

DATA SHEET

SURFACE-MOUNT CERAMIC MULTILAYER CAPACITORS

Low-Inductance

X5R / X7R

6.3 V TO 50 V

10 nF to 1 μ 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)

(1) SIZE – INCH BASED (METRIC)

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

(2) TOLERANCE

K = ±10%
 M = ±20%

(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

(4) TC MATERIAL

X5R / X7R

(5) RATED VOLTAGE

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

(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 × 10¹ = 120 pF

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.

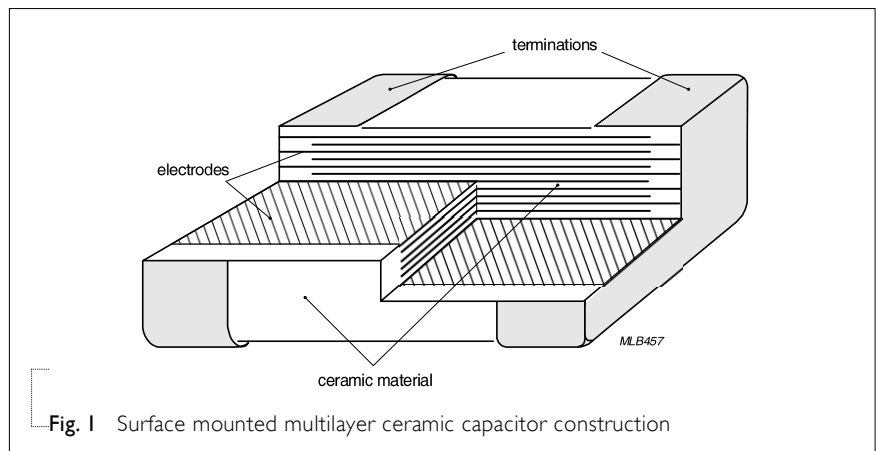


Fig. 1 Surface mounted multilayer ceramic capacitor construction

DIMENSION

Table I For outlines see fig. 2

| TYPE | L ₁ (mm) | W (mm) | T (mm) | L ₂ / L ₃ (mm) | | L ₄ (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

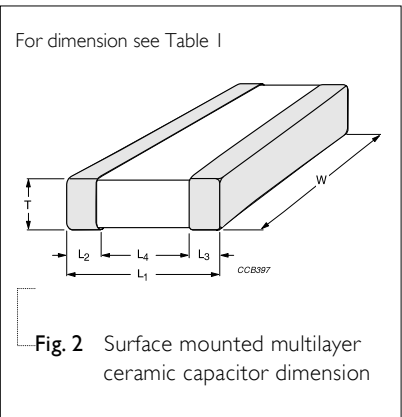


Fig. 2 Surface mounted multilayer ceramic capacitor dimension

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 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: f = 1 KHz, measuring at voltage 1 Vrms at 20 °C | Within specified tolerance |
| Dissipation Factor (D.F.) | 4.5.2 | Class 2: 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 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: X7R/X5R : $\Delta C/C : \pm 15\%$</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 | <p>A force applied for 10 seconds to the line joining the terminations and in a plane parallel to the substrate</p> | <p>Force size ≥ 0306: 5N 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>$\Delta C/C$ Class2: X7R/X5R : $\pm 10\%$</p> | | | | | | | | | | | |

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

| TEST | TEST METHOD | PROCEDURE | REQUIREMENTS |
|------------------------|-------------|--|--|
| Damp Heat with Ur load | 4.13 | <p>1. Preconditioning, class 2 only: 150 +0/-10 °C /1 hour, then keep for 24 ± 1 hour at room temp</p> <p>2. Initial measure: Spec: refer initial spec C, D, IR</p> <p>3. Damp heat test: 500 ± 12 hours at 40 ± 2 °C; 90 to 95% R.H; 1.0 Ur applied.</p> <p>4. Recovery: Class 1: 6 to 24 hours Class 2: 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 precondition according to "IEC 60384 4.1" and then the requirement shall be met.</p> | <p>No visual damage after recovery</p> <hr/> <p>$\Delta C/C$ Class2: X7R/X5R : ±20% D.F.</p> <p>Class2: X7R/X5R : ≤ 2 × specified value R_{ins} Class2: X7R/X5R : ≥ 500 MΩ or $R_{ins} \times C_r \geq 25s$ whichever is less</p> <p>$\Delta C/C$ Class2: X7R/X5R : ±25% D.F. Class2: X7R/X5R : ≤ 2 × specified value R_{ins} $R_{ins} \times C_r \geq 25\Omega \cdot F$</p> |

| TEST | TEST METHOD | PROCEDURE | REQUIREMENTS | |
|----------------------|-----------------|-----------|--|--|
| Endurance | IEC 60384-21/22 | 4.14 | <p>1. Preconditioning, class 2 only: 150 +0/-10 °C /1 hour, then keep for 24 ±1 hour at room temp</p> <p>2. Initial measure: Spec: refer initial spec C, D, IR</p> <p>3. Endurance test: Temperature: NP0: 125 °C Specified stress voltage applied for 1,000 hours: Applied 2.0 × U_r for general product Temperature: X7R: 125°C Specified stress voltage applied for 1,000 hours: Recovery time: 24 ±2 hours</p> <p>4. 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 precondition according to "IEC 60384 4.1" and then the requirement shall be met.</p> | <p>No visual damage</p> <hr/> <p>ΔC/C Class2: X7R/X5R : ±20%</p> <p>D.F. Class2: X7R/X5R : ≤ 2x initial value max</p> <p>R_{ins} Class2: X7R/X5R : ≥ 1,000 MΩ or R_{ins} × Cr ≥ 50s whichever is less</p> <p>Δ C/C Class2: X7R/X5R : ±25%</p> <p>D.F. Class2: X7R/X5R : ≤ 2x initial value max</p> <p>R_{ins} Class2: R_{ins} × Cr ≥ 50 Ω· F</p> |
| Voltage Proof | IEC 60384-1 | 4.5.4 | <p>Specified stress voltage applied for 1 to 5 seconds U_r ≤ 100 V: series applied 2.5 U_r Charge/Discharge current less than 50mA</p> | 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 |