

DATA SHEET

SURFACE MOUNT MULTILAYER CERAMIC CAPACITORS

General purpose & High capacitance

Class 2, X5R

4 V TO 50 V



SCOPE

This specification describes X5R series chip capacitors with lead-free terminations.

APPLICATIONS

PCs, Hard disk, Game PCs

Power supplies

DVD players

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 & I2NC

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

(1)
(2)
(3)
(4)
(5)

(1) SIZE – INCH BASED (METRIC)

0201 (0603)

0402 (1005)

0603 (1608)

0805 (2012)

1206 (3216)

1210 (3225)

(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

C = Bulk case

(4) RATED VOLTAGE

4 = 4 V

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 × 10³ = 10,000 pF = 10 nF

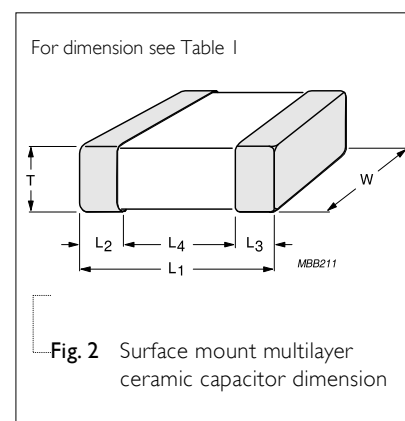
CONSTRUCTION

The capacitor consists of a rectangular block of ceramic

DIMENSION

Table I For outlines see fig. 2

TYPE	L ₁ (mm)	W (mm)	T (MM)	L ₂ / L ₃ (mm)		L ₄ (mm)	DIMENSION CODE
				min.	max.		
0201	0.6 ±0.03	0.3 ±0.03	0.3 ±0.03	0.1	0.2	0.2	BA
	0.6 ±0.05	0.3 ±0.05	0.3 ±0.05	0.1	0.2	0.2	BB
	0.6 ±0.09	0.3 ±0.09	0.3 ±0.09	0.1	0.25	0.2	BC
	0.6 ±0.15	0.3 ±0.15	0.3 ±0.15	0.1	0.25	0.2	BD
0402	1.0 ±0.05	0.5 ±0.05	0.5 ±0.05	0.15	0.35	0.4	CA
	1.0 ±0.10	0.5 ±0.10	0.5 ±0.10	0.15	0.35	0.4	CB
	1.0 ±0.15	0.5 ±0.15	0.5 ±0.15	0.15	0.35	0.4	CC
	1.0 ±0.20	0.5 ±0.20	0.5 ±0.20	0.15	0.35	0.4	CD
0603	1.6 ±0.10	0.8 ±0.10	0.8 ±0.10	0.2	0.6	0.4	DA
	1.6 ±0.15	0.8 ±0.15	0.8 ±0.15	0.2	0.6	0.4	DB
	1.6 ±0.20	0.8 ±0.20	0.8 ±0.20	0.2	0.6	0.4	DC
0805	2.0 ±0.20	1.25 ±0.20	0.85 ±0.10	0.25	0.75	0.7	EA
	2.0 ±0.20	1.25 ±0.20	1.25 ±0.20	0.25	0.75	0.7	EB
1206	3.2 ±0.3	1.6 ±0.2	1.15 ±0.10	0.25	0.75	1.4	FA
	3.2 ±0.3	1.6 ±0.2	1.25 ±0.20	0.25	0.75	1.4	FB
	3.2 ±0.3	1.6 ±0.2	1.6 ±0.2	0.25	0.8	1.4	FC
	3.2 ±0.3	1.6 ±0.3	1.6 ±0.3	0.3	0.9	1.4	FD
1210	3.2 ±0.20	2.5 ±0.20	1.25 ±0.20	0.25	0.75	1.4	GA
	3.2 ±0.20	2.5 ±0.20	1.9 ±0.20	0.25	0.75	1.4	GB
	3.2 ±0.20	2.5 ±0.20	2.5 ±0.20	0.25	0.75	1.0	GC
	3.2 ±0.30	2.5 ±0.30	2.5 ±0.30	0.25	0.75	1.0	GD



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	50 V	4 V	6.3 V	10 V	16 V	25 V	50 V
100 pF		BA	BA	BA	BA	BA						
150 pF		BA	BA	BA	BA	BA						
220 pF		BA	BA	BA	BA	BA						
330 pF		BA	BA	BA	BA	BA						
470 pF		BA	BA	BA	BA	BA						
680 pF		BA	BA	BA	BA	BA						
1.0 nF		BA	BA	BA	BA	BA						
1.5 nF		BA	BA		BA							
2.2 nF		BA	BA	BA	BA							
3.3 nF		BA	BA	BA	BA							
4.7 nF		BA	BA	BA	BA							
6.8 nF		BA	BA	BA	BA							
10												

CAP.	0603						0805					
	4V	6.3 V	10 V	16 V	25 V	50V	4V	6.3 V	10 V	16 V	25 V	50V
10 nF												
15 nF												
22 nF												

Table 4 Sizes from 1206 to 1210

CAP.	1206						1210				
	4 V	6.3 V	10 V	16 V	25 V	50V	6.3 V	10 V	16 V	25 V	50V
10 nF											
15 nF											
22 nF											
33 nF											
47nF											
68 nF											
100 nF											
150 nF											
220 nF											
330 nF											
470 nF											
680 nF											
1.0 μF		FA	FA	FA			FC	GA	GA	GA	GA
2.2 μF											

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	
0201	0.3 ±0.03 mm	8 mm	15,000	---	50,000	---	---
0402	0.5 ±0.05 / 0.1 mm	8 mm	10,000	---	50,000	---	50,000
	0.5 ±0.15 / 0.2 mm	8 mm	10,000	---	40,000	---	---
0603	0.8 ±0.1 mm	8 mm	4,000	---	15,000	---	15,000
0805	0.6 ±0.1 mm	8 mm	4,000	---	20,000	---	10,000
	0.85 ±0.1 mm	8 mm	4,000	---	15,000	---	8,000
	1.25 ±0.2 mm	8 mm	---	3,000	---	10,000	5,000
1206	0.6 ±0.1 mm	8 mm	4,000	---	20,000	---	---
	0.85 ±0.1 mm	8 mm	4,000	---	15,000	---	---
	1.00 / 1.15 ±0.1 mm	8 mm	---	3,000	---	10,000	---
	1.25 ±0.2 mm	8 mm	---	3,000	---	10,000	---
	1.6 ±0.15 mm	8 mm	---	2,500	---	10,000	---
1210	1.6 ±0.2 mm	8 mm	---	2,000	---	8,000	---
	0.6 / 0.7 ±0.1 mm	8 mm	---	4,000	---	15,000	---
	0.85 ±0.1 mm	8 mm	---	4,000	---	10,000	---
	1.15 ±0.1 mm	8 mm	---	3,000	---	10,000	---
	1.15 ±0.15 mm	8 mm	---	3,000	---	10,000	---
	1.25 ±0.2 mm	8 mm	---	3,000	---	---	---
	1.5 ±0.1 mm	8 mm	---	2,000	---	---	---
	1.6 / 1.9 ±0.2 mm	8 mm	---	2,000	---	---	---
2.0 ±0.2 mm	8 mm	---	2,000 1,000	---	---	---	
2.5 ±0.2 mm	8 mm	---	1,000 500	---	---	---	

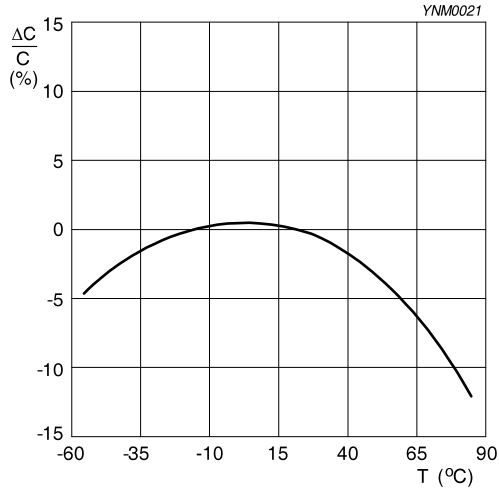


Fig. 3 Typical capacitance change as a function of temperature

Size 0201 10 nF / 16 V
Solid lines: Impedance / Dotted lines: ESR

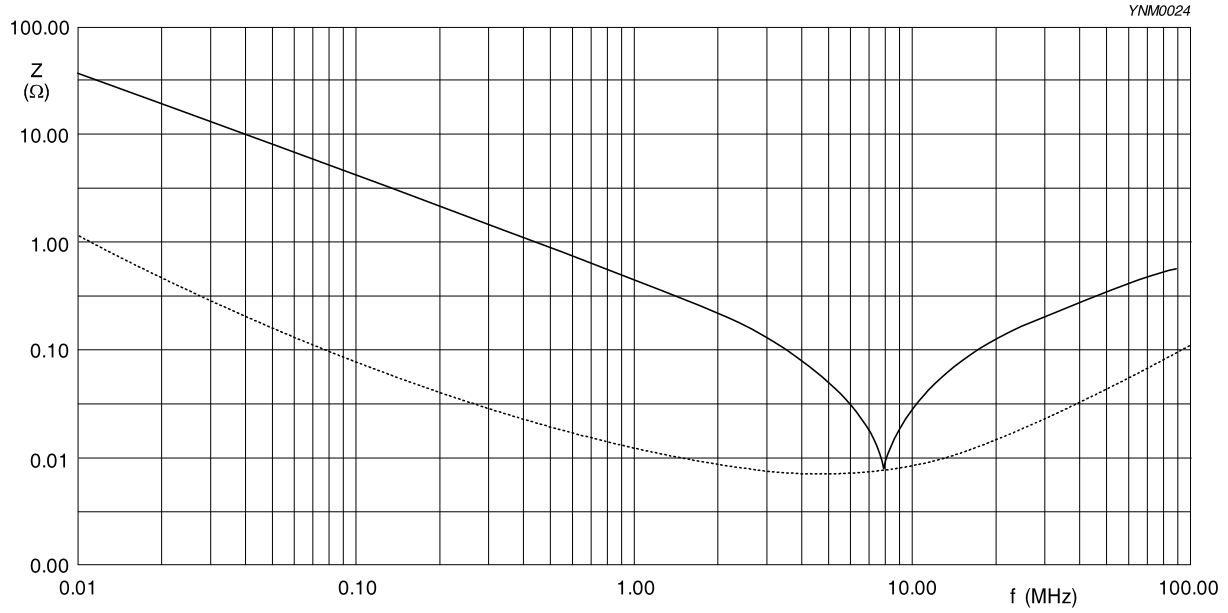


Fig. 4 Impedance ESR vs. frequency characteristics for multilayer chip capacitors

Size 0603 1 μF / 10 V
Solid lines: Impedance / Dotted lines: ESR

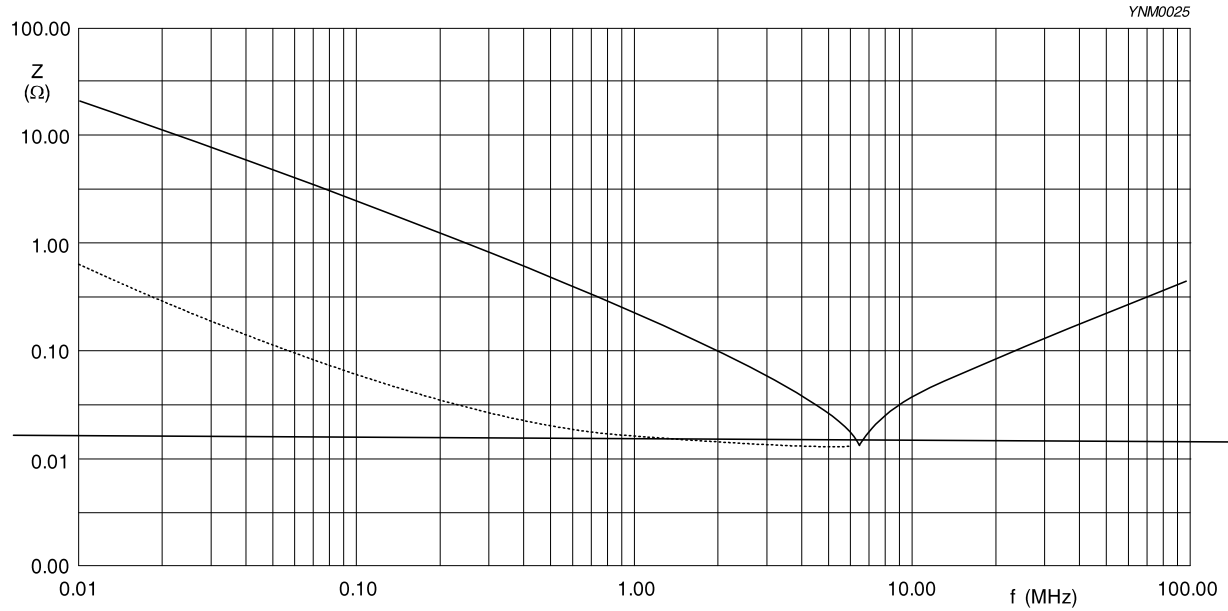


Fig. 5 Impedance ESR vs. frequency characteristics for multilayer chip capacitors

Size 0805 10 μ F / 6.3 V
Solid lines: Impedance / Dotted lines: ESR

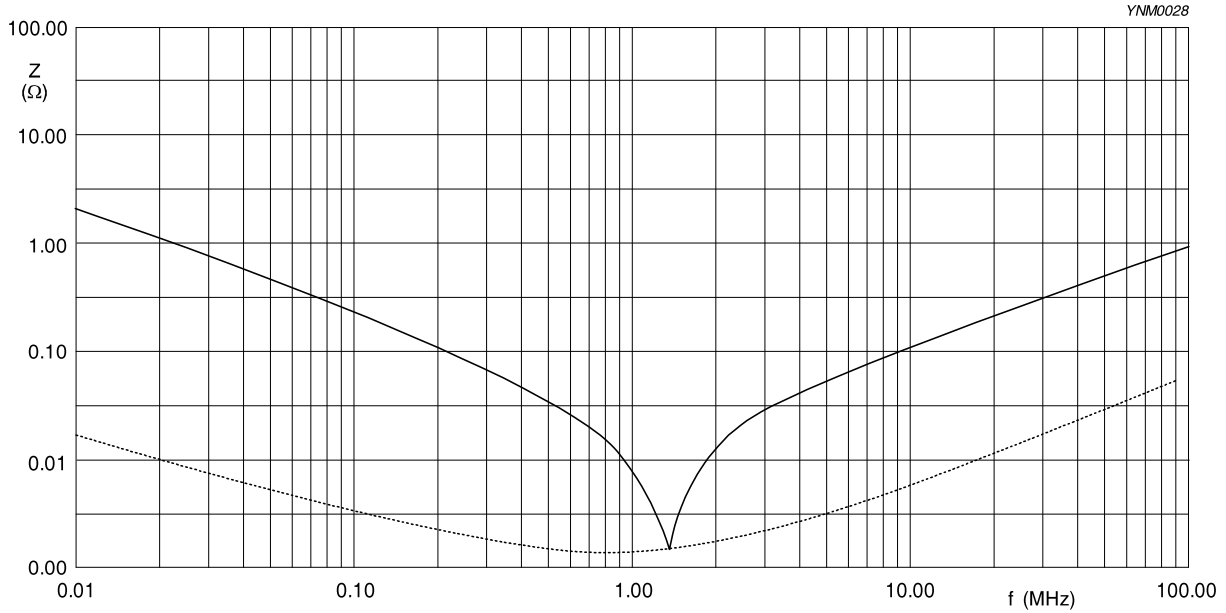


Fig. 6 Impedance ESR vs. frequency characteristics for multilayer chip capacitors

Size 1206 10 μ F / 16 V
Solid lines: Impedance / Dotted lines: ESR

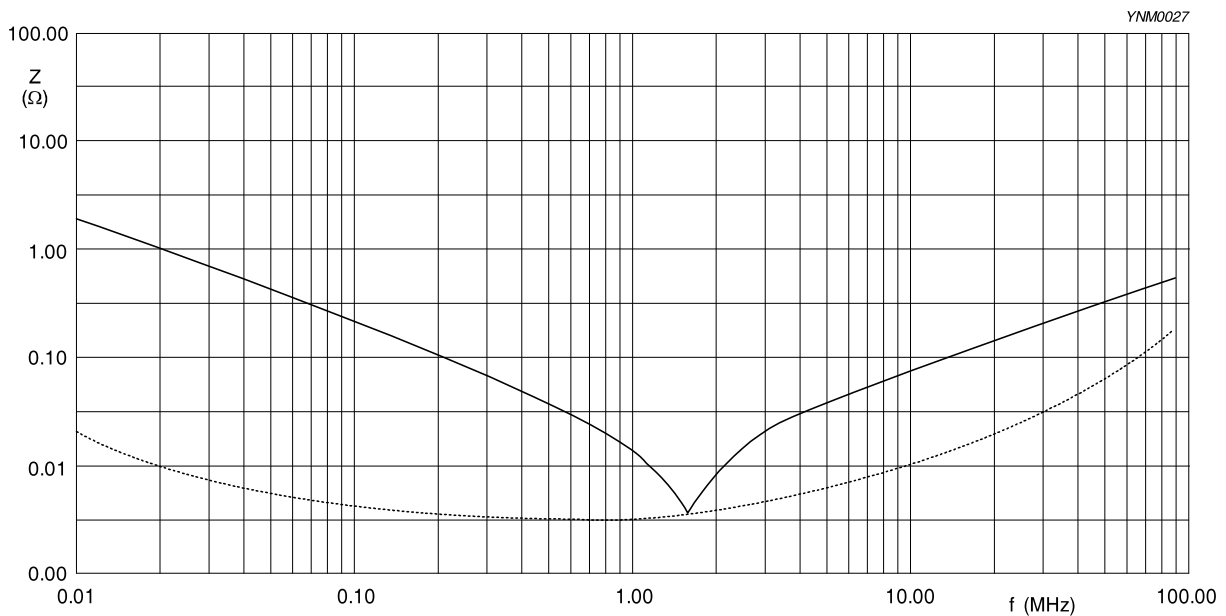


Fig. 7 Impedance ESR vs. frequency characteristics for multilayer chip capacitors

Size 1210 10 μ F / 25 V
Solid lines: Impedance / Dotted lines: ESR

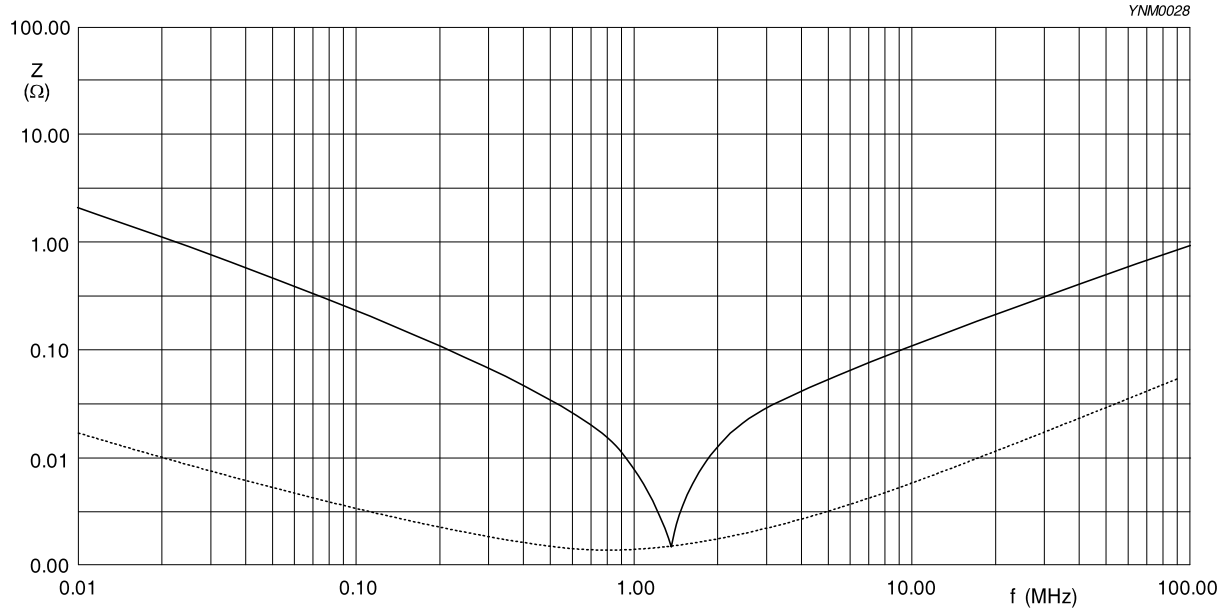


Fig. 8 Impedance ESR vs. frequency characteristics for multilayer chip capacitors

SOLDERING RECOMMENDATION

Table 7

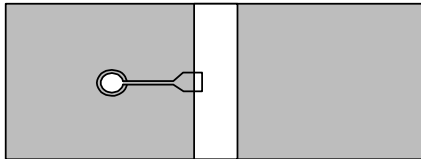
SOLDERING METHOD	SIZE					
	0201	0402	0603	0805	1206	\geq 1210
Reflow	Reflow only	> 100 nF	> 1 μ F	> 2.2 μ F	> 2.2 μ F	Reflow only
Reflow/Wave		100 nF	1 μ F	2.2 μ F	2.2 μ F	---

TESTS AND REQUIREMENTS

Table 8 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: At 20 °C, 24 hrs after annealing f = 1 KHz for C ≤ 10 μF, rated voltage > 6.3 V, measuring at voltage 1 V _{rms} at 20 °C f = 1 KHz, for C ≤ 10 μF, rated voltage ≤ 6.3 V, measuring at voltage 0.5 V _{rms} at 20 °C 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: At 20 °C, 24 hrs after annealing f = 1 KHz for C ≤ 10 μF, rated voltage > 6.3 V, measuring at voltage 1 V _{rms} at 20 °C f = 1 KHz, for C ≤ 10 μF, rated voltage ≤ 6.3 V, measuring at voltage 0.5 V _{rms} at 20 °C 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

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

TEST	TEST METHOD	PROCEDURE	REQUIREMENTS																															
Temperature Characteristic	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"> <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>(1) Class I</p> <p>Temperature Coefficient shall be calculated from the formula as below</p> $\text{Temp. Coefficient} = \frac{C2 - C1}{C1 \times \Delta T} \times 10^6 \text{ [ppm/°C]}$ <p>C1: Capacitance at step c C2: Capacitance at 125°C T: 100°C(=125°C-25°C)</p> <p>(2) Class II</p> <p>Capacitance Change shall be calculated from the formula as below</p> $C = \frac{C2 - C1}{C1} \times 100\%$ <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><General purpose series></p> <p>Class1: C/C: ±30ppm</p> <p>Class2: -82%</p> <p><High Capacitance series></p> <p>Class2: -82%</p>																			
		Step	Temperature(°C)																															
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b	Lower temperature±3°C																																	
c	25±2																																	
d	Upper Temperature±2°C																																	
e	25±2																																	
Adhesion	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 0603: 5N size = 0402: 2.5N size = 0201: 1N</p>																															
Bending Strength	IEC 60384-21/22	<p>4.8 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>Test Substrate:</p> 	<p>No visible damage</p> <p>C/C</p> <p>Class2: <General purpose series> X5R: ±10% <High Capacitance series> X5R: ±12.5%</p> <table border="1"> <thead> <tr> <th rowspan="2">Type</th> <th colspan="3">Dimension(mm)</th> </tr> <tr> <th>a</th> <th>b</th> <th>c</th> </tr> </thead> <tbody> <tr> <td>0201</td> <td>0.3</td> <td>0.9</td> <td>0.3</td> </tr> <tr> <td>0402</td> <td>0.4</td> <td>1.5</td> <td>0.5</td> </tr> <tr> <td>0603</td> <td>1.0</td> <td>3.0</td> <td>1.2</td> </tr> <tr> <td>0805</td> <td>1.2</td> <td>4.0</td> <td>1.65</td> </tr> <tr> <td>1206</td> <td>2.2</td> <td>5.0</td> <td>1.65</td> </tr> <tr> <td>1210</td> <td>2.2</td> <td>5.0</td> <td>2.0</td> </tr> </tbody> </table> <p>Unit: mm</p>	Type	Dimension(mm)			a	b	c	0201	0.3	0.9	0.3	0402	0.4	1.5	0.5	0603	1.0	3.0	1.2	0805	1.2	4.0	1.65	1206	2.2	5.0	1.65	1210	2.2	5.0	2.0
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TEST	TEST METHOD	PROCEDURE	REQUIREMENTS
Damp Heat with U _r Load	4.13	<ol style="list-style-type: none"> 1. Preconditioning, class 2 only: 150 +0/-10 °C /1 hour, then keep for 24 ±1 hour at room temp 2. Initial measure: Spec: refer to initial spec C, D, IR 3. Damp heat test: 500 ±12 hours at 40 ±2 °C; 90 to 95% R.H. 1.0 U_r applied 4. Recovery: Class 2: 24 ±2 hours 5. Final measure: C, D, IR <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 preconditioned according to "IEC 60384 4.1" and then the requirements shall be met.</p>	<p>No visual damage after recovery</p> <hr/> <p><General purpose series></p> <p>C/C</p> <p>Class2: X5R: ±15%</p> <p>D.F.</p> <p>Class2: X5R: 16V: 7% 25V: 5%</p> <p>R_{ins}</p> <p>Class2: X5R: 500 M or R_{ins} × C_r 25s whichever is less</p> <p><High Capacitance series></p> <p>C/C</p> <p>Class2: X5R: ±20%</p> <p>D.F.</p> <p>Class2: X5R: 2 × initial value max</p> <p>R_{ins}</p> <p>Class2: Rins × Cr ≥ 5s whichever is less</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 to initial spec C, D, IR</p> <p>3. Endurance test: Temperature: X5R: 85 °C Specified stress voltage applied for 1,000 hours: Applied 2.0 × Ur for general product*. Applied 1.5 × Ur for high cap. product*. Applied 1.0 × Ur for high cap. product*.</p> <p>0201: 100nF/25V, 220nF/10V, 1uF, 2.2uF/ 4V, 6.3V 0402: 4.7uF/16V, 10V, 6.3V; 10uF/4V, 6.3V 0603: 10uF/ 10V; 22uF/6.3V, 10V; 47uF/4V 0805: 10uF/ 25V, 50V; 22uF/ 6.3V, 10V, 16V 47uF/ 6.3V, 10V; 100uF/ 4V 1206: 10uF/ 50V;</p> <p>4. Recovery time: 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 preconditioned according to "IEC 60384 4.1" and then the requirements shall be met.</p> <p>* General product: 0201 ≤ 10nF 0402 ≤ 100nF 0603 ≤ 470nF 0805, 1206, 1210 ≤ 1uF</p> <p>* High cap product: 0201 > 10nF 0402 > 100nF 0603 > 470nF 0805, 1206, 1210 > 1uF</p>	<p>No visual damage</p> <hr/> <p><General purpose series> C/C Class2: X5R: ±15% D.F. Class2: X5R: 16V: 7% 25V: 5% R_{ins} Class2: X5R: 1,000 M or R_{ins} × C_r 50s whichever is less</p> <p><High Capacitance series> C/C Class 2: X5R: ±20% D.F. Class 2: X5R: 2 × initial value max R_{ins} Class 2: R_{ins} × C_r ≥ 10s whichever is less</p>
Voltage Proof	4.6	<p>Specified stress voltage applied for 1~5 seconds</p> <p>Ur ≤ 100 V: series applied 2.5 Ur</p> <p>100 V < Ur ≤ 200 V series applied (1.5 Ur + 100)</p> <p>200 V < Ur ≤ 500 V series applied (1.3 Ur + 100)</p> <p>Ur > 500 V: 1.3 Ur</p> <p>Ur ≥ 1000 V: 1.2 Ur</p> <p>Charge/Discharge current is less than 50 mA</p>	No breakdown or flashover

REVISION HISTORY

REVISION	DATE	CHANGE NOTIFICATION	DESCRIPTION
Version 24	Mar. 6, 2017	-	- 0805 L4 spec updated
Version 23	Nov. 15, 2016	-	- Dimension updated
Version 22	Oct. 3, 2016	-	- Dimension and Soldering recommendation updated
Version 21	Jan. 28, 2016	-	- Tests and requirements updated
Version 20	Dec. 04, 2015	-	- Size updated
Version 19	Apr. 09, 2015	-	- Voltage updated
Version 18	Jul. 07, 2014	-	- Voltage updated
Version 17	Mar. 31, 2014	-	- Test condition updated
Version 16	Nov. 29, 2012	-	- Test condition updated
Version 15	Sep. 03, 2012	-	- Test condition updated
Version 14	May 16, 2012	-	- Product range updated
Version 13	May 02, 2012	-	- Product range updated
Version 12	Feb 10, 2012	-	- Product range updated
Version 11	Oct 21, 2011	-	- Product range updated
Version 10	Jun 21, 2011	-	- Product range updated
Version 9	Mar 23, 2011	-	- Product range updated
Version 8	Jan 25, 2011	-	- Rated voltage of 0201 extend to 50V
Version 7	Jan 05, 2011	-	- Product range updated
Version 6	Jul 27, 2010	-	- Dimension on 0603 and 1206 case size updated
Version 5	Apr 21, 2010	-	- The statement of "Halogen free" on the cover added - Dimension updated
Version 4	Jan 13, 2010	-	- Thickness updated
Version 3	Aug 17, 2009	-	- Dimension updated
Version 2	Jun 09, 2009	-	- Ordering code updated
Version 1	May 15, 2009	-	- Product range updated
Version 0	Apr 15, 2009	-	- New datasheet for general purpose and high capacitance X5R series with RoHS compliant - Replace the "6.3V to 50V" part of pdf files: UP-X5R_X7R_HighCaps_6.3-to-25V_11, UY-X5R_X7R_HighCaps_6.3-to-25V_11 - Combine 0201 from pdf files: UP-NP0X5RX7RY5V_0201_6.3-to-50V_2 and UY-NPOX5RX7RY5V_0201_6.3-to-50V_2 - Define global part number