

DATA SHEET

SURFACE-MOUNT CERAMIC MULTILAYER CAPACITORS

General purpose & High capacitance

Class 2, X7R

6.3 V TO 50 V

100 pF to 22 μ F

RoHS compliant



SCOPE

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

APPLICATIONS

- PCs, Hard disk, Game PCs
- DVDs, Camcorders
- 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. Please note that 12 digits ordering code will expire at the end of 2010.

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 = $\pm 5\%$ ⁽¹⁾
 K = $\pm 10\%$
 M = $\pm 20\%$

(3) PACKING STYLE

R = Paper taping reel; Reel 7 inch
 K = Blister taping reel; Reel 7 inch
 P = Paper 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 = $10 \times 10^3 = 10,000 \text{ pF} = 10 \text{ nF}$

NOTE

1. Tolerance $\pm 5\%$ doesn't available for full product range, please contact local sales force before order

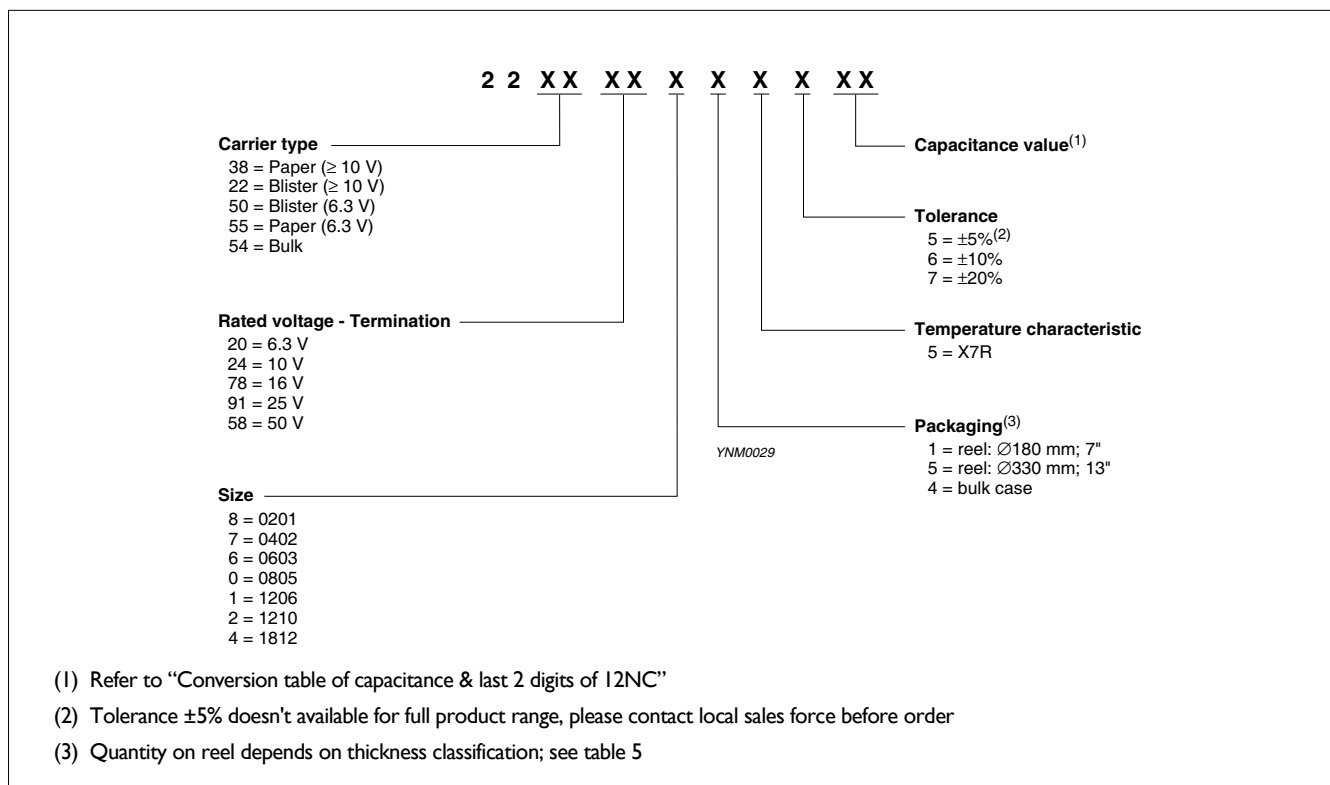
PHYCOMP BRAND ordering codes

GLOBAL PART NUMBER (preferred), PHYCOMP CTC (for North America) and I2NC (traditional) codes are acceptable to order Phycomp brand products.

GLOBAL PART NUMBER (PREFERRED)

For detailed information of GLOBAL PART NUMBER and ordering example, please refer to page 2.

I2NC CODE



PHYCOMP CTC CODE (FOR NORTH AMERICA)

Example: 02012R102K8B20D

0201	2R	102	K	8	B	2	0	D
Size code	Temp. Char.	Capacitance in pF	Tolerance	Voltage	Termination	Packing	Marking	Range identifier
0201	2R = X7R	101 = 100 pF;	J = $\pm 5\%$ ⁽¹⁾	5 = 6.3 V	B = NiSn	2 = 180 mm /	0 = no marking	D = Class 2 MLCC
0402		the third digit	K = $\pm 10\%$	6 = 10 V		7" paper		
0603		signifies the	M = $\pm 20\%$	7 = 16 V		3 = 330 mm		
0805		multiplying factor:		8 = 25 V		13" paper		
1206		0 = $\times 1$		9 = 50 V		B = 180 mm		
1210		1 = $\times 10$				7" blister		
1812		2 = $\times 100$				F = 330 mm		
		3 = $\times 1,000$				13" blister		
						P = Bulk case		

NOTE

I. Tolerance $\pm 5\%$ 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 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.

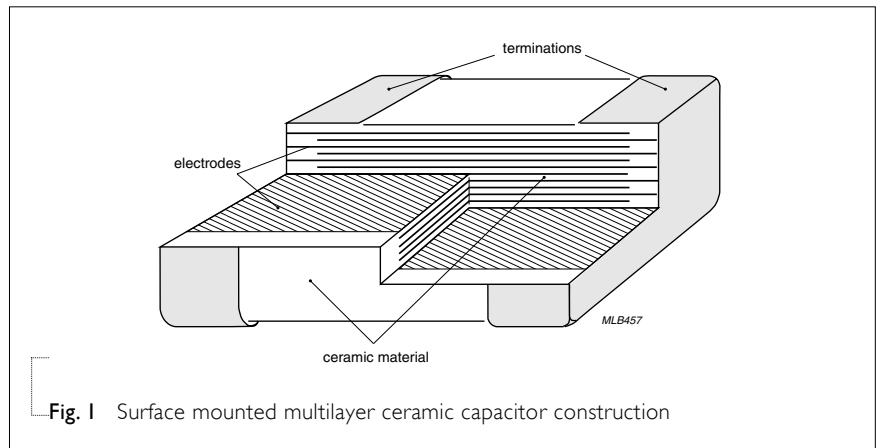


Fig. 1 Surface mounted multilayer ceramic capacitor construction

DIMENSION

Table I For outlines see fig. 2

TYPE	L _I (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		0.20	0.30	.40
0603	1.6 ±0.10	0.8 ±0.10		0.20	0.60	0.40
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 ±0.20 ⁽²⁾	1.6 ±0.20 ⁽²⁾				
1210	3.2 ±0.20	2.5 ±0.20		0.25	0.75	1.40
1812	4.5 ±0.20 ⁽¹⁾	3.2 ±0.20	0.25	0.75	2.20	
	4.5 ±0.40 ⁽²⁾					

NOTE

1. Dimension for size 0805 to 1812, C < 1 µF
2. Dimension for size 0805 to 1812, C ≥ 1 µF

OUTLINES

For dimension see Table I

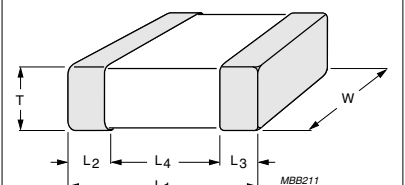


Fig. 2 Surface mounted multilayer ceramic capacitor dimension

CAPACITANCE RANGE & THICKNESS FOR X7R**Table 2** Sizes from 0201 to 0402

CAP.	Last 2 digits of 12NC	0201				0402				
		6.3 V	10 V	16 V	25 V	6.3 V	10 V	16 V	25 V	50 V
100 pF	09									
150 pF	12									
220 pF	14									
330 pF	16				0.3±0.03					
470 pF	18									
680 pF	21									
1.0 nF	23									0.5±0.05
1.5 nF	25								0.5±0.05	
2.2 nF	27									
3.3 nF	29									
4.7 nF	32	0.3±0.03	0.3±0.03	0.3±0.03				0.5±0.05		
6.8 nF	34									
10 nF	36									
15 nF	38									
22 nF	41									
33 nF	43									
47 nF	45					0.5±0.05	0.5±0.05			
68 nF	47									
100 nF	49									
150 nF	52									
220 nF	54									
330 nF	56									
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 order

CAPACITANCE RANGE & THICKNESS FOR X7R

Table 3 Sizes from 0603 to 0805

CAP.	Last 2 digits 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										
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				0.8±0.1	0.8±0.1				0.6±0.1	0.6±0.1
6.8 nF	34		0.8±0.1	0.8±0.1							
10 nF	36										
15 nF	38										
22 nF	41										
33 nF	43										
47 nF	45										
68 nF	47								0.6±0.1		0.85±0.1
100 nF	49									0.85±0.1	
150 nF	52						0.85±0.1	0.85±0.1	0.85±0.1		
220 nF	54	0.8±0.1									1.25±0.2
330 nF	56										
470 nF	58										
680 nF	61								1.25±0.2	1.25±0.2	
1.0 µF	63	0.8±0.1	0.8±0.1	0.8±0.1			1.25±0.2	1.25±0.2			
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 order

CAPACITANCE RANGE & THICKNESS FOR X7R**Table 4** Sizes from 1206 to 1812

CAP.	Last 2 digits of 12NC	1206					1210				1812	
		6.3 V	10 V	16 V	25 V	50 V	10 V	16 V	25 V	50 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				0.85±0.1							
10 nF	36											
15 nF	38									0.85±0.1		
22 nF	41										0.85±0.1	
33 nF	43											
47 nF	45											
68 nF	47											
100 nF	49											
150 nF	52											
220 nF	54					1.15±0.1						
330 nF	56			0.85±0.1	0.85±0.1	0.85±0.1			0.85±0.1	1.15±0.1	1.15±0.1	
470 nF	58			0.85±0.1	0.85±0.1	1.0±0.1			1.15±0.1	1.6±0.2		
680 nF	61											
1.0 µF	63	1.15±0.1	1.15±0.1	1.15±0.1	1.15±0.1	1.6±0.2			1.25±0.2	1.25±0.2	1.6±0.2	
2.2 µF	67											
4.7 µF	72				1.6±0.2				1.9±0.2			
10 µF	76	1.6±0.2	1.6±0.2	1.6±0.2			1.9±0.2	1.9±0.2	2.5±0.3			
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 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	
0201	0.3 ±0.03 mm	8 mm	15,000	---	50,000	---	---
0402	0.5 ±0.05 mm	8 mm	10,000	---	50,000	---	50,000
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	---
	1.6 ±0.2 mm	8 mm	---	2,000	---	10,000	---
1210	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	---	---	---
1808	1.15 ±0.15 mm	12 mm	---	3,000	---	---	---
	1.25 ±0.2 mm	12 mm	---	3,000	---	---	---
	1.35 ±0.15 mm	12 mm	---	2,000	---	---	---
	1.5 ±0.1 mm	12 mm	---	2,000	---	---	---
	1.6 ±0.2 mm	12 mm	---	2,000	---	---	---
	2.0 ±0.2 mm	12 mm	---	2,000	---	---	---
1812	0.6 / 0.85 ±0.1 mm	12 mm	---	2,000	---	---	---
	1.15 ±0.1 mm	12 mm	---	1,500	---	---	---
	1.15 ±0.15 mm	12 mm	---	1,500	---	---	---
	1.35 ±0.15 mm	12 mm	---	1,000	---	---	---
	1.5 ±0.1 mm	12 mm	---	1,000	---	---	---
	1.6 ±0.2 mm	12 mm	---	1,000	---	---	---
	2.0 ±0.2 mm	12 mm	---	1,000	---	---	---
	2.5 ±0.2 mm	12 mm	---	500	50,000	---	---

ELECTRICAL CHARACTERISTICS**X7R DIELECTRIC CAPACITORS; NISN TERMINATIONS**

Unless otherwise stated all electrical values apply at an ambient temperature of 20 ± 1 °C, an atmospheric pressure of 86 to 106 kPa, and a relative humidity of 63 to 67%.

Table 6

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

NOTE

Capacitance tolerance $\pm 5\%$ doesn't available for full product range, please contact local sales force before order

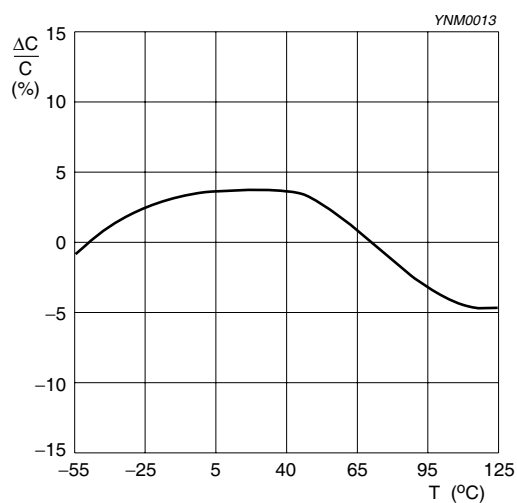


Fig. 3 Typical capacitance change as a function of temperature

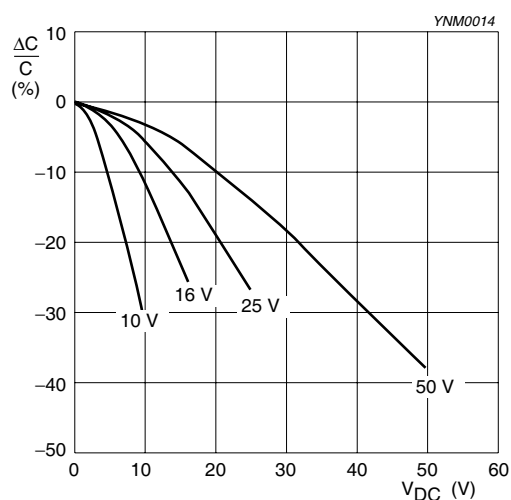


Fig. 4 Typical capacitance change with respect to the capacitance at 1 V as a function of DC voltage at 20 °C

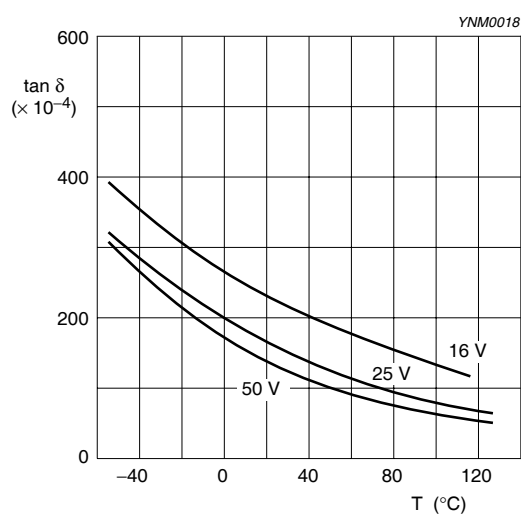


Fig. 5 Typical $\tan \delta$ as a function of temperature

SOLDERING RECOMMENDATION

Table 7

SOLDERING METHOD	SIZE 0402	0603	0805	1206	≥ 1210
Reflow	≥ 0.1 μ F	≥ 1.0 μ F	≥ 2.2 μ F	≥ 4.7 μ F	Reflow only
Reflow/Wave	< 0.1 μ F	< 1.0 μ F	< 2.2 μ F	< 4.7 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 $\times 10$ magnification	In accordance with specification
Capacitance	4.5.1	Class 2: f = 1 KHz for C ≤ 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.)	4.5.2	Class 2: f = 1 KHz for C ≤ 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	In accordance with specification
Insulation resistance	4.5.3	At U _r (DC) for 1 minute	In accordance with specification
Temperature characteristic	4.6	Class 2: Between minimum and maximum temperature X7R: -55 °C to +125 °C Normal Temperature: 20 °C	<General purpose series> $\Delta C/C$ Class 2: X7R: $\pm 15\%$ <High Capacitance series> $\Delta C/C$ Class 2: X7R: $\pm 15\%$

TEST	TEST METHOD	PROCEDURE	REQUIREMENTS
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	Force size $\geq$ 0603: 5N size = 0402: 2.5N size = 0201: 1N
Bond strength of plating on end face	4.8	Mounting in accordance with IEC 60384-22 paragraph 4.3 Conditions: bending 1 mm at a rate of 1 mm/s, radius jig 340 mm	No visible damage <General purpose series> $\Delta C/C$ Class2: X7R: $\pm 10\%$ <High Capacitance series> $\Delta C/C$ Class2: X7R: $\pm 10\%$
Resistance to soldering heat	4.9	Precondition: 150 $\pm 0/-10$ °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> $\Delta C/C$ Class2: X7R: $\pm 10\%$ <High Capacitance series> $\Delta C/C$ Class2: X7R: $\pm 10\%$ D.F. within initial specified value R_{ins} within initial specified value

TEST	TEST METHOD	PROCEDURE	REQUIREMENTS
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
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> $\Delta C/C$ Class2: X7R: ±15% <High Capacitance series> $\Delta C/C$ Class2: X7R: ±15% D.F. meet initial specified value R_{ins} meet initial specified value

TEST	TEST METHOD	PROCEDURE	REQUIREMENTS
Damp heat with U_r load	IEC 60384- 21/22	4.13	
		1. Preconditioning, class 2 only: 150 $\pm$ 10 °C / 1 hour, then keep for 24 $\pm$ 1 hour at room temp 2. Initial measure: Spec: refer initial spec C, D, IR 3. Damp heat test: 500 $\pm$ 12 hours at 40 $\pm$ 2 °C; 90 to 95% R.H. 1.0 U_r applied 4. Recovery: Class 2: 24 $\pm$ 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> $\Delta C/C$ Class2: X7R: $\pm$ 15% D.F. Class2: X7R: $\leq$ 16V: $\leq$ 7% $\geq$ 25V: $\leq$ 5% R_{ins} Class2: X7R: $\geq$ 500 MΩ or $R_{ins} \times C_r \geq$ 25s whichever is less <High Capacitance series> $\Delta C/C$ Class2: X7R: $\pm$ 20% D.F. Class2: X7R: 2 $\times$ initial value max R_{ins} Class2: X7R: 500 MΩ or $R_{ins} \times C_r \geq$ 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 $2.0 \times U_r$ for general product. Applied $1.5 \times U_r$ for high cap. 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 <General purpose series> $\Delta C/C$ 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 $R_{ins} \times C_r \geq 50s$ whichever is less <High Capacitance series> $\Delta C/C$ Class 2: X7R: ±20% D.F. Class 2: X7R: 2 × initial value max R_{ins} Class 2: X7R: 1,000 MΩ or $R_{ins} \times C_r \geq 50s$ whichever is less
Voltage proof	IEC 60384-1 4.6	Specified stress voltage applied for 1 minute $U_r \leq 100 V$: series applied $2.5 U_r$ $100 V < U_r \leq 200 V$ series applied $(1.5 U_r + 100)$ $200 V < U_r \leq 500 V$ series applied $(1.3 U_r + 100)$ $U_r > 500 V$: $1.3 U_r$ I: 7.5 mA	No breakdown or flashover

REVISION HISTORY

REVISION	DATE	CHANGE NOTIFICATION	DESCRIPTION
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 - 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 - 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 - Description of "Halogen Free compliant" added - Test method and procedure updated

Mouser Electronics

Authorized Distributor

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Yageo:

[CC0603JRX7R9BB821](#)