25V, 120nF~470nF/50V

**OUTLINES**

For dimension see Table I

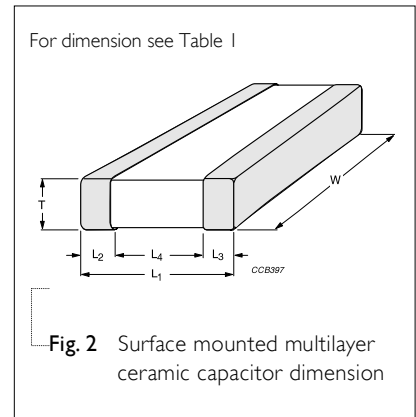


Fig. 2 Surface mounted multilayer ceramic capacitor dimension

CAPACITANCE RANGE & THICKNESS FOR X5R

Table 2 Sizes from 0204

**CAP.                      0204**  
**6.3 V / 10V**

|        |          |
|--------|----------|
| 10 nF  | 0.3 ±0.1 |
| 15 nF  | 0.3 ±0.1 |
| 22 nF  | 0.3 ±0.1 |
| 33 nF  | 0.3 ±0.1 |
| 47 nF  | 0.3 ±0.1 |
| 68 nF  | 0.3 ±0.1 |
| 100 nF | 0.3 ±0.1 |
| 150 nF |          |
| 220 nF |          |
| 330 nF |          |
| 470 nF |          |
| 680 nF |          |
| 1 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 special ordering code, please contact local sales force before order.

CAPACITANCE RANGE & THICKNESS FOR X7R

Table 3 Sizes from 0306 to 0508

| CAP.   | 0306        |  | 0508      |           |           |
|--------|-------------|--|-----------|-----------|-----------|
|        | 6.3 V / 10V |  | 10 V      | 16 V      | 25 V      |
| 10 nF  |             |  | 0.85 ±0.1 | 0.85 ±0.1 | 0.85 ±0.1 |
| 15 nF  |             |  | 0.85 ±0.1 | 0.85 ±0.1 | 0.85 ±0.1 |
| 22 nF  |             |  | 0.85 ±0.1 | 0.85 ±0.1 | 0.85 ±0.1 |
| 33 nF  |             |  | 0.85 ±0.1 | 0.85 ±0.1 | 0.85 ±0.1 |
| 47 nF  |             |  | 0.85 ±0.1 | 0.85 ±0.1 | 0.85 ±0.1 |
| 68 nF  |             |  | 0.85 ±0.1 | 0.85 ±0.1 | 0.85 ±0.1 |
| 100 nF | 0.5 ±0.1    |  | 0.85 ±0.1 | 0.85 ±0.1 | 0.85 ±0.1 |
| 150 nF |             |  | 0.85 ±0.1 | 0.85 ±0.1 |           |
| 220 nF | 0.5 ±0.1    |  | 0.85 ±0.1 | 0.85 ±0.1 |           |
| 330 nF |             |  |           |           |           |
| 470 nF |             |  | 0.85 ±0.1 |           |           |
| 680 nF |             |  |           |           |           |
| 1 uF   |             |  | 0.85 ±0.1 |           |           |

**NOTE**

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

**CAPACITANCE RANGE & THICKNESS FOR X7R**
**Table 4** Sizes from 0612

| CAP.   | 0612      |           |           |           |           |
|--------|-----------|-----------|-----------|-----------|-----------|
|        | 6.3 V     | 10 V      | 16 V      | 25 V      | 50 V      |
| 10 nF  | 0.85 ±0.1 | 0.85 ±0.1 | 0.85 ±0.1 | 0.85 ±0.1 | 0.85 ±0.1 |
| 15 nF  | 0.85 ±0.1 | 0.85 ±0.1 | 0.85 ±0.1 | 0.85 ±0.1 | 0.85 ±0.1 |
| 22 nF  | 0.85 ±0.1 | 0.85 ±0.1 | 0.85 ±0.1 | 0.85 ±0.1 | 0.85 ±0.1 |
| 33 nF  | 0.85 ±0.1 | 0.85 ±0.1 | 0.85 ±0.1 | 0.85 ±0.1 | 0.85 ±0.1 |
| 47 nF  | 0.85 ±0.1 | 0.85 ±0.1 | 0.85 ±0.1 | 0.85 ±0.1 | 0.85 ±0.1 |
| 68 nF  | 0.85 ±0.1 | 0.85 ±0.1 | 0.85 ±0.1 | 0.85 ±0.1 | 0.85 ±0.1 |
| 100 nF | 0.85 ±0.1 | 0.85 ±0.1 | 0.85 ±0.1 | 0.85 ±0.1 | 0.85 ±0.1 |
| 150 nF | 0.85 ±0.1 | 0.85 ±0.1 | 0.85 ±0.1 | 1.15 ±0.1 | 1.15 ±0.1 |
| 220 nF | 0.85 ±0.1 | 0.85 ±0.1 | 0.85 ±0.1 | 1.15 ±0.1 | 1.15 ±0.1 |
| 330 nF | 0.85 ±0.1 | 0.85 ±0.1 | 0.85 ±0.1 | 1.15 ±0.1 | 1.15 ±0.1 |
| 470 nF | 0.85 ±0.1 | 0.85 ±0.1 | 0.85 ±0.1 | 1.15 ±0.1 | 1.15 ±0.1 |
| 680 nF | 1.15 ±0.1 | 1.15 ±0.1 | 1.15 ±0.1 | 1.15 ±0.1 | 1.15 ±0.1 |
| 1 µF   | 1.15 ±0.1 | 1.15 ±0.1 | 1.15 ±0.1 | 1.15 ±0.1 | 1.15 ±0.1 |

**NOTE**

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

**THICKNESS CLASSES AND PACKING QUANTITY**
**Table 5**

| 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 |                        |
| 0204      | 0.3 ±0.1 mm              | 8 mm                         | 10,000           | ---     | ---               | ---     | ---                    |
| 0306      | 0.5 ±0.1 mm              | 8 mm                         | 4,000            | ---     | 15,000            | ---     | ---                    |
| 0508      | 0.85 ±0.1 mm             | 8 mm                         | 4,000            | ---     | 15,000            | ---     | ---                    |
| 0612      | 0.85 ±0.1 mm             | 8 mm                         | 4,000            | ---     | 15,000            | ---     | ---                    |
| 0612      | 1.15 ±0.1 mm             | 8 mm                         | ---              | 3,000   | ---               | ---     | ---                    |

ELECTRICAL CHARACTERISTICS

**X7R DIELECTRIC CAPACITORS;**

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 6

| DESCRIPTION   | VALUE  |
|---|--|
| Capacitance range   | 10 nF to 1 uF  |
| Capacitance tolerance   |  |
| X5R / X7R   | ±10%, ±20%   |
| Dissipation factor (D.F.)   |  |
| X5R / X7R   | ≤ 5 %  |
| 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): |  |
| X5R / X7R   | ±15%   |
| Operating temperature range:  |  |
| X5R   | -55 °C to +85 °C   |
| X7R   | -55 °C to +125 °C  |

**SOLDERING RECOMMENDATION**

Table 7

| SOLDERING METHOD | SIZE |      |      |      |
|------------------|------|------|------|------|
|                  | 0204 | 0306 | 0508 | 0612 |
| Reflow           |      |      |      |      |
| Reflow/Wave      | ○    | ○    | ○    | ○    |

**TESTS AND REQUIREMENTS**

Table 8 Test procedures and requirements

| TEST                                  | TEST METHOD            | PROCEDURE   | REQUIREMENTS                     |
|---------------------------------------|------------------------|---|----------------------------------|
| Mounting                              | IEC 4.3<br>60384-21/22 | 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                  | Class 2:<br>f = 1 KHz, measuring at voltage 1 Vrms at 20 °C                   | Within specified tolerance       |
| Dissipation Factor (D.F.)             | 4.5.2                  | Class 2:<br>f = 1 KHz, measuring at voltage 1 Vrms at 20 °C                   | In accordance with specification |
| Insulation Resistance                 | 4.5.3                  | At Ur (DC) for 1 minute   | In accordance with specification |



| TEST                    | TEST METHOD           | PROCEDURE   | REQUIREMENTS  |                 |   |      |   |                       |   |      |   |                       |   |      |   |
|-------------------------|-----------------------|---|---|-----------------|---|------|---|-----------------------|---|------|---|-----------------------|---|------|---|
| Temperature coefficient | 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" style="margin-left: 20px;"> <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>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>Class2:<br/>X7R/X5R : <math>\Delta C/C : \pm 15\%</math></p> <p>In case of applying voltage, the capacitance change should be measured after 1 more min. with applying voltage in equilibration of each temp. stage.</p> |
| Step                    | Temperature(°C)       |   |   |                 |   |      |   |                       |   |      |   |                       |   |      |   |
| a                       | 25±2                  |   |   |                 |   |      |   |                       |   |      |   |                       |   |      |   |
| b                       | Lower temperature±3°C |   |   |                 |   |      |   |                       |   |      |   |                       |   |      |   |
| c                       | 25±2                  |   |   |                 |   |      |   |                       |   |      |   |                       |   |      |   |
| d                       | Upper Temperature±2°C |   |   |                 |   |      |   |                       |   |      |   |                       |   |      |   |
| e                       | 25±2                  |   |   |                 |   |      |   |                       |   |      |   |                       |   |      |   |
| Adhesion                | IEC 60384-21/22       | 4.7 A force applied for 10 seconds to the line joining the terminations and in a plane parallel to the substrate  | <p><b>Force</b><br/>size ≥ 0306: 5N<br/>size = 0204: 2.5N</p>   |                 |   |      |   |                       |   |      |   |                       |   |      |   |
| Bending Strength        | 4.8                   | <p>Mounting in accordance with IEC 60384-22 paragraph 4.3</p> <p>Conditions: bending 1 mm at a rate of 1 mm/s, radius jig 5 mm</p>  | <p>No visible damage</p> <hr/> <p><math>\Delta C/C</math><br/>Class2:<br/>X7R/X5R : <math>\pm 10\%</math></p> |                 |   |      |   |                       |   |      |   |                       |   |      |   |

| TEST                         | TEST METHOD     | PROCEDURE   | REQUIREMENTS   |
|------------------------------|-----------------|---|--|
| Resistance to Soldering Heat | 4.9             | Precondition: 150 +0/-10 °C for 1 hour, then keep for 24 ±1 hours at room temperature   | Dissolution of the end face plating shall not exceed 25% of the length of the edge concerned                                     |
|                              |                 | Preheating: 120 °C to 150 °C for 1 minute and 170 °C to 200 °C for 1 minute.<br>Solder bath temperature: 260 ±5 °C<br>Dipping time: 10 ±0.5 seconds<br>Recovery time: 24 ±2 hours | $\Delta C/C$<br>Class2:<br>X7R/X5R : ±10%<br><br>D.F. within initial specified value<br>$R_{ins}$ within initial specified value |
| Solderability                | 4.10            | Preheated the temperature of 80 °C to 140 °C and maintained for 30 seconds to 60 seconds.   | The solder should cover over 95% of the critical area of each termination  |
|                              |                 | Test conditions for leadfree containing solder alloy<br>Temperature: 245 ±5 °C<br>Dipping time: 3 ±0.3 seconds<br>Depth of immersion: 10 mm                                       |  |
| Rapid Change of Temperature  | IEC 60384-21/22 | 4.11 Preconditioning; 150 +0/-10 °C for 1 hour, then keep for 24 ±1 hours at room temperature   | No visual damage   |
|                              |                 | 5 cycles with following detail:<br>30 minutes at lower category temperature<br>30 minutes at upper category temperature<br><br>Recovery time 24 ±2 hours                          | $\Delta C/C$<br>Class2:<br>X7R/X5R : ±15%<br><br>D.F. meet initial specified value<br>$R_{ins}$ meet initial specified value     |

| TEST                   | TEST METHOD | PROCEDURE   | REQUIREMENTS   |
|------------------------|-------------|---|--|
| Damp Heat with Ur load | 4.13        | <ol style="list-style-type: none"> <li>1. Preconditioning, class 2 only:<br/>150 +0/-10 °C /1 hour, then keep for<br/>24 ± 1 hour at room temp</li> <li>2. Initial measure:<br/>Spec: refer initial spec C, D, IR</li> <li>3. Damp heat test:<br/>500 ± 12 hours at 40 ± 2 °C;<br/>90 to 95% R.H; 1.0 Ur applied.</li> <li>4. Recovery:<br/>Class 1: 6 to 24 hours<br/>Class 2: 24 ± 2 hours</li> <li>5. 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 precondition according to "IEC 60384 4.1" and then the requirement shall be met.</p> | <p>No visual damage after recovery</p> <hr/> <p><math>\Delta C/C</math><br/>Class2:<br/>X7R/X5R : ±20%<br/>D.F.<br/>Class2:<br/>X7R/X5R : ≤ 2 × specified value<br/>R<sub>ins</sub><br/>Class2:<br/>X7R/X5R : ≥ 500 MΩ or R<sub>ins</sub> × C<sub>r</sub> ≥ 25s<br/>whichever is less</p> <p><math>\Delta C/C</math><br/>Class2:<br/>X7R/X5R : ±25%<br/>D.F.<br/>Class2:<br/>X7R/X5R : ≤ 2 × specified value<br/>R<sub>ins</sub><br/>R<sub>ins</sub> × C<sub>r</sub> ≥ 25Ω · F</p> |

| TEST          | TEST METHOD     | PROCEDURE | REQUIREMENTS   |  |
|---------------|-----------------|-----------|--|--|
| Endurance     | IEC 60384-21/22 | 4.14      | 1. Preconditioning, class 2 only:<br>150 +0/-10 °C /1 hour, then keep for<br>24 ±1 hour at room temp   | No visual damage   |
|               |                 |           | 2. Initial measure:<br>Spec: refer initial spec C, D, IR   | $\Delta C/C$<br>Class2:<br>X7R/X5R : ±20%  |
|               |                 |           | 3. Endurance test:<br>Temperature: NPO: 125 °C<br>Specified stress voltage applied for 1,000 hours:<br>Applied $2.0 \times U_r$ for general product<br>Temperature: X7R: 125°C Specified stress voltage applied for 1,000 hours:<br>Recovery time: 24 ±2 hours | D.F.<br>Class2:<br>X7R/X5R : ≤ 2x initial value max<br>$R_{ins}$<br>Class2:<br>X7R/X5R : ≥ 1,000 MΩ or<br>$R_{ins} \times Cr \geq 50s$ whichever is less               |
|               |                 |           | 4. Final measure: C, D, IR   | $\Delta C/C$<br>Class2:<br>X7R/X5R : ±25%<br>D.F.<br>Class2:<br>X7R/X5R : ≤ 2x initial value max<br>$R_{ins}$<br>Class2:<br>$R_{ins} \times Cr \geq 50 \Omega \cdot F$ |
|               |                 |           | P.S. If the capacitance value is less than the minimum value permitted, then after the other measurements have been made the capacitor shall be precondition according to "IEC 60384 4.1" and then the requirement shall be met.                               |  |
| Voltage Proof | IEC 60384-1     | 4.5.4     | Specified stress voltage applied for 1 to 5 seconds<br>$U_r \leq 100 V$ : series applied $2.5 U_r$<br>Charge/Discharge current less than 50mA  | No breakdown or flashover  |

REVISION HISTORY

| REVISION  | DATE          | CHANGE NOTIFICATION | DESCRIPTION       |
|-----------|---------------|---------------------|-------------------|
| Version 1 | Nov. 7, 2016  | -                   | - Add 13" packing |
| Version 0 | Jun. 26, 2015 | -                   | - New             |