

DATA SHEET

SURFACE-MOUNT CERAMIC MULTILAYER CAPACITORS

High-capacitance: Class 2, X5R/X7R
(Pb Free & RoHS compliant)

6.3 V TO 25 V

56 nF to 47 μ F



SCOPE

This specification describes high capacitance X5R/X7R series chip capacitors with lead-free terminations.

APPLICATIONS

- PCs, hard disk, game PCs
- Power supplies
- DVDs, camcorders
- Mobile phones, PDAs

FEATURES

- Supplied in tape on reel
- Nickel-barrier end termination

ORDERING INFORMATION

Part number is identified by the series, size, tolerance, packing style, TC material, rated voltage and capacitance value.

YAGEO ORDERING CODE

CC XXXX X X XXX X **BB** XXX
 (1) (2) (3) (4) (5) (6)

(1) SIZE – INCH BASED (METRIC)

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

(2) TOLERANCE

J = ±5%
 K = ±10%
 M = ±20%

(3) PACKING STYLE

R = 7" paper tape
 K = 7" blister tape
 P = 13" paper tape
 F = 13" blister tape
 C = Bulk case

(4) TC MATERIAL

X5R
 X7R

(5) RATED VOLTAGE

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

(6) CAPACITANCE VALUE:

First two for significant figures and 3rd for number of zero
 Letter "R" for decimal point

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.

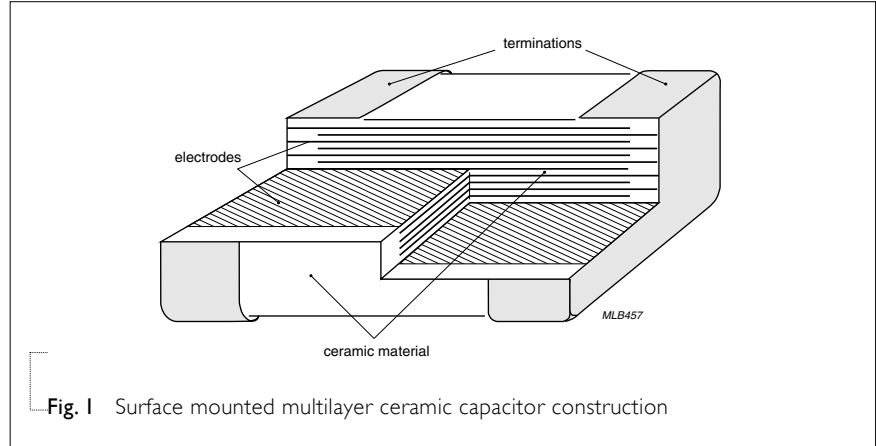


Fig. 1 Surface mounted multilayer ceramic capacitor construction

DIMENSION

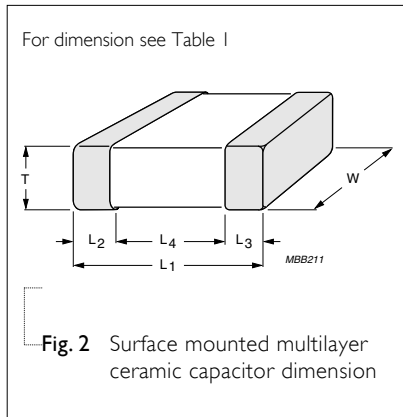


Table 1

TYPE	CC0402	CC0603	CC0805	CC1206	CC1210	CC1812
L₁ (mm)	1.0 ±0.05	1.6 ±0.10	2.0 ±0.20	3.2±0.20	3.2 ±0.20	4.5 ±0.20
W (mm)	0.5 ±0.05	0.8 ±0.07	1.25 ±0.20	1.6±0.20	2.5 ±0.20	3.2 ±0.20
T (mm)	Refer to table 2 to 4					
L₂/L₃ (mm)	min.	0.15	0.20	0.25	0.25	0.25
	max.	0.30	0.50	0.75	0.75	0.75
L₄ (mm)	min.	0.40	0.60	0.55	1.40	2.20

CAPACITANCE RANGE & THICKNESS FOR X5R/X7R 6.3 V

Table 2

CAPACITANCE (μ F)	6.3 V				
	0402	0603	0805	1206	1210
0.056					
0.068					
0.082					
0.10	0.5 \pm 0.05				
0.12					
0.15					
0.18					
0.22					
0.27					
0.33					
0.39					
0.47					
0.56					
0.68					
0.82					
1.0		0.8 \pm 0.07			
1.5		0.8 \pm 0.1			
2.2			1.25 \pm 0.1		
3.3			1.25 \pm 0.2		
4.7					
6.8					
10				1.6 \pm 0.2	
22					2.5 \pm 0.2
47					

NOTE

1. Values in shaded cells indicate thickness class in mm.
2. X5R: ; X7R: ; both X5R and X7R: .

CAPACITANCE RANGE & THICKNESS FOR X5R/X7R 10V

Table 3

CAPACITANCE (μ F)	10 V				
	0402	0603	0805	1206	1210
0.056	0.5 \pm 0.05				
0.068					
0.082					
0.10	0.5 \pm 0.05				
0.12	0.5 \pm 0.05				
0.15					
0.18					
0.22					
0.27		0.8 \pm 0.07			
0.33					
0.39					
0.47					
0.56		0.8 \pm 0.07			
0.68					
0.82					
1.0			1.25 \pm 0.1		
1.5		0.8 \pm 0.1			
2.2			1.25 \pm 0.1		
3.3			1.25 \pm 0.2		
4.7				1.6 \pm 0.2	
6.8				1.6 \pm 0.2	
10					1.9 \pm 0.2
22					2.5 \pm 0.2

NOTE

- Values in shaded cells indicate thickness class in mm.
- X5R: ; X7R: ; both X5R and X7R: .

CAPACITANCE RANGE & THICKNESS FOR X5R/X7R 16V TO 25V

Table 4

CAPACITANCE (μ F)	16V				25V				
	0402	0603	0805	1206	1210	1812	0603	1206	1210
0.056	0.5 ±0.05								
0.068									
0.082									
0.10									
0.12		0.8 ±0.07							
0.15									
0.18									
0.22									
0.27									
0.33							0.8 ±0.07		
0.39									
0.47									
0.56			1.25 ±0.2						
0.68									
0.82									
1.0								1.6 ±0.2	
1.5									
2.2				1.15 ±0.1					
3.3					1.9 ±0.2				1.9 ±0.2
4.7				1.6 ±0.2	1.9 ±0.2				
6.8					2.5 ±0.2				2.5 ±0.2
10									
22						2.5 ±0.2			

NOTE

- Values in shaded cells indicate thickness class in mm.
- X5R: ; X7R: ; both X5R and X7R: .

THICKNESS CLASSES AND PACKING QUANTITY

Table 5

DESCRIPTION	SIZE CODE	THICKNESS CLASSIFICATION (mm)	8 mm TAPE WIDTH/AMOUNT PER REEL				12 mm TAPE WIDTH /AMOUNT PER REEL		AMOUNT PER BULK CASE
			Ø180 mm, 7"		Ø330 mm, 13"		Ø180 mm, 7" Blister		
			Paper	Blister	Paper	Blister			
Discrete capacitors	0201	0.3 ±0.03	15,000	---	50,000	---	---	---	
	0402	0.5 ±0.05	10,000	---	50,000	---	---	50,000	
	0603	0.8 ±0.07	4,000	---	15,000	---	---	15,000	
	0805	0.6 ±0.10	4,000	---	20,000	---	---	10,000	
		0.85 ±0.1	4,000	---	15,000	---	---	8,000	
		1.25 ±0.10	---	3,000	---	10,000	---	5,000	
	1206	0.6 ±0.10	4,000	---	20,000	---	---	---	
		0.85 ±0.10	4,000	---	15,000	---	---	---	
		1.00 / 1.15 ±0.10	---	3,000	---	10,000	---	---	
		1.6 ±0.15	---	2 500	---	10,000	---	---	
		1.6 ±0.20	---	2,000	---	10,000	---	---	
	1210	0.6 / 0.7 ±0.10	---	4,000	---	15,000	---	---	
		0.85 ±0.10	---	4,000	---	10,000	---	---	
		1.15 ±0.10	---	3,000	---	10,000	---	---	
		1.15 ±0.15	---	3,000	---	10,000	---	---	
		1.5 ±0.10	---	2,000	---	---	---	---	
		1.6 / 1.9 ±0.20	---	2,000	---	---	---	---	
		2.5 ±0.20	---	1,000	---	---	---	---	
	1808	1.15 ±0.15	---	---	---	---	1 500	---	
		1.35 ±0.15	---	---	---	---	1,000	---	
		1.5 ±0.10	---	---	---	---	1,000	---	
	1812	0.6 / 0.85 ±0.10	---	---	---	---	2,000	---	
		1.15 ±0.10	---	---	---	---	1,500	---	
		1.15 ±0.15	---	---	---	---	1,500	---	
		1.35 ±0.15	---	---	---	---	1,000	---	
		1.5 ±0.1	---	---	---	---	1,000	---	
		1.6 ±0.2	---	---	---	---	1,000	---	
	Low inductance	0306	0.5 ±0.10	4,000	---	15,000	---	---	
0508		0.85 ±0.10	4,000	---	15,000	---	---		
0612		0.85 ±0.10	4,000	---	15,000	---	---		
Arrays	0508	0.6 ±0.10	4,000	---	---	---	---		
		0.85 ±0.10	4,000	---	---	---	---		
	0612	0.8 ±0.10	4,000	---	---	---	---		
		1.2 ±0.10	---	3,000	---	---	---		

ELECTRICAL CHARACTERISTICS

CLASS 2 CAPACITORS; X5R/X7R DIELECTRIC; 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 ⁽¹⁾	56 nF to 47 µF
Capacitance tolerance ^{(1) (2)}	±5%, ±10%, and ±20%
Dissipation factor (D.F.) ⁽¹⁾	See table 7 - 12
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)	±15%
Operating temperature range:	
X5R	-55 °C to +85 °C
X7R	-55 °C to +125 °C

NOTE

1. $f=1$ KHz for $C \leq 10 \mu\text{F}$; measuring at voltage $1 V_{rms}$; $f=120$ Hz for $C > 10 \mu\text{F}$; measuring at voltage $0.5 V_{rms}$.
2. ±5% capacitance tolerance is on request for capacitance value $< 1 \mu\text{F}$.

DISSIPATION FACTOR (D.F.) FOR SIZES 0402 TO 1812

Table 7 For size 0402 (1005 metric)

TC	SIZE	CAPACITANCE VALUE (μF)	CAPACITANCE TOLERANCE (%)	DC RATED VOLTAGE (V)	DISSIPATION FACTOR- D.F. (%)	THICKNESS (mm)
X5R	0402	0.10	±10; ±20	6.3	7.0	0.50
X5R	0402	0.12	±10; ±20	6.3	7.0	0.50
X5R	0402	0.15	±10; ±20	6.3	7.0	0.50
X5R	0402	0.18	±10; ±20	6.3	7.0	0.50
X5R	0402	0.22	±10; ±20	6.3	7.0	0.50
X5R	0402	0.27	±10; ±20	6.3	10.0	0.50
X5R	0402	0.33	±10; ±20	6.3	10.0	0.50
X5R	0402	0.39	±10; ±20	6.3	10.0	0.50
X5R	0402	0.47	±10; ±20	6.3	10.0	0.50
X5R	0402	0.56	±10; ±20	6.3	10.0	0.50
X5R	0402	0.68	±10; ±20	6.3	10.0	0.50
X5R	0402	0.82	±10; ±20	6.3	10.0	0.50
X5R	0402	1.00	±10; ±20	6.3	10.0	0.50
X7R	0402	0.056	±10; ±20	10	5.0	0.50
X7R	0402	0.068	±10; ±20	10	5.0	0.50
X7R	0402	0.082	±10; ±20	10	5.0	0.50
X5R	0402	0.10	±10; ±20	10	5.0	0.50
X7R	0402	0.10	±10; ±20	10	5.0	0.50
X5R	0402	0.12	±10; ±20	10	7.0	0.50
X5R	0402	0.15	±10; ±20	10	7.0	0.50
X5R	0402	0.18	±10; ±20	10	7.0	0.50
X5R	0402	0.22	±10; ±20	10	7.0	0.50
X5R	0402	0.056	±10; ±20	16	5.0	0.50
X7R	0402	0.056	±10; ±20	16	5.0	0.50
X5R	0402	0.068	±10; ±20	16	5.0	0.50
X7R	0402	0.068	±10; ±20	16	5.0	0.50
X5R	0402	0.082	±10; ±20	16	5.0	0.50
X7R	0402	0.082	±10; ±20	16	5.0	0.50
X5R	0402	0.10	±10; ±20	16	5.0	0.50
X7R	0402	0.10	±10; ±20	16	5.0	0.50

Table 8 For size 0603 (1608 metric)

TC	SIZE	CAPACITANCE VALUE (μF)	CAPACITANCE TOLERANCE (%)	DC RATED VOLTAGE (V)	DISSIPATION FACTOR-D.F. (%)	THICKNESS (mm)
X5R	0603	1.00	±10; ±20	6.3	7.0	0.80
X5R	0603	1.50	±10; ±20	6.3	10.0	0.80
X5R	0603	2.20	±10; ±20	6.3	10.0	0.80
X5R	0603	3.30	±10; ±20	6.3	10.0	0.80
X5R	0603	4.70	±20	6.3	10.0	0.80
X7R	0603	0.27	±10; ±20	10	5.0	0.80
X7R	0603	0.33	±10; ±20	10	5.0	0.80
X7R	0603	0.39	±10; ±20	10	5.0	0.80
X7R	0603	0.47	±10; ±20	10	5.0	0.80
X5R	0603	0.56	±10; ±20	10	7.0	0.80
X5R	0603	0.68	±10; ±20	10	7.0	0.80
X5R	0603	0.82	±10; ±20	10	7.0	0.80
X5R	0603	1.00	±10; ±20	10	7.0	0.80
X5R	0603	1.50	±10; ±20	10	7.0	0.80
X5R	0603	2.20	±10; ±20	10	10.0	0.80
X7R	0603	0.12	±10; ±20	16	5.0	0.80
X7R	0603	0.15	±10; ±20	16	5.0	0.80
X7R	0603	0.18	±10; ±20	16	5.0	0.80
X7R	0603	0.22	±10; ±20	16	5.0	0.80
X7R	0603	0.27	±10; ±20	16	5.0	0.80
X7R	0603	0.33	±10; ±20	16	5.0	0.80
X7R	0603	0.39	±10; ±20	16	5.0	0.80
X7R	0603	0.47	±10; ±20	16	5.0	0.80
X5R	0603	0.33	±10; ±20	25	5.0	0.80
X5R	0603	0.39	±10; ±20	25	5.0	0.80
X5R	0603	0.47	±10; ±20	25	5.0	0.80

Table 9 For size 0805 (2012 metric)

TC	SIZE	CAPACITANCE VALUE (μF)	CAPACITANCE TOLERANCE (%)	DC RATED VOLTAGE (V)	DISSIPATION FACTOR-D.F. (%)	THICKNESS (mm)
X5R	0805	2.20	±10; ±20	6.3	7.0	1.25
X7R	0805	2.20	±10; ±20	6.3	7.0	1.25
X5R	0805	3.30	±10; ±20	6.3	7.0	1.25
X5R	0805	4.70	±10; ±20	6.3	7.0	1.25
X5R	0805	6.80	±10; ±20	6.3	10.0	1.25
X5R	0805	10.00	±10; ±20	6.3	10.0	1.25
X7R	0805	1.00	±10; ±20	10	5.0	1.25
X7R	0805	1.50	±10; ±20	10	7.0	1.25
X5R	0805	2.20	±10; ±20	10	7.0	1.25
X7R	0805	2.20	±10; ±20	10	7.0	1.25
X5R	0805	3.30	±10; ±20	10	7.0	1.25
X5R	0805	4.70	±10; ±20	10	7.0	1.25
X5R	0805	6.80	±10; ±20	10	10.0	1.25
X5R	0805	10.00	±10; ±20	10	10.0	1.25
X7R	0805	0.56	±10; ±20	16	5.0	1.25
X7R	0805	0.68	±10; ±20	16	5.0	1.25
X7R	0805	0.82	±10; ±20	16	5.0	1.25
X7R	0805	1.00	±10; ±20	16	5.0	1.25

Table 10 For size 1206 (3216 metric)

TC	SIZE	CAPACITANCE VALUE (μF)	CAPACITANCE TOLERANCE (%)	DC RATED VOLTAGE (V)	DISSIPATION FACTOR-D.F. (%)	THICKNESS (mm)
X5R	1206	10.00	±10; ±20	6.3	7.5	1.60
X5R	1206	22.00	±10; ±20	6.3	10.0	1.60
X5R	1206	4.70	±10; ±20	10	5.0	1.60
X7R	1206	4.70	±10; ±20	10	5.0	1.60
X5R	1206	6.80	±10; ±20	10	7.5	1.60
X5R	1206	10.00	±10; ±20	10	7.5	1.60
X7R	1206	2.20	±10; ±20	16	5.0	1.15
X5R	1206	4.70	±10; ±20	16	5.0	1.60
X7R	1206	1.00	±10; ±20	25	7.5	1.60

Table 11 For size 1210 (3225 metric)

TC	SIZE	CAPACITANCE VALUE (μF)	CAPACITANCE TOLERANCE (%)	DC RATED VOLTAGE (V)	DISSIPATION FACTOR-D.F. (%)	THICKNESS (mm)
X5R	1210	22.00	±20	6.3	2.5	2.50
X5R	1210	47.00	±20	6.3	10.0	2.50
X5R	1210	10.00	±10; ±20	10	3.5	1.90
X5R	1210	22.00	±20	10	7.0	2.50
X5R	1210	3.30	±10; ±20	16	3.5	1.90
X5R	1210	4.70	±10; ±20	16	3.5	1.90
X7R	1210	4.70	±10; ±20	16	3.5	1.90
X5R	1210	6.80	±10; ±20	16	3.5	2.50
X5R	1210	10.00	±10; ±20	16	3.5	2.50
X5R	1210	3.30	±10; ±20	25	3.5	1.90
X5R	1210	4.70	±10; ±20	25	3.5	1.90
X5R	1210	6.80	±10; ±20	25	2.5	2.50
X5R	1210	10.00	±10; ±20	25	2.5	2.50

Table 12 For size 1812 (4532 metric)

TC	SIZE	CAPACITANCE VALUE (μF)	CAPACITANCE TOLERANCE (%)	DC RATED VOLTAGE (V)	DISSIPATION FACTOR-D.F. (%)	THICKNESS (mm)
X5R	1812	22.00	±10; ±20	16	3.5	2.50

SOLDERING RECOMMENDATION

Table 13

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 14 Test condition, procedure and requirements

TEST	TEST METHOD	PROCEDURE	REQUIREMENTS
Mounting	IEC 60384-22 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	4.5.1	Precondition: 150 +0/-10 °C for 1 hour, then keep for 48 ± 1 hours at room temperature f = 1 kHz for C ≤ 10 μF: measuring voltage 1 V _{rms} at 20 °C f = 120 Hz for C > 10 μF: measuring voltage 0.5 V _{rms} at 20 °C	Within specified tolerance
Dissipation factor (D.F.)	4.5.2	f = 1 kHz for C ≤ 10 μF: measuring voltage 1 V _{rms} at 20 °C f = 120 Hz for C > 10 μF: measuring 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
Voltage proof	4.5.4.2	2.5 × U _r for 1 minute	No breakdown or flashover
Temperature characteristic	4.6	Between minimum and maximum temperature	In accordance with specification
Adhesion	4.15	A force applied for 10 seconds to the line joining the terminations and in a plane parallel to the substrate for size ≥ 0603: a force of 5 N applied for size 0402: a force of 2.5 N applied	No visible damage
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 X5R/X7R: ΔC/Ci: ≤ 10% Y5V: ΔC/Ci: ≤ 20%

Table 14 Test condition, procedure and requirements (continued)

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: for size ≤ 1206: 120 to 150 °C for 1 minute</p> <p>Preheating: for size >1206: 100 to 120 °C for 1 minute and 170 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>The termination shall be well tinned</p> <p>X5R/X7R: $\Delta C/C_i \leq 10\%$</p> <p>Y5V: $\Delta C/C_i \leq 20\%$</p> <p>D.F.: within initial specified value</p> <p>R_{ins}: within initial specified value</p>
Solderability	4.10	<p>Unmounted chips completely immersed in a solder bath at 235 ±5 °C</p> <p>Dipping time: size ≤ 1206 for 2 ±0.5 seconds; size > 1206 for 4 ±0.5 seconds</p>	<p>The termination shall be well tinned.</p>
Rapid change of temperature	IEC 60384-22 4.11	<p>Preconditioning; 150 +0/-10 °C for 1 hour, then keep for 24 ±1 hours at room temperature</p> <hr/> <p>5 cycles with following detail: 30 minutes at lower category temperature; 30 minutes at upper category temperature</p> <hr/> <p>Recovery time 24 ±2 hours.</p>	<p>No visual damage</p> <p>X5R/X7R: $\leq 15\%$</p> <p>Y5V: $\leq 20\%$</p> <p>D.F.: within initial specified value</p> <p>R_{ins}: within initial specified value</p>
Damp heat steady state	4.13	<p>Initial measurements; after 150 +0/-10 °C for 1 hour, then keep for 24 ±1 hours at room temperature</p> <p>Duration and conditions: 500 ±12 hours at 40 ±2 °C; 90 to 95% RH</p> <p>Final measurement: perform a heat treatment at 150 +0/-10 °C for 1 hour, final measurements shall be carried out 24 ±1 hours after recovery at room temperature without load.</p>	<p>X5R/X7R: $\Delta C/C_i \pm 20\%$</p> <p>Y5V: $\Delta C/C_i \pm 30\%$</p> <p>D.F.: 2 × initial value max.</p> <p>R_{ins}: 1,000 MΩ or $R_{ins} \times C_r \geq 50$ seconds, whichever is less</p>
Endurance	4.14	<p>Preconditioning;</p> <p>Initial measurements; after 150 +0/-10 °C for 1 hour, then keep for 24 ±1 hours at room temperature</p> <p>Duration and conditions: 1,000 ±12 hours at upper category temperature with $1.5 \times U_r$ voltage applied</p> <p>Final measurement: perform a heat treatment at 150 +0/-10 °C for 1 hour, final measurements shall be carried out 24 ±1 hours after recovery at room temperature without load.</p>	<p>X5R/X7R: $\Delta C/C_i \pm 20\%$</p> <p>Y5V: $\Delta C/C_i \pm 30\%$</p> <p>D.F.: 2 × initial value max.</p> <p>R_{ins}: 1,000 MΩ or $R_{ins} \times C_r \geq 50$ seconds, whichever is less</p>

Table 14 Test condition, procedure and requirements (continued)

TEST	TEST METHOD	PROCEDURE	REQUIREMENTS
Resistance to leaching	IEC 60384-10 4.10	Solder bath temperature: 260 ±5 °C Dipping time 30 ±0.5 seconds	Using visual enlargement of × 10, dissolution of the termination shall not exceed 10%
Damp heat, with U _r load	4.14	Initial measurements; after 150 +0/-10 °C for 1 hour, then keep for 24 ±1 hours at room temperature Duration and conditions: 500 ±12 hours at 40 ±2 °C; 90 to 95% RH; U _r applied Final measurement: perform a heat treatment at 150 +0/-10 °C for 1 hour; final measurements shall be carried out 24 ±1 hours after recovery at room temperature without load.	X5R/X7R: IΔC/CI: ±20% Y5V: IΔC/CI: ±30% D.F.: 2 × initial value max. R _{ins} : 500 MΩ or R _{ins} × C _r ≥ 25 seconds, whichever is less

REVISION HISTORY

REVISION	DATE	CHANGE NOTIFICATION	DESCRIPTION
Version 10	Feb 18, 2005	-	- Capacitance range extended
Version 8	Nov 19, 2004	-	- Extended capacitance 0.68 μ F and 2.2 μ F of X5R 0603 10 V
Version 7	Sep 09, 2004	-	- Updated contents
Version 6	Aug 13, 2004	-	- Extended capacitance to value 47 μ F