



X5R, X7R Dielectrics

■ Features

- A monolithic structure ensures high reliability and mechanical strength.
- High capacitance density.
- A wide range of capacitance values in standard case size.
- Suitable for high speed SMT placement on PCBs.
- Ni barrier termination highly resistance to migration.
- Lead-free termination is in compliance with the requirement of green plan and ROHS.

■ Applications

- General electronic equipment.
- Communication equipment.
- Custom Application

■ X5R, X7R Dielectric Characteristics

Capacitance Range	100pF to 100uF
Size (mm)	0603 1005 1608 2012 3216 3225
(EIA inch)	(0201) (0402) (0603) (0805) (1206) (1210)
Test Voltage	1.0 ± 0.2Vrms
Test Frequency	1.0 ± 0.2KHz
Capacitance Tolerance	± 10%, ± 20% (± 5% available on request)
Operating Temperature Range	-55°C to +85°C for X5R -55°C to +125°C for X7R
Maximum Capacitance Change	± 15 %
Rated Voltage	6.3, 10, 16, 25, 50, 100 VDC
Dissipation Factor	Pls refer to DF table on page No. 7
Insulation Resistance (+25°C, RVDC)	10,000 MΩ min. or 500Ω-F min., whichever is smaller
Insulation Resistance (Maximum operating temperature, RVDC)	1,000 MΩ min. or 50Ω-F min., whichever is smaller

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2



■ **Product Range and Thickness**

CLASS	Class II																									
TYPE	Standard																									
T.C.	X7R																									
SIZE (EIA)	0603				1005				1608				2012				3216				3225					
RV	0201				0402				0603				0805				1206				1210					
	10V	16V	25V	50V	10V	16V	25V	50V	10V	16V	25V	50V	100V	6.3V	10V	16V	25V	50V	100V	10V	16V	25V	50V	100V	16V	25V
100 p			A	A	B	B	B	B	D	D	D	D	D													
120 p			A	A	B	B	B	B	D	D	D	D	D													
150 p			A	A	B	B	B	B	D	D	D	D	D						C	E	E					
180 p			A	A	B	B	B	B	D	D	D	D	D						C	E	E					
220 p			A	A	B	B	B	B	D	D	D	D	D						C	E	E					
270 p			A	A	B	B	B	B	D	D	D	D	D						C	E	E					
330 p			A	A	B	B	B	B	D	D	D	D	D						C	E	E					
390 p			A	A	B	B	B	B	D	D	D	D	D						C	E	E					
470 p			A	A	B	B	B	B	D	D	D	D	D						C	E	E					
560 p			A	A	B	B	B	B	D	D	D	D	D						C	E	E					
680 p			A	A	B	B	B	B	D	D	D	D	D						C	E	E					
820 p			A	A	B	B	B	B	D	D	D	D	D						C	E	E					
1.0 n			A	A	B	B	B	B	D	D	D	D	D					C	E	C	E	E			E	E
1.2 n			A	A	B	B	B	B	D	D	D	D	D					C	E	C	E	E			E	E
1.5 n			A	A	B	B	B	B	D	D	D	D	D					C	E	C	E	E			E	E
1.8 n			A	A	B	B	B	B	D	D	D	D	D					C	E	C	E	E			E	E
2.2 n			A	A	B	B	B	B	D	D	D	D	D					C	E	C	E	E			E	E
2.7 n					B	B	B	B	D	D	D	D	D					C	E	C	E	E			E	E
3.3 n	A				B	B	B	B	D	D	D	D	D					C	E	C	E	E			E	E
3.9 n					B	B	B	B	D	D	D	D	D					C	E	C	E	E			E	E
4.7 n	A				B	B	B	B	D	D	D	D	D					C	E	C	E	E			E	E
5.6 n					B	B	B	B	D	D	D	D	D					C	E	C	E	E			E	E
6.8 n					B	B	B	B	D	D	D	D	D					C	E	C	E	E			E	E
8.2 n					B	B	B	B	D	D	D	D	D					C	E	C	E	E			E	E
10 n	A				B	B	B	B	D	D	D	D	D					C	E	C	E	E			E	E
12 n					B	B	B	B	D	D	D	D	D					C	E	C	E	E			E	E
15 n					B	B	B	B	D	D	D	D	D					C	E	C	E	E			E	E
18 n					B	B	B	B	D	D	D	D	D					C	E	C	E	E			E	E
22 n					B	B	B	B	D	D	D	D	D					C	E	C	E	E			E	E
27 n					B	B	B	B	D	D	D	D	D					C	E	C	E	E			E	E
33 n					B	B	B	B	D	D	D	D*	D					C	E	C	E	E			E	E
39 n					B	B	B	B	D	D	D	D*	D					C	E	C	E	E			E	E
47 n					B	B	B	B	D	D	D	D*	D					E	E	E	E	E			E	E
56 n					B	B	B	B	D	D	D	D*	D					E	E	E	E	E			E	E
68 n					B	B	B	B	D	D	D	D*	D					E	E	E	E	E			E	E
82 n					B	B	B	B	D	D	D	D*	D					E	E	E	E	E			E	E G
100 n					B	B	B	B	D	D	D	D*	D					E	E	E	E	E			E	E G
120 n																		E	E	E	E	E				
150 n																		E	E	E	E	E				
180 n																		E	E	E	E	E				
220 n									D	D	D*	D	D					E	E	E	E	E		I	I	
270 n																										
330 n									D*	D*	D*	D*	D*				G	G	G	G	G		I	G		
390 n																										
470 n									D*	D*	D*	D*	D*				G	G	G	G	G		G	G	L	
560 n																										
680 n																										
820 n																										
1.0 u									D*	D*	D*	D*	D*			G	G	G	G	G		G	G	G	L	
1.2 u																										
1.5 u																										
1.8 u																										
2.2 u															G	G						L	L	L		
2.7 u																										
3.3 u																										
3.9 u																										
4.7 u														G	G							L	L			N
10 u														G	G							L	L			N

- Non-standard capacitance or thickness is available on request
- * Special length/width tolerance
- The thickness might be changed due to technology improvement.

S 2



Product Range and Thickness

CLAS	Class II																								
TYPE	Standard																								
T.C.	X5R																								
SIZE	0603		1005				1608				2012				3216				3225						
(EIA)	0201		0402				0603				0805				1206				1210						
RV	6.3V	10V	6.3V	10V	16V	25V	6.3V	10V	16V	25V	6.3V	10V	16V	25V	6.3V	10V	16V	25V	6.3V	10V	16V	25V			
2.2 n	A	A																							
3.3 n	A	A																							
4.7 n	A	A																							
5.6 n	A	A																							
6.8 n	A	A																							
8.2 n	A	A																							
10 n	A	A																							
15 n				B	B																				
22 n	A	A		B	B																				
33 n				B	B																				
47 n	A	A		B	B																				
56 n				B	B																				
68 n				B	B																				
82 n				B	B																				
100 n	A	A		B	B	B																			
120 n				B	B																				
150 n				B	B																				
180 n				B	B																				
220 n	A			B	B			D	D	D															
270 n																									
330 n								D	D																
390 n																									
470 n			B	B				D	D																
560 n																									
680 n								D	D																
820 n																									
1.0 u	A*		B	B	B			Q	D	D	D			E	G	E	G								
1.5 u																									
1.8 u																									
2.2 u			B					D	D	D				E	G	G		L	L	L					
2.7 u																									
3.3 u																									
3.9 u																									
4.7 u			B*					D	D				G	G	G	G		L	L	L		N	N		
6.8 u																									
10 u								D*					G	G	G			L	L	L		N	N		
22 u													G					L				N	P	N	P
47 u																		L				P			
100 u																						P			

- Non-standard capacitance or thickness is available on request
- * Special length/width tolerance
- The thickness might be changed due to technology improvement.

Thickness Tolerance

Thickness (mm)		Thickness (mm)		Thickness (mm)		Thickness (mm)		Thickness (mm)		Thickness (mm)	
Code	Class	Code	Class	Code	Class	Code	Class	Code	Code	Code	Code
A	0.30+/-0.03	B	0.50+/-0.20	D	0.8+/-0.20	G	1.25+/-0.20	L	1.60+/-0.20	N	2.00+/-0.30
A	0.30+/-0.05	C	0.60+/-0.15	E	0.85+/-0.15	G	1.25 -0.20/+0.30	L	1.60+0.3/-0.20	P	2.50+/-0.20
B	0.50+/-0.05	D	0.80+/-0.10	F	1.15+/-0.20	I	0.95+/-0.15	N	2.00+/-0.20	Q	0.45+/-0.05

Special Length/Width Tolerance

Size Code(EIA)	0603(0201)	1005(0402)	1608(0603)	2012(0805)	3216(1206)	3225(1210)
Length(mm)	0.6 ± 0.05	1.0 ± 0.20	1.6 ± 0.20	2.0 ± 0.20	3.2 ± 0.30	3.2 ± 0.30
Width(mm)	0.3 ± 0.05	0.5 ± 0.20	0.8 ± 0.20	1.25 ± 0.30	1.6 ± 0.30	2.5 ± 0.30



Taping Amount

Thickness			Amount per reel					
Code	Spec	Size(EIA)	180 mm (7")		250 mm (10")		330 mm (13")	
			Paper	Embossed	Paper	Embossed	Paper	Embossed
A	0.30+/-0.03	0603 (0201)	15K					
<u>A</u>	0.30+/-0.05	0603 (0201)	15K					
B	0.50+/-0.05	1005 (0402)	10K				50K	
<u>B</u>	0.50+/-0.15	1005 (0402)	10K				50K	
Q	0.45+/-0.05	1005 (0402)	10K				50K	
C	0.60+/-0.15	2012 (0805)	4K		10K		15K	
		3216(1206)	4K		10K		15K	
Q	0.45+/-0.05	1608(0603)	4K		10K		15K	
D	0.80+/-0.10	1608(0603)	4K		10K		15K	
<u>D</u>	0.80+0.15/ -0.10	1608 (0603)	4K		10K		15K	
E	0.85+/-0.15	2012 (0805)	4K		10K		15K	
		3216 (1206)	4K		10K		15K	
		3225 (1210)		3K				10K
I	0.95+/-0.15	4532 (1812)		1K				
		2012(0805)		3K				
F	1.15+/-0.20	3216(1206)		3K				10K
		4520 (1808)		3K				
G	1.25 +/-0.20	2012 (0805)		2K/3K				10K
		3216 (1206)		3K				10K
		3225 (1210)		3K				
		4520(1808)		3K				
<u>G</u>	1.25+0.3/-0.2	4532(1812)		1K				
		2012(0805)		2K/3K				10K
		3216(1206)		3K				10K
L	1.60+/-0.20	3225(1210)		3K				
		3216(1206)		2K				
		3225(1210)		2K				
		4520(1808)		2K				
<u>L</u>	1.60+0.30/-0.20	4532(1812)		1K				
		3216(1206)		2K				
		3225(1210)		2K				
		4520(1808)		2K				
N	2.00+/-0.20	45321812)		1K				
		3216 (1206)		2K/3K				
		3225 (1210)		2K				
		4520 (1808)		1K				
<u>N</u>	2.00+/-0.30	4532(1812)		1K				
P	2.50+/-0.20	3225(1210)		500pcs/1K				
<u>P</u>	2.50+/-0.30	3225(1210)		500pcs/1K				

S 2

■ **X5R, X7R Specifications**

Item	Specification	Test Method																																
1 Operating Temperature Range	X7R: -55 to 125 degree C X5R: -55 to 85 degree C	---																																
2 Rated Voltage	6.3VDC, 10VDC, 16VDC, 25VDC, 35VDC, 50VDC, 100VDC,	The rated voltage is defined as the maximum voltage, which may be applied continuously to the capacitor.																																
3 Appearance	No defects or abnormalities.	Visual inspection																																
4 Dimensions	Within the specified dimension.	Using calipers																																
5 Dielectric Strength	No defects or abnormalities.	No failure shall be observed when 250%* of the rated voltage is applied between the terminations for 1 to 5 seconds. The charge and discharge current is less than 50mA.																																
6 Insulation Resistance (I.R.)	Rated Voltage: <500V To apply rated voltage. Rated Voltage: ≥ 500V To apply 500V.	I.R. ≥ 10G or R _C ≥ 500Ω-F (whichever is smaller) The insulation resistance shall be measured with a DC voltage not exceeding the rated voltage at 25°C and 75%RH max, and within 1 minute of charging.																																
7 Capacitance	Within the specified tolerance * X7R, X5R at 1000 hours	The capacitance / D.F. shall be measured at 25°C at the frequency and voltage shown in the tables.																																
8 Q/Dissipation Factor (D.F.)	I. X5R, X7R: See X5R,X7R DF table 3 Table 1 <table border="1"> <thead> <tr> <th>Size</th> <th>Thickness</th> <th>TC</th> <th>RV</th> <th>Cap</th> </tr> </thead> <tbody> <tr> <td>0603</td> <td>0.3 mm</td> <td>X5R</td> <td>6.3V</td> <td>104</td> </tr> <tr> <td>1005</td> <td>0.5 mm</td> <td>X5R</td> <td>4V/6.3V</td> <td>475</td> </tr> <tr> <td>1608</td> <td>0.8 mm</td> <td>X5R</td> <td>4V/6.3V</td> <td>106</td> </tr> </tbody> </table>	Size	Thickness	TC	RV	Cap	0603	0.3 mm	X5R	6.3V	104	1005	0.5 mm	X5R	4V/6.3V	475	1608	0.8 mm	X5R	4V/6.3V	106	<table border="1"> <thead> <tr> <th>Item</th> <th>ClassII (≤ 10 uF)</th> <th>ClassII (>10 uF)</th> <th>* For item in Table1</th> </tr> </thead> <tbody> <tr> <td>Frequency</td> <td>1.0±0.2kHz</td> <td>120Hz±24Hz</td> <td>1.0±0.2kHz</td> </tr> <tr> <td>Voltage</td> <td>1.0±0.2Vrms</td> <td>0.5±0.1Vrms</td> <td>0.5±0.1Vrms</td> </tr> </tbody> </table>	Item	ClassII (≤ 10 uF)	ClassII (>10 uF)	* For item in Table1	Frequency	1.0±0.2kHz	120Hz±24Hz	1.0±0.2kHz	Voltage	1.0±0.2Vrms	0.5±0.1Vrms	0.5±0.1Vrms
Size	Thickness	TC	RV	Cap																														
0603	0.3 mm	X5R	6.3V	104																														
1005	0.5 mm	X5R	4V/6.3V	475																														
1608	0.8 mm	X5R	4V/6.3V	106																														
Item	ClassII (≤ 10 uF)	ClassII (>10 uF)	* For item in Table1																															
Frequency	1.0±0.2kHz	120Hz±24Hz	1.0±0.2kHz																															
Voltage	1.0±0.2Vrms	0.5±0.1Vrms	0.5±0.1Vrms																															
9 Capacitance Temperature Characteristics	Capacitance change X7R/X5R within ±15%	The ranges of capacitance change compared with the 25°C value over the temperature ranges shall be within the specified ranges.																																
10 Termination Strength	No removal of the terminations or marking defect.	Apply a parallel force of 5N to a PCB mounted sample for 10±1sec. *2N for 0603 (EIA 0201).																																
11 Deflection (Bending Strength)	No cracking or marking defects shall occur at 1mm deflection. Capacitance change: X7R, X5R: within ±12.5%	Solder the capacitor to the test jig (glass epoxy boards) shown in Fig.a using a SAC305(Sn96.5Ag3.0Cu0.5) solder (then let sit for 48±4 hours for X7R X5R and Y5V). Then apply a force in the direction shown in Fig.b. The soldering shall be done with the reflow method and shall be conducted with care so that the soldering is uniform and free of defects such as heat shock.																																
	<table border="1"> <thead> <tr> <th>Size</th> <th>a</th> <th>b</th> <th>C</th> </tr> </thead> <tbody> <tr> <td>0603</td> <td>0.3</td> <td>0.9</td> <td>0.3</td> </tr> <tr> <td>1005</td> <td>0.4</td> <td>1.5</td> <td>0.5</td> </tr> <tr> <td>1608</td> <td>1.0</td> <td>3.0</td> <td>1.2</td> </tr> <tr> <td>2012</td> <td>1.2</td> <td>4.0</td> <td>1.65</td> </tr> <tr> <td>3216</td> <td>2.2</td> <td>5.0</td> <td>2.0</td> </tr> <tr> <td>4520</td> <td>3.5</td> <td>7.0</td> <td>2.5</td> </tr> <tr> <td>4532</td> <td>3.5</td> <td>7.0</td> <td>3.7</td> </tr> </tbody> </table>	Size	a	b	C	0603	0.3	0.9	0.3	1005	0.4	1.5	0.5	1608	1.0	3.0	1.2	2012	1.2	4.0	1.65	3216	2.2	5.0	2.0	4520	3.5	7.0	2.5	4532	3.5	7.0	3.7	
Size	a	b	C																															
0603	0.3	0.9	0.3																															
1005	0.4	1.5	0.5																															
1608	1.0	3.0	1.2																															
2012	1.2	4.0	1.65																															
3216	2.2	5.0	2.0																															
4520	3.5	7.0	2.5																															
4532	3.5	7.0	3.7																															
12 Solderability of Termination	90% of the terminations are to be soldered evenly and continuously.	Immerse the test capacitor into a methanol solution containing rosin for 3 to 5 seconds, preheat it 150 to 180°C for 2 to 3 minutes and immerse it into Sn-3.0Ag-0.5Cu solder of 245 ± 5°C for 3±1seconds.																																

S 2



Continued from previous page.

	Item	Specification	Test Method
13	Resistance to Soldering Heat	Appearance	No marking defects
		Cap. Change	X7R/X5R within $\pm 7.5\%$
		Q/D.F.	To satisfy the specified initial spec.
		I.R.	I.R. $\geq 10,000M\Omega$ or $R_1C_R \geq 500\Omega\cdot F$. (whichever is smaller)
			<p>*Preheat the capacitor at 120 to 150°C for 1 minute. Immerse the capacitor in a SAC305(Sn96.5Ag3.0Cu0.5) solder solution at 270\pm5°C for 10\pm1 seconds. Let sit at room temperature for 24\pm2 hours (temperature compensating type) or 48\pm4 hours (high dielectric constant type), then measure.</p> <p>* Preheat 150 to 200°C for size ≥ 3216.</p> <p>Initial measurement : perform a heat treatment at 150+0/-10°C for one hour and then let sit for 48\pm4 hours at room temperature. Perform the initial measurement.</p>
14	Temperature cycle (Thermal shock)	Appearance	No marking defects
		Cap. Change	X7R/X5R within $\pm 7.5\%$
		Q/D.F.	To satisfy the specified initial spec.
		I.R.	I.R. $\geq 10,000M\Omega$ or $R_1C_R \geq 500\Omega\cdot F$. (whichever is smaller)
			<p>Solder the capacitor to supporting jig (glass epoxy board) and perform the five cycles according to the four heat treatments listed in the following table. Let sit for 24\pm2hrs at room temperature, then measure.</p> <p>Step 1: Minimum operating temperature 30\pm3min Step 2: Room temperature 2~3 min Step 3: Maximum operating temperature 30\pm3min Step 4: Room temperature 2~3min</p> <p>Initial measurement: perform a heat treatment at 150+/-10°C for an hour and then let sit for 48\pm4 hours at room temp. Perform the initial measurement.</p>
15	Humidity load	Appearance	No marking defects
		Cap. Change	X7R/X5R within $\pm 12.5\%$
		Q/D.F.	X7R 200% max of initial spec. X5R 200% max of initial spec.
		I.R.	I.R. $\geq 500M\Omega$ or $R_1C_R \geq 25\Omega\cdot F$. (whichever is smaller) * some of the parts are $RiCr \geq 12.5\Omega\cdot F$, please refer to table 2
			<p>Apply the rated voltage at 40\pm2°C and 90 to 95% humidity for 500\pm12 hours. Remove and let sit for 24\pm2 hours (temperature compensating type) or 48\pm4 hours (high dielectric constant type) at room temperature, then measure.</p> <p>The charge / discharge current is less than 50mA.</p> <p>Initial measurement: perform a heat treatment at 150+/-10°C for one hour and then let sit for 48\pm4hours at room temperature. Perform the initial measurement.</p>
16	High temperature load life test	Appearance	No marking defects
		Cap. Change	X7R/X5R within $\pm 12.5\%$
		Q/D.F.	X7R 200% max of initial value X5R 200% max of initial value
		I.R.	More than 1G Ω or $R_1C_R \geq 50\Omega\cdot F$ (whichever is less.) * some of the parts are $RiCr \geq 25\Omega\cdot F$, please refer to table 2
			<p>Apply 200% of the rated voltage for 1000\pm12 hours at the maximum operating temperature $\pm 3^\circ C$. Let sit for 24\pm 2 hours (temperature compensating type) or 48\pm4 hours (high dielectric constant type) at room temperature, then measure.</p> <p>The charge/discharge current is less than 50mA.</p> <p>Initial measurement: perform a heat treatment at 150+/-10°C for one hour and then let sit for 48\pm4hours at room temperature. Perform the initial measurement. P.S.: Please refer to table 2 for items applying 150% voltage.</p> <p>* some of the parts are applicable in rated voltage *1.5. please refer to table 2</p>

Table 2

TC	Product Range
X5R	0603 (EIA 0201): C > 10 nF
	1005 (EIA 0402): C > 0.1 uF
	1608 (EIA 0603): C \geq 1.0 uF
	2012 (EIA 0805): C \geq 2.2 uF
	3216 (EIA 1206): C \geq 10 uF
	3225 (EIA 1210): C \geq 22 uF

S 2



■ X5R/X7R DF (tan δ) Table 3

Rated Voltage	Size	Capacitance	D.F Max.	
			X5R	X7R
4V	All	All	15.0%	
6.3V	All	cap ≤1.0uF	10.0%	7.5%
	All	1.0uF < cap <4.7uF	10.0%	10.0%
	All	4.7uF ≤ cap ≤100uF	15.0%	15.0%
10V	0603/3216/3225	All	7.5%	5.0%
	0603	100nF ≤ cap	10.0%	
		cap ≤100nF	7.5%	5.0%
	1005	100nF < cap <330nF	7.5%	
		330nF ≤ cap	10.0%	
		cap ≤1.0uF	7.5%	5.0%
	1608	1.0uF < cap <2.2uF	7.5%	
		2.2uF ≤ cap	10.0%	
		cap <2.2uF	7.5%	5.0%
	2012	2.2uF ≤ cap	10.0%	
10uF		10.0%	10.0%	
10uF < cap ≤22uF		10.0%	10.0%	
16V	0603/3216/3225	All	5.0%	5.0%
	1005	cap ≤100nF	5.0%	5.0%
		100nF < cap ≤220nF	7.5%	
	1608	cap ≤470nF	5.0%	5.0%
		470nF < cap <1.0uF	7.5%	5.0%
		1.0uF ≤ cap	10.0%	10.0%
	2012	cap ≤2.2uF	5.0%	5.0%
		2.2uF < cap ≤4.7uF	7.5%	
		4.7uF < cap ≤10uF	10.0%	
	3216	4.7uF < cap	10.0%	10.0%
3225	10uF < cap ≤22uF	15.0%		
25V	All	All	5.0%	3.5%
		1.0uF ≤ cap	10.0%	
	1608	470nF		10.0%
	3216	1.0uF < cap ≤4.7u	5.0%	5.0%
		4.7uF < cap	10.0%	
3225	4.7uF < cap ≤10u	10.0%		
≥50V	All	All but below	2.5%	3.0%
	3216/3225	cap ≤1.0uF	3.5%	3.5%

S 2