

DATA SHEET

SURFACE-MOUNT CERAMIC MULTILAYER CAPACITORS

Soft termination

Class 2, X7R

16 V TO 630V

100 pF to 470 nF

RoHS compliant & Halogen Free



SCOPE

This specification describes X7R series chip capacitors with Flexible leadfree terminations.

APPLICATIONS

High flexure stress circuit boards
Switch power supplies
Telecom base station

FEATURES

- Supplied in tape on reel
- Flexible termination system
- Leaded-free termination meet RoHS requirements
- Improved resistance to thermal stresses
- Increased mechanical performance

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 / PHYCOMP BRAND ordering code

GLOBAL PART NUMBER (PREFERRED)

CS XXXX X X **X7R** X **BB** XXX
 (1) (2) (3) (4) (5)

(1) SIZE – INCH BASED (METRIC)

0603 (1608)
0805 (2012)
1206 (3216)

(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

(4) RATED VOLTAGE

7 = 16 V
8 = 25 V
9 = 50 V
0 = 100 V
A = 200 V
Y = 250 V
B = 500 V
Z = 630 V
C = 1 kV

(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

NOTE

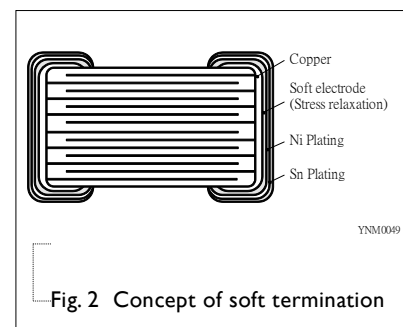
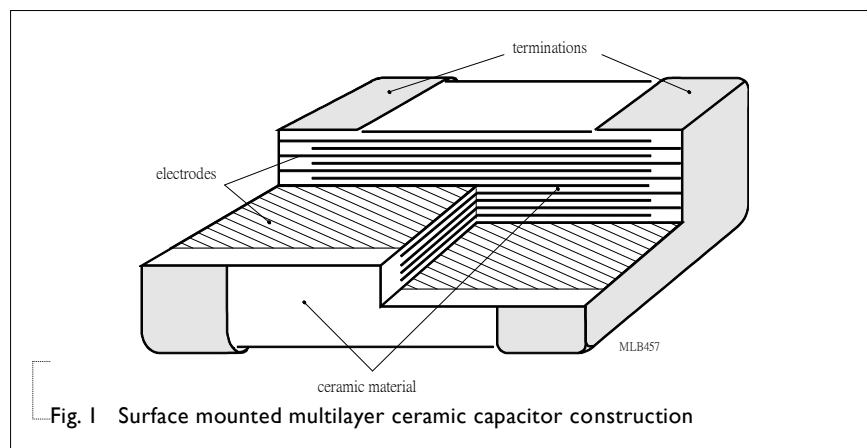
- I. Tolerance ±5% doesn't available for full product range, please contact local sales force before order

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 flexible 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 and Fig.2.



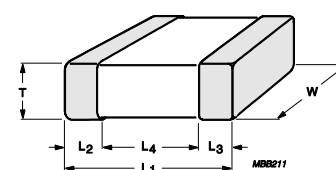
DIMENSION

Table I For outlines see fig. 3

TYPE	L ₁ (mm)	W (mm)	T (MM)	L ₂ / L ₃ (mm)		L ₄ (mm)
				min.	max.	min.
0603	1.6 ±0.20	0.8 ±0.15	Refer to table 2 to 3	0.20	0.65	0.30
0805	2.0 ±0.30	1.25 ±0.20		0.25	0.75	0.55
1206	3.2 ±0.40	1.6 ±0.20		0.25	0.85	1.40

OUTLINES

For dimension see Table I



CAPACITANCE RANGE & THICKNESS

Table 2 Size from 0603

CAP.	0603 16V	25V	50V	100V
100 pF	0.8±0.15	0.8±0.15	0.8±0.15	0.8±0.15
150 pF	0.8±0.15	0.8±0.15	0.8±0.15	0.8±0.15
220 pF	0.8±0.15	0.8±0.15	0.8±0.15	0.8±0.15
330 pF	0.8±0.15	0.8±0.15	0.8±0.15	0.8±0.15
470 pF	0.8±0.15	0.8±0.15	0.8±0.15	0.8±0.15
680 pF	0.8±0.15	0.8±0.15	0.8±0.15	0.8±0.15
1.0 nF	0.8±0.15	0.8±0.15	0.8±0.15	0.8±0.15
1.5 nF	0.8±0.15	0.8±0.15	0.8±0.15	0.8±0.15
2.2 nF	0.8±0.15	0.8±0.15	0.8±0.15	0.8±0.15
3.3 nF	0.8±0.15	0.8±0.15	0.8±0.15	0.8±0.15
4.7 nF	0.8±0.15	0.8±0.15	0.8±0.15	0.8±0.15
6.8 nF	0.8±0.15	0.8±0.15	0.8±0.15	0.8±0.15
10 nF	0.8±0.15	0.8±0.15	0.8±0.15	0.8±0.15
15 nF	0.8±0.15	0.8±0.15	0.8±0.15	
22 nF	0.8±0.15	0.8±0.15	0.8±0.15	
27 nF	0.8±0.15	0.8±0.15	0.8±0.15	
33 nF	0.8±0.15	0.8±0.15	0.8±0.15	
47 nF	0.8±0.15	0.8±0.15	0.8±0.15	
68 nF	0.8±0.15	0.8±0.15	0.8±0.15	
100 nF	0.8±0.15	0.8±0.15	0.8±0.15	
150 nF	0.8±0.15	0.8±0.15	0.8±0.15	
220 nF	0.8±0.15	0.8±0.15	0.8±0.15	
470 nF	0.8±0.15			
1 μF				

NOTE

1. Values in shaded cells indicate thickness class in mm
2. For product with 5% tolerance, please contact local sales force before order

CAPACITANCE RANGE & THICKNESS

Table 3 Size 0805

CAP.	0805				
	16V	25V	50V	100V	200V / 250V
100 pF					
150 pF					
180 pF	0.60±0.15	0.60±0.15	0.6±0.15	0.6±0.15	0.85±0.15
220 pF	0.60±0.15	0.60±0.15	0.6±0.15	0.6±0.15	0.85±0.15
330 pF	0.60±0.15	0.60±0.15	0.6±0.15	0.6±0.15	0.85±0.15
390 pF	0.60±0.15	0.60±0.15	0.6±0.15	0.6±0.15	0.85±0.15
470 pF	0.60±0.15	0.60±0.15	0.6±0.15	0.6±0.15	0.85±0.15
680 pF	0.60±0.15	0.60±0.15	0.6±0.15	0.6±0.15	0.85±0.15
1.0 nF	0.60±0.15	0.60±0.15	0.6±0.15	0.6±0.15	0.85±0.15
1.5 nF	0.60±0.15	0.60±0.15	0.6±0.15	0.6±0.15	0.85±0.15
2.2 nF	0.60±0.15	0.60±0.15	0.6±0.15	0.6±0.15	0.85±0.15
3.3 nF	0.60±0.15	0.60±0.15	0.6±0.15	0.6±0.15	0.85±0.15
4.7 nF	0.60±0.15	0.60±0.15	0.6±0.15	0.6±0.15	0.85±0.15
6.8 nF	0.60±0.15	0.60±0.15	0.6±0.15	0.6±0.15	1.25±0.2
10 nF	0.60±0.15	0.60±0.15	0.6±0.15	0.6±0.15	1.25±0.2
15 nF	0.60±0.15	0.60±0.15	0.6±0.15	0.85±0.15	1.25±0.2
18 nF	0.60±0.15	0.60±0.15	0.6±0.15	0.85±0.15	1.25±0.2
22 nF	0.60±0.15	0.60±0.15	0.6±0.15	0.85±0.15	1.25±0.2
27 nF	0.85±0.15	0.85±0.15	0.85±0.15	1.25±0.2	
33 nF	0.85±0.15	0.85±0.15	0.85±0.15	1.25±0.2	
47 nF	0.85±0.15	0.85±0.15	0.85±0.15	1.25±0.2	
68 nF	0.85±0.15	0.85±0.15	0.85±0.15	1.25±0.2	
100 nF	0.85±0.15	0.85±0.15	0.85±0.15	1.25±0.2	
150 nF	1.25±0.2	1.25±0.2	1.25±0.2		
220 nF	1.25±0.2	1.25±0.2	1.25±0.2		
270 nF	1.25±0.2	1.25±0.2	1.25±0.2		
330 nF	1.25±0.2	1.25±0.2	1.25±0.2		
390 nF	1.25±0.2	1.25±0.2	1.25±0.2		
470 nF	1.25±0.2	1.25±0.2	1.25±0.2		
680 nF	1.25±0.2	1.25±0.2			
1000 nF	1.25±0.2	1.25±0.2			

NOTE

1. Values in shaded cells indicate thickness class in mm
2. For product with 5% tolerance, please contact local sales force before order

CAPACITANCE RANGE & THICKNESS

Table 4 Size I206

CAP.	I206					
	16V	25V	50V	100V	200V / 250V	500V / 630V
100 pF						
150 pF						
180 pF						
220 pF	0.85±0.15	0.85±0.15	0.85±0.15	0.85±0.15	0.85±0.15	1.25±0.2
330 pF	0.85±0.15	0.85±0.15	0.85±0.15	0.85±0.15	0.85±0.15	1.25±0.2
390 pF	0.85±0.15	0.85±0.15	0.85±0.15	0.85±0.15	0.85±0.15	1.25±0.2
470 pF	0.85±0.15	0.85±0.15	0.85±0.15	0.85±0.15	0.85±0.15	1.25±0.2
680 pF	0.85±0.15	0.85±0.15	0.85±0.15	0.85±0.15	0.85±0.15	1.25±0.2
1.0 nF	0.85±0.15	0.85±0.15	0.85±0.15	0.85±0.15	0.85±0.15	1.25±0.2
1.5 nF	0.85±0.15	0.85±0.15	0.85±0.15	0.85±0.15	0.85±0.15	1.25±0.2
2.2 nF	0.85±0.15	0.85±0.15	0.85±0.15	0.85±0.15	0.85±0.15	1.25±0.2
3.3 nF	0.85±0.15	0.85±0.15	0.85±0.15	0.85±0.15	0.85±0.15	1.25±0.2
4.7 nF	0.85±0.15	0.85±0.15	0.85±0.15	0.85±0.15	0.85±0.15	1.25±0.2
6.8 nF	0.85±0.15	0.85±0.15	0.85±0.15	0.85±0.15	0.85±0.15	1.25±0.2
10 nF	0.85±0.15	0.85±0.15	0.85±0.15	0.85±0.15	0.85±0.15	1.25±0.2
15 nF	0.85±0.15	0.85±0.15	0.85±0.15	0.85±0.15	0.85±0.15	
18 nF	0.85±0.15	0.85±0.15	0.85±0.15	0.85±0.15	1.25±0.2	
22 nF	0.85±0.15	0.85±0.15	0.85±0.15	0.85±0.15	1.25±0.2	
27 nF	0.85±0.15	0.85±0.15	0.85±0.15	0.85±0.15		
33 nF	0.85±0.15	0.85±0.15	0.85±0.15	0.85±0.15		
47 nF	0.85±0.15	0.85±0.15	0.85±0.15	0.85±0.15		
68 nF	0.85±0.15	0.85±0.15	0.85±0.15	1.25±0.2		
100 nF	0.85±0.15	0.85±0.15	0.85±0.15	1.25±0.2		
150 nF	0.85±0.15	0.85±0.15	1.15±0.2			
220 nF	0.85±0.15	0.85±0.15	1.15±0.2			
270 nF						
330 nF						
390 nF						
470 nF						
680 nF						
1000 nF						

NOTE

1. Values in shaded cells indicate thickness class in mm
2. For product with 5% tolerance, 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	
0603	0.8 ±0.15 mm	8 mm	4,000	---	15,000	---	15,000
0805	0.6 ±0.15 mm	8 mm	4,000	---	20,000	---	10,000
	0.85 ±0.15 mm	8 mm	4,000	---	15,000	---	8,000
1206	0.85 ±0.15 mm	8 mm	4,000	---	15,000	---	---
	1.15 ±0.2 mm	8 mm	---	3,000	---	10,000	---
	1.25 ±0.2 mm	8 mm	---	3,000	---	10,000	---

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 6

DESCRIPTION	VALUE
Capacitance range	100 pF to 1000 nF
Capacitance tolerance	±5%, ±10%, ±20%
Dissipation factor (D.F.)	
16 V	≤ 3.5%
25 V	≤ 2.5%
Exception: 0603 ≥ 47 nF	≤ 3.5%
≥ 50 V	≤ 2.5%
Insulation resistance after 1 minute at U_r (DC)	$R_{ins} \geq 10 \text{ G}\Omega$ or $R_{ins} \times C_r \geq 500$ 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% doesn't available for full product range, please contact local sales force before order

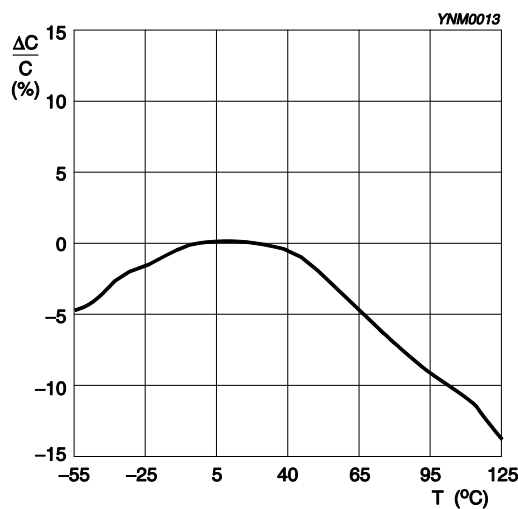


Fig. 4 Typical capacitance change as a function of temperature

SOLDERING RECOMMENDATION

Table 7

SOLDERING METHOD	SIZE 0603	0805	1206	≥ 1210
Reflow	≥ 1.0 μF	≥ 2.2 μF	≥ 4.7 μF	Reflow only
Reflow/Wave	< 1.0 μF	< 2.2 μF	< 4.7 μF	---

TESTS AND REQUIREMENTS

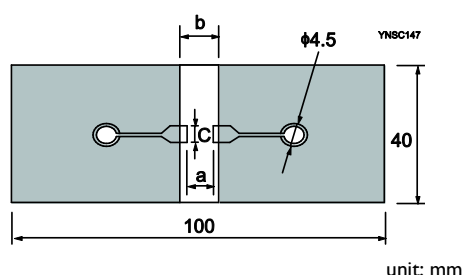
Table 8 Test procedures and requirements

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 $\times 10$ magnification	In accordance with specification
Capacitance ⁽¹⁾	4.5.1	Class 2: At 20 °C, 24 hrs after annealing f = 1 KHz for C $\leq$ 10 μ F, measuring at voltage 1 V _{rms} at 20 °C f = 120 Hz for C > 10 μ F, 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 $\leq$ 10 μ F, rated voltage > 6.3 V, measuring at voltage 1 V _{rms} at 20 °C f = 1 KHz, for C $\leq$ 10 μ F, rated voltage $\leq$ 6.3 V, measuring at voltage 0.5 V _{rms} at 20 °C f = 120 Hz for C > 10 μ F, measuring at voltage 0.5 V _{rms} at 20 °C	In accordance with specification
Insulation Resistance	4.5.3	U _r $\leq$ 500 V: At U _r for 1 minute U _r > 500 V: At 500 V for 1 minute	In accordance with specification

TEST	TEST METHOD	PROCEDURE	REQUIREMENTS												
Temperature Characteristic	IEC 60384- 21/22 4.6	Capacitance shall be measured by the steps shown in the following table. The capacitance change should be measured after 5 min at each specified temperature stage. <table><tr><th>Step</th><th>Temperature(°C)</th></tr><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></table> (1) Class I Temperature Coefficient shall be calculated from the formula as below Temp. Coefficient = $\frac{C2-C1}{C1 \times \Delta T} \times 10^6$ [ppm/°C] C1: Capacitance at step c C2: Capacitance at 125°C ΔT: 100°C(=125°C-25°C) (2) Class II Capacitance Change shall be calculated from the formula as below ΔC = $\frac{C2-C1}{C1} \times 100\%$ C1: Capacitance at step c C2: Capacitance at step b or d	Step	Temperature(°C)	a	25±2	b	Lower temperature±3°C	c	25±2	d	Upper Temperature±2°C	e	25±2	<General purpose series> Class I: Δ C/C: ±30ppm Class2: X7R: Δ C/C: ±15% Y5V: Δ C/C: 22~-82% <High Capacitance series> Class2: X7R/X5R: Δ C/C: ±15% Y5V: Δ C/C: 22~-82%
Step	Temperature(°C)														
a	25±2														
b	Lower temperature±3°C														
c	25±2														
d	Upper Temperature±2°C														
e	25±2														
Adhesion	4.7	A force applied for 10 seconds to the line joining the terminations and in a plane parallel to the substrate	Force size ≥ 0603: 5N size = 0402: 2.5N size = 0201: 1N												

TEST	TEST METHOD	REQUIREMENTS	TEST
Bond Strength of Plating on End Face	4.8	Mounting in accordance with IEC 60384-22 paragraph 4.3 Conditions: bending 3 mm at a rate of 1 mm/s, radius jig 5 mm	No visible damage $\Delta C/C$ Class2: X7R: $\pm 12.5\%$

Test Substrate:



Dimension(mm)			
Type	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
1808	3.5	7.0	3.7

Resistance to Soldering Heat	4.9	Precondition: 150 ± 10 °C for 1 hour, then keep for 24 ± 1 hours at room temperature Preheating: for size $\leq$ 1206: 120 °C to 150 °C for 1 minute Preheating: for size $>$ 1206: 100 °C to 120 °C for 1 minute and 170 °C to 200 °C for 1 minute Solder bath temperature: 260 ± 5 °C Dipping time: 10 ± 0.5 seconds Recovery time: 24 ± 2 hours	Dissolution of the end face plating shall not exceed 25% of the length of the edge concerned <General purpose series> C/C Class2: X7R: $\pm 10\%$ <High Capacitance series> C/C Class2: X7R: $\pm 10\%$ D.F. within initial specified value Rins within initial specified value
Solderability	IEC 60384-21/22	4.10 Preheated the temperature of 80 °C to 140 °C and maintained for 30 seconds to 60 seconds. Test conditions for lead containing solder alloy Temperature: 235 ± 5 °C Dipping time: 2 ± 0.2 seconds Depth of immersion: 10 mm Alloy Composition: 60/40 Sn/Pb Number of immersions: 1 Test conditions for leadfree containing solder alloy Temperature: 245 ± 5 °C Dipping time: 3 ± 0.3 seconds Depth of immersion: 10 mm Alloy Composition: SAC305 Number of immersions: 1	The solder should cover over 95% of the critical area of each termination

TEST	TEST METHOD	PROCEDURE	REQUIREMENTS
Rapid Change of Temperature	4.11	Preconditioning: 150 +0/-10 °C for 1 hour, then keep for 24 ±1 hours at room temperature 5 cycles with following detail: 30 minutes at lower category temperature 30 minutes at upper category temperature Recovery time 24 ±2 hours	No visual damage <General purpose series> ΔC/C Class2: X7R: ±15% <High Capacitance series> ΔC/C Class2: X7R: ±15% D.F. meet initial specified value R_{ins} meet initial specified value
Damp Heat with U _r Load	IEC 60384-21/22 4.13	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 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.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.	No visual damage after recovery <General purpose series> ΔC/C Class2: X7R: ±15% D.F. Class2: X7R: ≤ 16V: ≤ 7% ≥ 25V: ≤ 5% R_{ins} Class2: X7R: ≥ 500 MΩ or R_{ins} × C_r ≥ 25s whichever is less <High Capacitance series> ΔC/C Class2: X7R: ±20% D.F. Class2: X7R: 2 × initial value max R_{ins} Class2: X7R: 500 MΩ or R_{ins} × C_r ≥ 25s whichever is less

TEST	TEST METHOD	PROCEDURE	REQUIREMENTS
Endurance	IEC 60384-21/22 4.14	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 initial spec C, D, IR 3. Endurance test: Temperature: X7R: 125 °C Specified stress voltage applied for 1,000 hours: Applied 2.0 x U_r for general product. 4. Recovery time: 24 ±2 hours 5. Final measure: C, D, IR 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.	No visual damage $\Delta C/C$ Class2: X7R: ±15% D.F. Class2: X7R: $\leq 16V: \leq 7\%$ $\geq 25V: \leq 5\%$ R_{ins} Class2: X7R: $\geq 1,000 M\Omega$ or R_{ins} x C_r $\geq 50s$ whichever is less
Voltage Proof	IEC 60384-1 4.6	Specified stress voltage applied for 1~5 seconds U_r ≤ 100 V: series applied 2.5 U_r 100 V < U_r ≤ 200 V series applied (1.5 U_r + 100) 200 V < U_r ≤ 500 V series applied (1.3 U_r + 100) U_r > 500 V: 1.3 U_r U_r ≥ 1000 V: 1.2 U_r Charge/Discharge current is less than 50 mA	No breakdown or flashover

REVISION HISTORY

REVISION	DATE	CHANGE NOTIFICATION	DESCRIPTION
Version 9	Aug.. 04, 2015	-	- Capacitance range & thickness
Version 8	Jun. 04, 2015	-	- Capacitance range & thickness
Version 7	Dec. 01, 2014	-	- Capacitance range & thickness
Version 6	Mar. 27, 2014	-	- Capacitance range & thickness
Version 5	Mar. 12, 2014	-	- Modify Capacitance range & thickness
Version 4	Sep. 30, 2013	-	- Modify Capacitance range & thickness
Version 3	Nov 26, 2012	-	- Modify coding rule - thickness updated
Version 2	Sep 05, 2011	-	- Modify coding rule - thickness updated
Version 1	Jun 10, 2011	-	- Modify bending level
Version 0	Mar 31, 2011	-	- New datasheet for soft termination X7R series with RoHS compliant