Innovative Service Around the Globe YAGEO

# DATA SHEET

## SURFACE-MOUNT CERAMIC MULTILAYER CAPACITORS

General Purpose & High Capacitance

Class 2, X7R

6.3 V TO 50 V

**100 pF to 22 µF**

**RoHS compliant & Halogen Free**

Product Specification – October 13, 2011 V.8

## SCOPE

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

## APPLICATIONS

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

## FEATURES

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

## ORDERING INFORMATION - GLOBAL PART NUMBER, PHYCOMP CTC & 12NC

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

**YAGEO BRAND ordering code**

**GLOBAL PART NUMBER (PREFERRED)**

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

### (1) SIZE – INCH BASED (METRIC)

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

### (2) TOLERANCE

J = ±5% (1)
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
C = Bulk case

### (4) RATED VOLTAGE

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

### (5) CAPACITANCE VALUE

2 significant digits+number of zeros
The 3rd digit signifies the multiplying factor, and letter R is decimal point
Example: 103 = 10 x $10^3$ = 10,000 pF = 10 nF

**NOTE**

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

## CONSTRUCTION

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

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

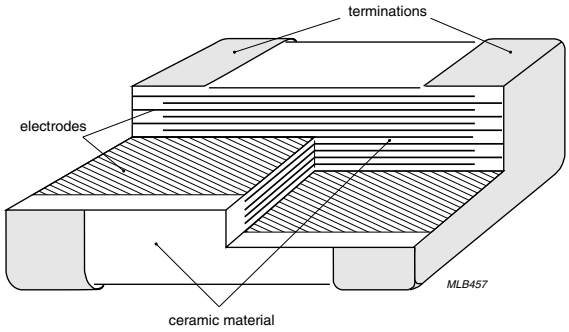



Fig. 1 Surface mounted multilayer ceramic capacitor construction

## DIMENSION

Table 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 ±0.03 | 0.3 ±0.03 | Refer to table 2 to 4 | 0.10 | 0.20 | 0.20 |
| 0402 | 1.0 ±0.05 | 0.5 ±0.05 | | 0.15 | 0.30 | 0.40 |
| 0603 | 1.6 ±0.10 (1) | 0.8 ±0.10 (1) | | 0.20 | 0.60 | 0.40 |
| | 1.6 ±0.15 (2) | 0.8 ±0.15 (2) | | | | |
| 0805 | 2.0 ±0.10 (1) | 1.25 ±0.10 (1) | | 0.25 | 0.75 | 0.55 |
| | 2.0 ±0.20 (2) | 1.25 ±0.20 (2) | | | | |
| 1206 | 3.2 ±0.15 (1) | 1.6 ±0.15 (1) | | 0.25 | 0.75 | 1.40 |
| | 3.2 ±0.30 (2) | 1.6 ±0.20 (2) | | | | |
| 1210 | 3.2 ±0.20 (1) | 2.5 ±0.20 (1) | | 0.25 | 0.75 | 1.40 |
| | 3.2 ±0.40 (2) | 2.5 ±0.30 (2) | | | | |
| 1812 | 4.5 ±0.20 (1) | 3.2 ±0.20 (1) | | 0.25 | 0.75 | 2.20 |
| | 4.5 ±0.40 (2) | 3.2 ±0.40 (2) | | | | |

**NOTE**

1. Dimension for size 0603, C < 10 µF; 0805 to 1812, C ≤ 100nF
2. Dimension for size 0603, C ≥ 10 µF; 0805 to 1812, C > 100 nF

### OUTLINES

For dimension see Table 1

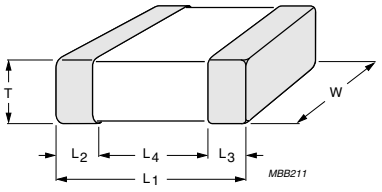



Fig. 2 Surface mounted multilayer ceramic capacitor dimension

## CAPACITANCE RANGE & THICKNESS FOR X7R

Table 3 Sizes from 0603 to 0805

| CAP. | Last 2-digit of 12NC | 0603 | | | | | 0805 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 6.3 V | 10 V | 16 V | 25 V | 50 V | 6.3 V | 10 V | 16 V | 25 V | 50 V |
| 100 pF | 09 | 0.8±0.1 | 0.8±0.1 | 0.8±0.1 | 0.8±0.1 | 0.8±0.1 | | | | | |
| 150 pF | 12 | | | | | | | | | | |
| 220 pF | 14 | | | | | | | | | 0.6±0.1 | 0.6±0.1 |
| 330 pF | 16 | | | | | | | | | | |
| 470 pF | 18 | | | | | | | | | | |
| 680 pF | 21 | | | | | | | | | | |
| 1.0 nF | 23 | | | | | | | | | | |
| 1.5 nF | 25 | | | | | | | | | | |
| 2.2 nF | 27 | | | | | | | | | | |
| 3.3 nF | 29 | | | | | | | | | | |
| 4.7 nF | 32 | | | | | | | | | | |
| 6.8 nF | 34 | | | | | | | | | | |
| 10 nF | 36 | | | | | | | | | | |
| 15 nF | 38 | | | | | | | | | | |
| 22 nF | 41 | | | | | | | | | | |
| 33 nF | 43 | | | | | | 0.85±0.1 | 0.85±0.1 | 0.85±0.1 | 0.85±0.1 | 0.85±0.1 |
| 47 nF | 45 | | | | | | | | | | |
| 68 nF | 47 | | | | | | | | | | |
| 100 nF | 49 | | | | | | | | | | |
| 150 nF | 52 | | | | | | | | | | |
| 220 nF | 54 | | | | | | | | | | 1.25±0.2 |
| 330 nF | 56 | | | | | | 1.25±0.2 | 1.25±0.2 | 1.25±0.2 | 1.25±0.2 | |
| 470 nF | 58 | | | | | | | | | | |
| 680 nF | 61 | | | | | | | | | | |
| 1.0 µF | 63 | | | | | | | | | | |
| 2.2 µF | 67 | | | | | | | | | | |
| 4.7 µF | 72 | | | | | | | | | | |
| 10 µF | 76 | | | | | | | | | | |
| 22 µF | 81 | | | | | | | | | | |

**NOTE**

1. Values in shaded cells indicate thickness class in mm
2. Capacitance value of non E-6 series is on request
3. For product with 5% tolerance, please contact local sales force before ordering

## CAPACITANCE RANGE & THICKNESS FOR X7R

Table 4 Size 1206

| CAP. | Last 2-digit of 12NC | 1206 6.3 V | 10 V | 16 V | 25 V | 50 V |
|---|---|---|---|---|---|---|
| 100 pF | 09 | | | | | |
| 150 pF | 12 | | | | | |
| 220 pF | 14 | | | | | |
| 330 pF | 16 | | | | | |
| 470 pF | 18 | | | | | |
| 680 pF | 21 | | | | | |
| 1.0 nF | 23 | | | | | |
| 1.5 nF | 25 | | | | | |
| 2.2 nF | 27 | | | | | |
| 3.3 nF | 29 | | | | | |
| 4.7 nF | 32 | | | | | 0.85±0.1 |
| 6.8 nF | 34 | | | | | |
| 10 nF | 36 | | | | 0.85±0.1 | |
| 15 nF | 38 | | | | | |
| 22 nF | 41 | | | | | |
| 33 nF | 43 | | | | | |
| 47 nF | 45 | | | | | |
| 68 nF | 47 | | | | | |
| 100 nF | 49 | | | | | |
| 150 nF | 52 | | | | | 1.15±0.1 |
| 220 nF | 54 | | | 0.85±0.1 | | |
| 330 nF | 56 | | | | | |
| 470 nF | 58 | | | | | 1.0±0.1 |
| 680 nF | 61 | | | 1.15±0.1 | 1.15±0.1 | |
| 1.0 µF | 63 | 1.15±0.1 | 1.15±0.1 | | | 1.6±0.2 |
| 2.2 µF | 67 | | | | | |
| 4.7 µF | 72 | 1.6±0.2 | 1.6±0.2 | 1.6±0.2 | 1.6±0.2 | |
| 10 µF | 76 | | | | | |
| 22 µF | 81 | | | | | |
| 47 µF | 85 | | | | | |

**NOTE**

1. Values in shaded cells indicate thickness class in mm
2. Capacitance value of non E-6 series is on request
3. For product with 5% tolerance, please contact local sales force before ordering
4. Please contact local sales force for special ordering code before ordering

## ELECTRICAL CHARACTERISTICS

### X7R DIELECTRIC CAPACITORS; NISN TERMINATIONS

Unless otherwise specified, all test and measurements shall be made under standard atmospheric conditions for testing as given in 5.3 of IEC 60068-1:

- Temperature: 15 °C to 35 °C
- Relative humidity: 25% to 75%
- Air pressure: 86 kPa to 106 kPa

Before the measurements are made, the capacitor shall be stored at the measuring temperature for a time sufficient to allow the entire capacitor to reach this temperature.

The period as prescribed for recovery at the end of a test is normally sufficient for this purpose.

Table 7

| DESCRIPTION | | | | | VALUE |
|---|---|---|---|---|---|
| Capacitance range | | | | | 100 pF to 22 µF |
| Capacitance tolerance | | | | | ±5%, ±10%, ±20% |
| Dissipation factor (D.F.) | | | | | |
| | ≤ 10 V | | | | ≤ 5% |
| | | Exception: 0201 ≥ 12 nF; | 0603 ≥ 2.2 µF; | 0805 ≥ 4.7 µF; | ≤ 10% |
| | | 1210 ≥ 4.7 µF | | | |
| | | 0805 ≥ 10 µF; | 1206 ≥ 10 µF | | ≤ 15% |
| | 16 V | | | | ≤ 3.5% |
| | | Exception: 0201 ≥ 1.5 nF; | 0402 ≥ 27 nF; | 0603 ≥ 220 nF; | ≤ 5% |
| | | 0805 ≥ 680 nF; | 1206 ≥ 2.2 µF; | 1210 ≥ 10 µF | |
| | | 1206 ≥ 10 µF; | 1210 ≥ 22 µF | | ≤ 10% |
| | 25 V | | | | ≤ 2.5% |
| | | Exception: 0402 ≥ 10 nF; | 0603 ≥ 47 nF; | 0805 ≥ 220 nF; | ≤ 3.5% |
| | | 1206 ≥ 1 µF; | 1210 ≥ 4.7 µF | | |
| | | 0201 ≥ 560 pF; | 0402 ≥ 56 nF; | 0603 ≥ 1 µF; | ≤ 5% |
| | | 0805 ≥ 680 nF; | 1206 ≥ 2.2 µF; | 1210 ≥ 10 µF | |
| | | 1206 ≥ 4.7 µF | | | ≤ 10% |
| | ≥ 50 V | | | | ≤ 2.5% |
| | | Exception: 0201 ≥ 47 pF; | 1206 ≥ 1 µF | | ≤ 3.5% |
| | | 0603 ≥ 47 nF | | | ≤ 3.0% |
| Insulation resistance after 1 minute at $U_r$ (DC) | | | | | $R_{ins}$ ≥ 10 GΩ or $R_{ins}$ × $C_r$ ≥ 500 seconds whichever is less |
| Maximum capacitance change as a function of temperature (temperature characteristic/coefficient): | | | | | ±15% |
| Operating temperature range: | | | | | –55 °C to +125 °C |

**NOTE**

Capacitance tolerance ±5% is not available for full product range, please contact local sales force before ordering

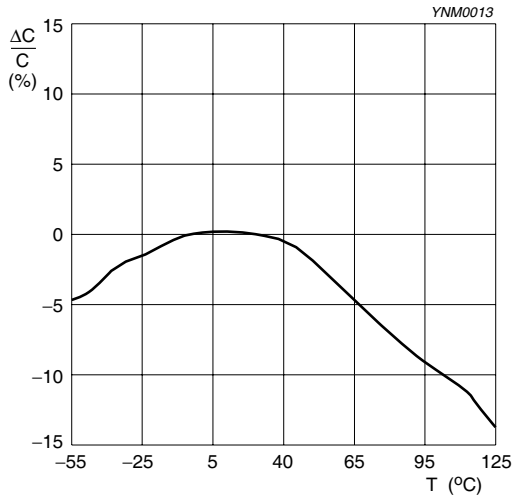
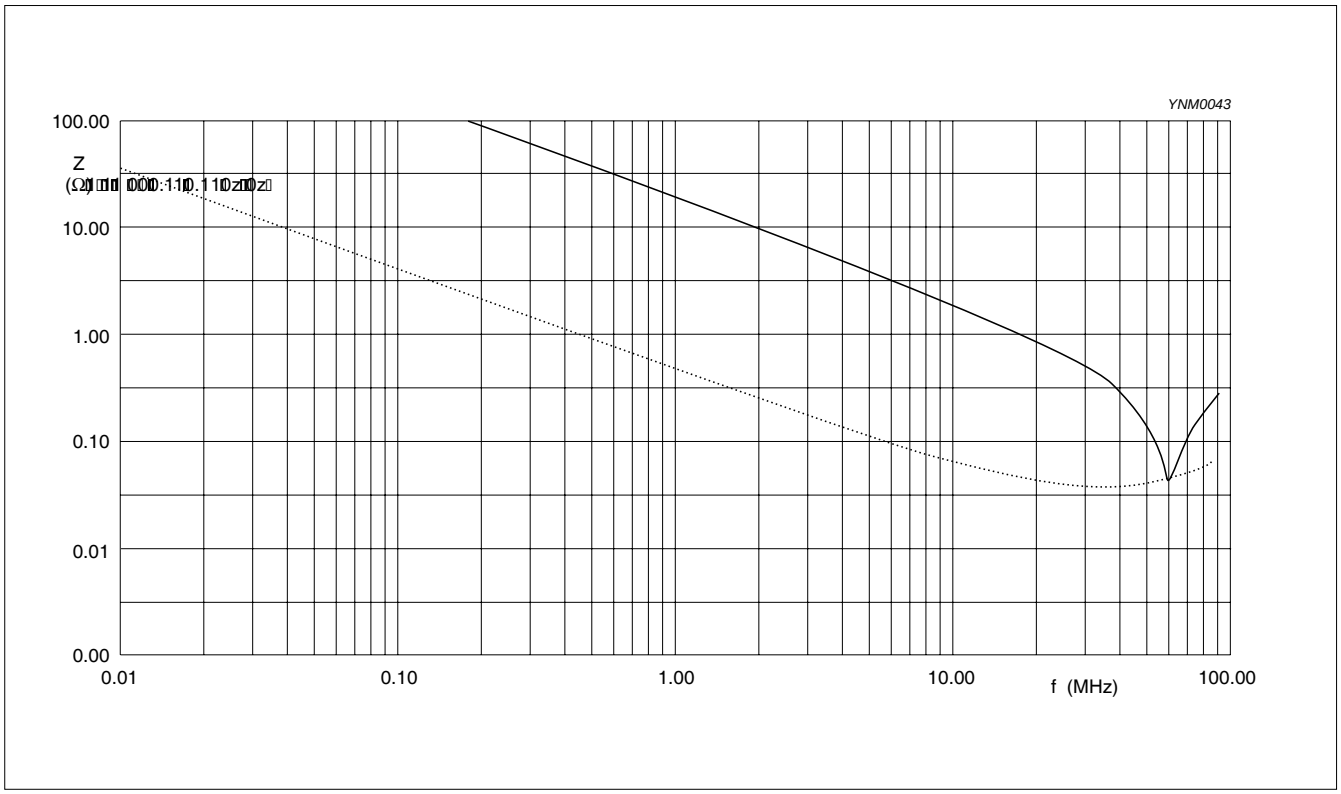
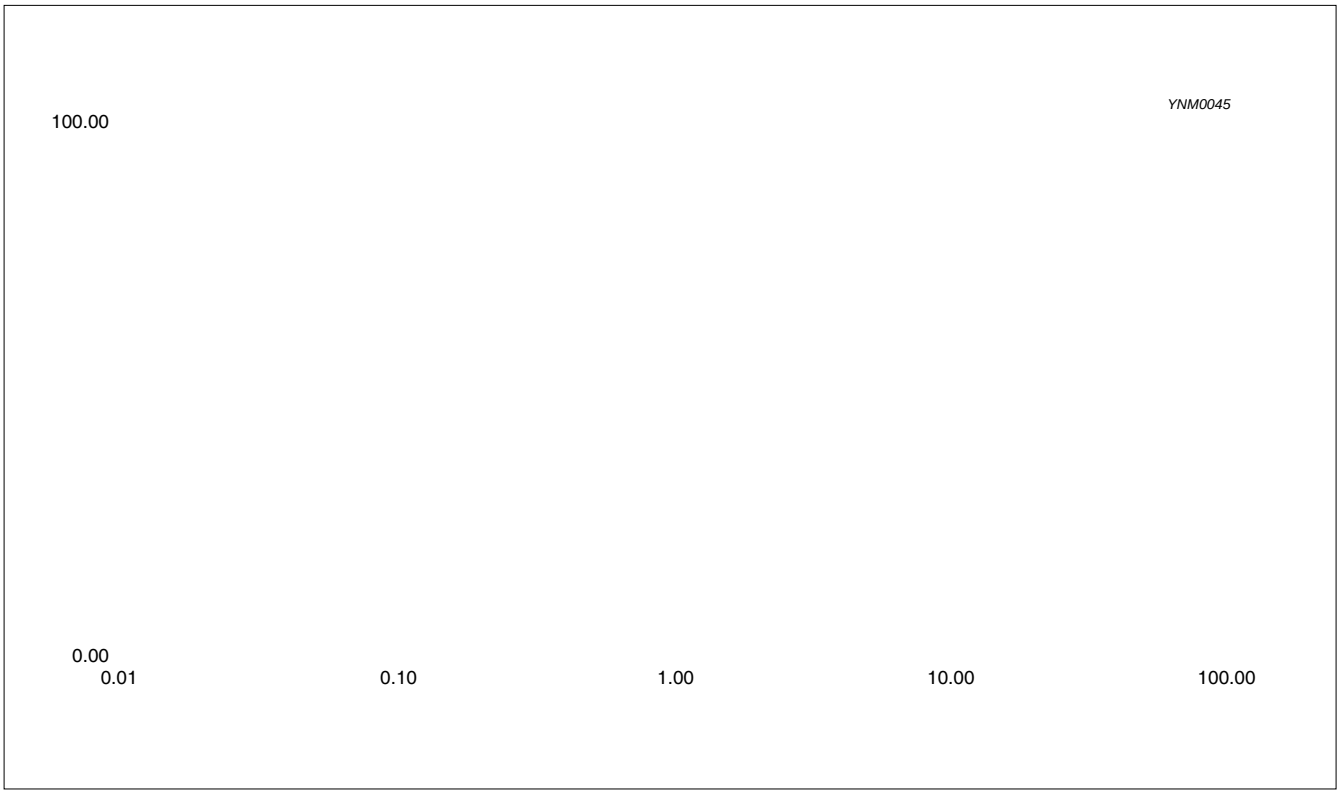



Fig. 3 Typical capacitance change as a function of temperature


YNM0043
100.00
10.00
1.00
0.10
0.01
0.00
0.01
0.10
1.00
10.00
100.00
f (MHz)


YNM0045
100.00
0.00
0.01
0.10
1.00
10.00
100.00

Size 1206 1 µF / 25 V
Solid lines: Impedance / Dotted lines: ESR

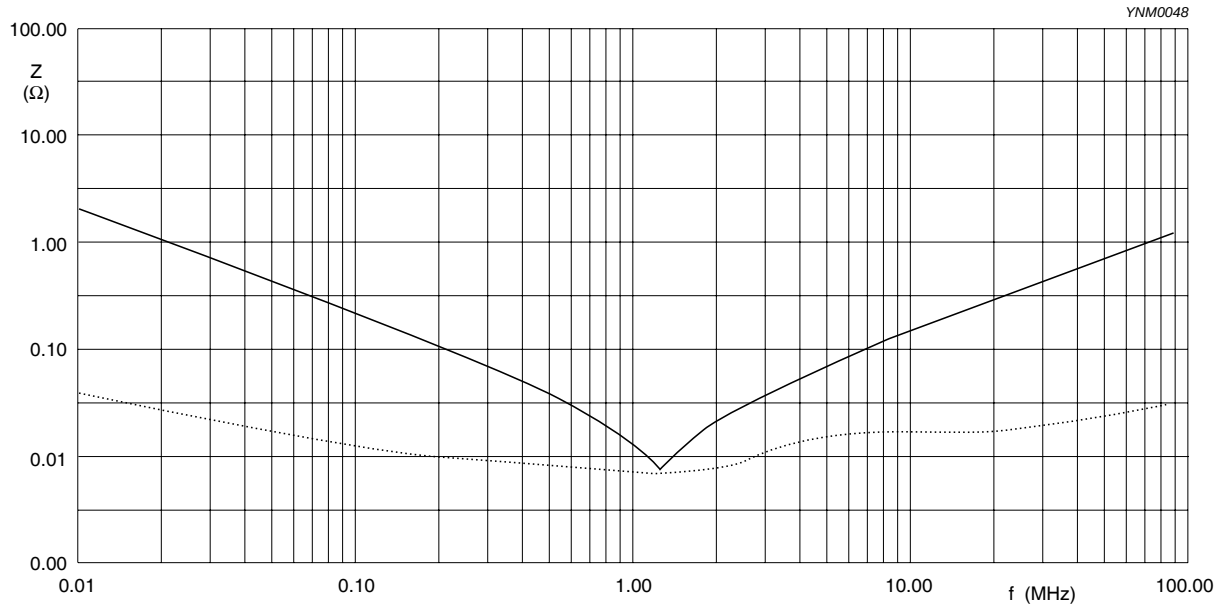



Fig. 8 Impedance ESR vs. frequency characteristics for multilayer chip capacitors

Size 1206 10 µF / 10 V
Solid lines: Impedance / Dotted lines: ESR

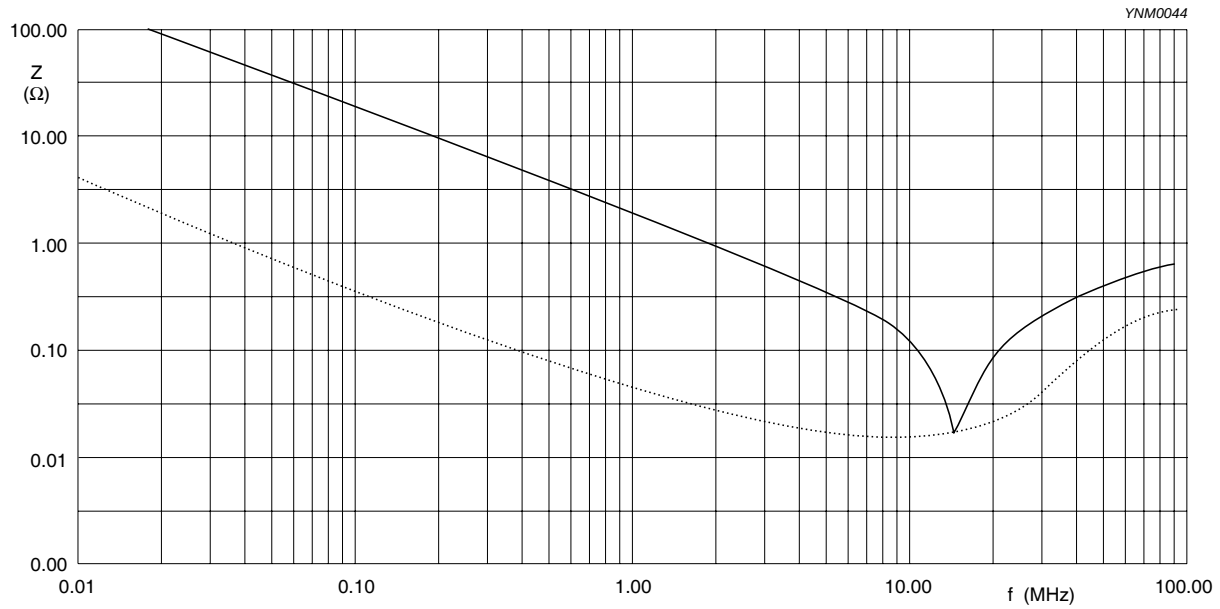



Fig. 9 Impedance ESR vs. frequency characteristics for multilayer chip capacitors

## SOLDERING RECOMMENDATION

Table 8

| SOLDERING METHOD | SIZE 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 9 Test procedures and requirements

| TEST | TEST METHOD | | PROCEDURE | REQUIREMENTS |
|---|---|---|---|---|
| Mounting | IEC 60384-21/22 | 4.3 | The capacitors may be mounted on printed-circuit boards or ceramic substrates | No visible damage |
| Visual Inspection and Dimension Check | | 4.4 | Any applicable method using × 10 magnification | In accordance with specification |
| Capacitance (1) | | 4.5.1 | Class 2:<br>At 20 °C, 24 hrs after annealing<br>f = 1 KHz for C ≤ 10 μF, rated voltage > 6.3 V, measuring at voltage 1 $V_{rms}$ at 20 °C<br>f = 1 KHz, for C ≤ 10 μF, rated voltage ≤ 6.3 V, measuring at voltage 0.5 $V_{rms}$ at 20 °C<br>f = 120 Hz for C > 10 μF, measuring at voltage 0.5 $V_{rms}$ at 20 °C | Within specified tolerance |
| Dissipation Factor (D.F.) (1) | | 4.5.2 | Class 2:<br>At 20 °C, 24 hrs after annealing<br>f = 1 KHz for C ≤ 10 μF, rated voltage > 6.3 V, measuring at voltage 1 $V_{rms}$ at 20 °C<br>f = 1 KHz, for C ≤ 10 μF, rated voltage ≤ 6.3 V, measuring at voltage 0.5 $V_{rms}$ at 20 °C<br>f = 120 Hz for C > 10 μF, measuring at voltage 0.5 $V_{rms}$ at 20 °C | In accordance with specification |
| Insulation Resistance | | 4.5.3 | At $U_r$ (DC) for 1 minute | In accordance with specification |

**NOTE:**

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

| TEST | TEST METHOD | PROCEDURE | REQUIREMENTS |
|---|---|---|---|
| Temperature Characteristic | IEC 60384-21/22 4.6 | Class 2:<br>Between minimum and maximum temperature<br>X7R: -55 °C to +125 °C<br>Normal Temperature: 20 °C | <General Purpose series><br>ΔC/C<br>Class 2:<br>X7R: ±15%<br><br><High Capacitance series><br>ΔC/C<br>Class 2:<br>X7R: ±15% |

| TEST | TEST METHOD | PROCEDURE | REQUIREMENTS |
|---|---|---|---|
| Solderability | IEC 60384-21/22 4.10 | Preheated to a temperature of 80 °C to 140 °C and maintained for 30 seconds to 60 seconds.<br><br>Test conditions for lead containing solder alloy<br>Temperature: 235 ±5 °C<br>Dipping time: 2 ±0.2 seconds<br>Depth of immersion: 10 mm<br>Alloy Composition: 60/40 Sn/Pb<br>Number of immersions: 1<br><br>Test conditions for lead-free containing solder alloy<br>Temperature: 245 ±5 °C<br>Dipping time: 3 ±0.3 seconds<br>Depth of immersion: 10 mm<br>Alloy Composition: SAC305<br>Number of immersions: 1 | The solder should cover over 95% of the critical area of each termination |
| Rapid Change of Temperature | 4.11 | Preconditioning;<br>150 +0/–10 °C for 1 hour, then keep for 24 ±1 hours at room temperature<br><br>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 | No visual damage<br><br><General Purpose series><br>ΔC/C<br>Class2:<br>X7R: ±15%<br><br><High Capacitance series><br>ΔC/C<br>Class2:<br>X7R: ±15%<br><br>D.F. meet initial specified value<br>$R_{ins}$ meet initial specified value |

| 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 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: X7R: 125 °C<br>Specified stress voltage applied for 1,000 hours:<br>Applied 2.0 x $U_r$ for general products<br>Applied 1.5 x $U_r$ for high cap. products<br>4. Recovery time: 24 ±2 hours<br>5. Final measure: C, D, IR<br><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 requirement shall be met. | No visual damage<br><br><General Purpose series><br>ΔC/C<br>Class2:<br>X7R: ±15%<br>D.F.<br>Class2:<br>X7R: ≤ 16V: ≤ 7%<br>≥ 25V: ≤ 5%<br>$R_{ins}$<br>Class2:<br>X7R: ≥ 1,000 MΩ or $R_{ins}$ x $C_r$ ≥ 50s whichever is less<br><br><High Capacitance series><br>ΔC/C<br>Class 2:<br>X7R: ±20%<br>D.F.<br>Class 2:<br>X7R: 2 x initial value max<br>$R_{ins}$<br>Class 2:<br>X7R: 1,000 MΩ or $R_{ins}$ x $C_r$ ≥ 50s whichever is less |
| Voltage Proof | IEC 60384-1 4.6 | Specified stress voltage applied for 1 minute<br>$U_r$ ≤ 100 V: series applied 2.5 $U_r$<br>100 V < $U_r$ ≤ 200 V series applied (1.5 $U_r$ + 100)<br>200 V < $U_r$ ≤ 500 V series applied (1.3 $U_r$ + 100)<br>$U_r$ > 500 V: 1.3 $U_r$<br>I: 7.5 mA | No breakdown or flashover |

## REVISION HISTORY

| REVISION | DATE | CHANGE NOTIFICATION | DESCRIPTION |
|---|---|---|---|
| Version 8 | Oct 13, 2011 | - | - Dimension updated |
| Version 7 | Jan 13, 2011 | - | - Dimension updated |
| Version 6 | Oct 13, 2010 | - | - Rated voltage of 0201 extend to 50 V<br>- Capacitance range of 0201 X7R 6.3V to 16V extend to 100 pF<br>- Capacitance range of 0805 X7R 10V extend to 10 µF<br>- Capacitance range of 0805 X7R 50V extend to 1 µF<br>- Capacitance range of 1210 X7R 10V extend to 22 µF<br>- Figures of impedance ESR updated |
| Version 5 | Jul 27, 2010 | - | - Dimension on 0603 and 1206 case size updated |
| Version 4 | Apr 21, 2010 | - | - The statement of "Halogen Free" on the cover added<br>- Dimension updated |
| Version 3 | Oct 26, 2009 | - | - Capacitance range of 0402 X7R 25 V extend to 100 nF |
| Version 2 | May 11, 2009 | - | - Product range updated |
| Version 1 | Apr 24, 2009 | - | - Ordering code updated |
| Version 0 | Apr 15, 2009 | - | - New datasheet for general purpose and high capacitance X7R series with RoHS compliant<br>- Replace the "6.3V to 50V" part of pdf files: X7R_10V_9, X7R_16V-to-100V_9, X7R_16-to-500V_9, UP-X5R_X7R_HighCaps_6.3-to-25V_11, UY-X5R_X7R_HighCaps_6.3-to-25V_11<br>- Combine 0201 from pdf files: UP-NP0X5RX7RY5V_0201_6.3-to-50V_2 and UY-NPOX5RX7RY5V_0201_6.3-to-50V_2<br>- Define global part number<br>- Description of "Halogen Free compliant" added<br>- Test method and procedure updated |

# Mouser Electronics

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Yageo:

CC0805KKX7R6BB225 CC0603KRX7R6BB474 CC0402KRX7R7BB682 CC0402KRX7R9BB121
CC0402KRX7R8BB822 CC0402KRX7R8BB682 CC0402KRX7R8BB562 CC0402KRX7R8BB472
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