

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 = $\pm 5\%$

K = $\pm 10\%$

M = $\pm 20\%$

(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.

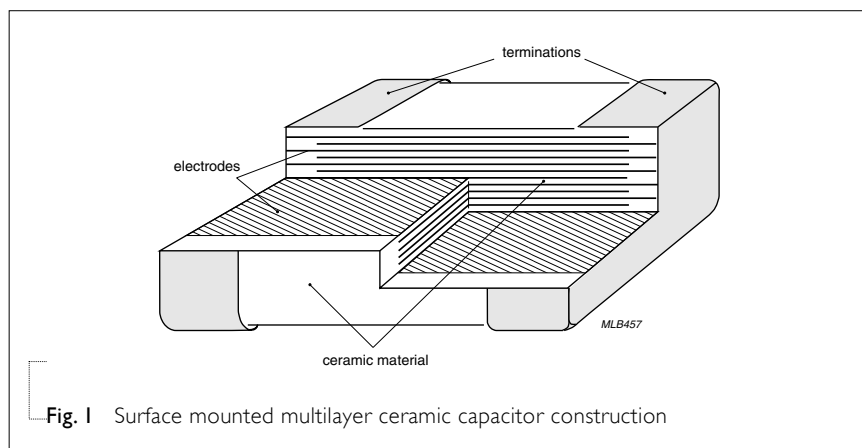


Fig. 1 Surface mounted multilayer ceramic capacitor construction

DIMENSION

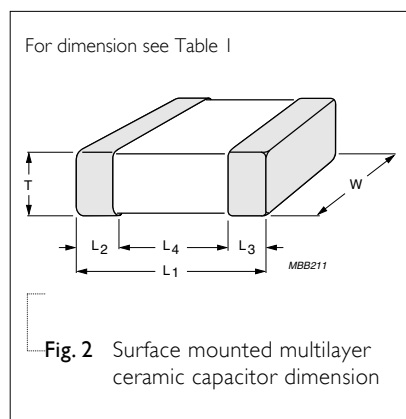


Fig. 2 Surface mounted multilayer ceramic capacitor dimension

Table I

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

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

CAPACITANCE RANGE & THICKNESS FOR X5R/X7R 10V

Table 3

CAPACITANCE (μF)	10 V 0402	0603	0805	1206	1210	
0.056	0.5 ±0.05					
0.068						
0.082						
0.10	0.5 ±0.05					
0.12	0.5 ±0.05					
0.15						
0.18						
0.22						
0.27			0.8 ±0.07			
0.33						
0.39						
0.47						
0.56		0.8 ±0.07				
0.68						
0.82						
1.0			1.25 ±0.1			
1.5		0.8 ±0.1				
2.2				1.25 ±0.1		
3.3			1.25 ±0.2			
4.7				1.6 ±0.2		
6.8				1.6 ±0.2		
10					1.9 ±0.2	
22					2.5 ±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 (μF)	16V 0402	0603	0805	1206	1210	1812	25V 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 μ F
Capacitance tolerance ⁽¹⁾ ⁽²⁾	$\pm 5\%$, $\pm 10\%$, and $\pm 20\%$
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)	$\pm 15\%$
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. $\pm 5\%$ 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	Precondition: 150 +0/-10 °C for 1 hour, then keep for 24 ±1 hours at room temperature Preheating: for size ≤ 1206: 120 to 150 °C for 1 minute Preheating: for size > 1206: 100 to 120 °C for 1 minute and 170 to 200 °C for 1 minute Solder bath temperature: 260 ±5 °C Dipping time: 10 ±0.5 seconds Recovery time: 24 ±2 hours.	The termination shall be well tinned X5R/X7R: $\Delta C/C_i \leq 10\%$ Y5V: $\Delta C/C_i \leq 20\%$ D.F.: within initial specified value R_{ins}: within initial specified value
Solderability	4.10	Unmounted chips completely immersed in a solder bath at 235 ±5 °C Dipping time: size ≤ 1206 for 2 ±0.5 seconds; size > 1206 for 4 ±0.5 seconds	The termination shall be well tinned.
Rapid change of temperature	IEC 60384-22 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 X5R/X7R: $\leq 15\%$ Y5V: $\leq 20\%$ D.F.: within initial specified value R_{ins}: within initial specified value
Damp heat steady state	4.13	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 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: $\Delta C/C_i \pm 20\%$ Y5V: $\Delta C/C_i \pm 30\%$ D.F.: 2 × initial value max. R_{ins}: 1,000 MΩ or $R_{ins} \times C_r \geq 50$ seconds, whichever is less
Endurance	4.14	Preconditioning; Initial measurements; after 150 +0/-10 °C for 1 hour, then keep for 24 ±1 hours at room temperature Duration and conditions: 1,000 ±12 hours at upper category temperature with $1.5 \times U_r$ voltage 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: $\Delta C/C_i \pm 20\%$ Y5V: $\Delta C/C_i \pm 30\%$ D.F.: 2 × initial value max. R_{ins}: 1,000 MΩ or $R_{ins} \times C_r \geq 50$ seconds, whichever is less

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 $\times 10$, 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: $\Delta C/C_i$: $\pm 20\%$ Y5V: $\Delta C/C_i$: $\pm 30\%$ D.F.: $2 \times$ initial value max. R_{ins} : $500 M\Omega$ or $R_{ins} \times C_r \geq 25$ 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