



## NP0(C0G) & X7R Mid-High Voltage Dielectrics

### ■ Features

- A monolithic structure ensures high reliability and mechanical strength.
- High capacitance density.
- Suitable for high speed SMT placement on PCBs.
- Ni barrier termination highly resistance to migration.
- Rated Voltage from 200VDC to 3,000VDC.
- Lead-free termination is in compliance with the requirement of green plan and ROHS.

### ■ Applications

- Input filtering circuit of modem and LAN interface.
- DC-DC Converters
- Backlighting inverters of LCD screen.
- Switching circuit.
- General high voltage circuit.

### ■ Mid-High Voltage C0G(NP0) & X7R Dielectric Characteristics

	C0G (NP0)	X7R
Capacitance Range	4.7pF to 2.2nF	100pF to 1.0uF
Size (mm) (EIA inch)	2012 3216 4520 (0805) (1206) (1808)	2012 3216 4520 4532 (0805) (1206) (1808) (1812)
Test Voltage	1.0 ± 0.2Vrms	1.0 ± 0.2Vrms
Test Frequency	1.0 ± 0.2MHz for cap ≤ 1,000pF, 1.0 ± 0.2KHz for cap > 1,000pF	1.0 ± 0.2KHz
Capacitance Tolerance	± 0.25pF, ± 0.50pF for cap < 5pF ± 0.50pF for 5pF ≤ cap < 10pF ± 5%, ± 10% for cap ≥ 10pF	± 10%
Operating Temperature Range	-55°C to +125°C	-55°C to +125°C
Maximum Capacitance Change	0 ± 30 ppm/°C (EIA C0G)	± 15 %
Rated Voltage	200/250, 500/630, 1K, 2K & 3K VDC	200/250, 500/630, 1K & 2K VDC
Dissipation Factor (DF)	0.1% max. for cap > 30pF 1/(400 + 20 x C) for cap ≤ 30pF, C in pF	2.5%
Insulation Resistance(+25°C, RVDC)	10,000 MΩ minimum	10,000 MΩ minimum
Insulation Resistance (Maximum operating temperature, RVDC)	1,000 MΩ min. or 50Ω-F min., whichever is smaller	1,000 MΩ min. or 50Ω-F min., whichever is smaller

Note : Capacitors above 500WVDC may require a surface coating to prevent external arcing.



■ **Product Range and Thickness**

CLASS	Class I												
TYPE	Mid-High Voltage												
T.C.	C0G (NP0)												
SIZE	2012			3216				4520					
(EIA)	(0805)			(1206)				(1808)					
RV	200/250V	500V/630V	200/250V	500V/630V	1KV	2KV	3KV						
4.7 p								F	G	H			
5.6 p								F	G	H			
6.8 p								F	G	H			
8.2 p								F	G	H			
10 p	C	E	I	E	E	I	E	F	E	G	F	G	H
12 p	C	E	I	E	E	I	E	F	E	G	F	G	H
15 p	C	E	I	E	E	I	E	F	E	G	F	G	H
18 p	C	E	I	E	E	I	E	F	E	G	F	G	H
22 p	C	E	I	E	E	I	E	F	E	G	F	G	H
27 p	C	E	I	E	E	I	E	F	E	G	F	G	H
33 p	C	E	I	E	E	F	F	F	G	F	G	H	
39 p	C	E	I	E	E	F	F	F	G	F	G	H	
47 p	C	E	I	E	E	F	F	F	G	F	G	H	
56 p	C	E	I	E	E	F	F	F	G	F	G	H	
68 p	C	E	I	E	E	F	F	F	G	F	G	H	
82 p	C	E	I	E	E	F	F	F	G	F	G	H	
100 p	C	E	I	E	E	F	F	F	G	F	G	H	
120 p	C	E	I	E	E	I	F	F	G	F	L		
150 p	E		I	E	E	I	F	F	G	F	L		
180 p	E		I	E	E	I	F	F	G		L		
220 p	E	G	I	E	E	I	F	F	G		L		
270 p	E	G	I	E	I	F	F	L			L		
330 p	E	G	I	E	I	F	F						
390 p	E	G	I	E	I	F	F						
470 p	E	G	I	I	I	F	F						
560 p	E	G		I	G								
680 p	E	G		I	G								
820 p	E	G		F	G								
1.0 n				L	L								
1.2 n				I									
1.5 n				I									
1.8 n				G									
2.2 n				G									
2.7 n													
3.3 n													

- Non-standard capacitance or thickness is available on request
- The thickness might be changed due to technology improvement.
- Capacitors above 500WVDC may require a surface coating to prevent external arcing.

Thickness (mm)		Thickness (mm)		Thickness (mm)		Thickness (mm)		Thickness (mm)	
Code	Class	Code	Class	Code	Class	Code	Class	Code	Class
A	0.30+/-0.03	M	0.70+/-0.15	I	0.95+/-0.15	H	1.50+/-0.20	N	2.00+/-0.20
B	0.50+/-0.05	D	0.80+/-0.10	F	1.15+/-0.20	P	2.50+/-0.20	R	3.20+/-0.20
C	0.60+/-0.15	E	0.85+/-0.15	G	1.25+/-0.20	L	1.60+/-0.20		

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■ **Product Range and Thickness**

CLASS	Class II															
TYPE	Mid-High Voltage															
T.C.	X7R															
SIZE	2012				3216				4520				4532			
(EIA)	(0805)				(1206)				(1808)				(1812)			
RV	200/250V	500V/630V	200/250V	500V/630V	1KV	2KV	2KV	3KV	2KV	3KV	100V	200/250V	500V/630V	2KV	3KV	
47 p																
56 p																
68 p																
82 p																
100 p														F		
120 p														F		
150 p														F		
180 p	E	E	E	E	E	G	E	G	F	H	G	N				
220 p	E	E	E	E	E	G	E	G	F	H	G	N				
270 p	E	E	E	E	E	G	E	G	F	H	G	N				
330 p	E	E	E	E	E	G	E	G	F	H	G	N				
390 p	E	E	E	E	E	G	E	G	F	H	G	N				
470 p	E	E	E	E	E	G	E	G	F	H	G	N			G L	
560 p	E	E	E	E	F	G	F	G	F	H	G	N			G L	
680 p	E	E	E	E	F	G	G	L	F	H	G	N			G L L	
820 p	E	E	E	E	F	G	G	L	F	H	G	N			G L N	
1.0 n	E	E	E	E	F	G	L	G	H	N	G	N			E H N	
1.2 n	E	E	E	E	F	G		H	N	G	N				G L N	
1.5 n	E	E	E	E	G	L		L	N	G	N				G L N	
1.8 n	E	E	E	E	G	L		L	N	G	N				G L N	
2.2 n	E	E	E	E	G	L		L	N						L N	
2.7 n	E	E	E	E											N	
3.3 n	E	E	E	E												
3.9 n	E		E	E												
4.7 n	E		E	E												
5.6 n	G		E	E												
6.8 n	G		E	E												
8.2 n	G		E	F												
10 n	G		E	F								G	G			
12 n	G		E	F								G	G			
15 n			E	L								G	G			
18 n			F	L								G	G			
22 n			F	L								G	G			
27 n			F	L								G	G			
33 n			F	L								G	G	L		
39 n			F									G	G	L		
47 n			F									G	G	L		
56 n												G	L	N		
68 n												G	L	N		
100 n											G	G	L	N		
150 n											G	N				
220 n											G	N				
330 n											G	N				
470 n											L	N	N			
680 n											L	N				
1.0 u											L	N				

- Non-standard capacitance or thickness is available on request
- The thickness might be changed due to technology improvement.
- Capacitors above 500WVDC may require a surface coating to prevent external arcing.

**Typical Tolerance**

Thickness (mm)		Thickness (mm)		Thickness (mm)		Thickness (mm)		Thickness (mm)	
Code	Class	Code	Class	Code	Class	Code	Class	Code	Class
A	0.30+/-0.03	M	0.70+/-0.15	I	0.95+/-0.15	H	1.50+/-0.20	N	2.00+/-0.20
B	0.50+/-0.05	D	0.80+/-0.10	F	1.15+/-0.20	P	2.50+/-0.20	R	3.20+/-0.20
C	0.60+/-0.15	E	0.85+/-0.15	G	1.25+/-0.20	L	1.60+/-0.20		

**Special Tolerance**

Thickness (mm)		Thickness (mm)		Thickness (mm)		Thickness (mm)		Thickness (mm)	
Code	Class	Code	Class	Code	Class	Code	Class	Code	Class
G	1.25 -0.20/+0.30	L	1.60 -0.20/+0.30	N	2.00+/-0.30	P	2.50+/-0.30	R	3.20+/-0.30

For Cap≥1μF, Tolerance of dimensions will be enlarged.



### ■ Taping Amount

Thickness			Amount per reel					
			180 mm (7")		250 mm (10")		330 mm (13")	
Code	Spec	Size(EIA)	Paper	Embossed	Paper	Embossed	Paper	Embossed
A	0.30+/-0.03	0603 (0201)	15K					
B	0.50+/-0.05	1005 (0402)	10K				50K	
C	0.60+/-0.15	2012 (0805)	4K		10K		15K	
		3216 (1206)	4K		10K		15K	
D	0.80+/-0.10	1608 (0603)	4K		10K		15K	
D*	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				
G	1.25+0.3/-0.2	4532 (1812)		1K				
		2012 (0805)		2K/3K				10K
		3216 (1206)		3K				10K
H	1.50+/-0.20	3225 (1210)		2K				
		4520 (1808)		2K				
		4532 (1812)		1K				
L	1.60+/-0.20	3216 (1206)		2K				
		3225 (1210)		2K				
		4520 (1808)		2K				
L	1.60+0.30/-0.20	4532 (1812)		1K				
		3216 (1206)		2K				
		3225 (1210)		2K				
N	2.00+/-0.20	4520 (1808)		2K				
		4532 (1812)		1K				
		3216 (1206)		2K/3K				
		3225 (1210)		2K				
N	2.00+/-0.30	4520 (1808)		1K				
N	2.00+/-0.30	4532 (1812)		1K				
N	2.00+/-0.30	3225 (1210)		2K				
P	2.50+/-0.20	3225 (1210)		500pcs/1K				
P	2.50+/-0.30	3225 (1210)		500pcs/1K				
R	3.20+/-0.20			500pcs				
R	3.20+/-0.30			500pcs				

\*: For some products, the thickness spec can be 0.8+0.15/-0.1mm.

■ **Mid-High Voltage C0G(NP0) Specifications**

No.	Item	Specification	Test Method																		
1	Operating Temperature Range	-55°C to 125°C	-																		
2	Rated Voltage	200/250VDC, 500/630VDC, 1000VDC, 2000VDC and 3000VDC	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 (Flash)	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. *150% for 500VDC; 120% for 1KVDC, 2KVDC&3KVDC																		
6	Insulation Resistance ( I.R.)	Rated Voltage: <500V	To apply rated voltage.																		
		Rated Voltage: ≥500V	To apply 500V.																		
		I.R. ≥10G or R <sub>C</sub> ≥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.	The capacitance/D.F. shall be measured at 25°C at the frequency and voltage shown in the tables.																		
8	Dissipation Factor ( D.F.)	If C > 30pF, DF ≤ 0.1% If C ≤ 30pF, DF ≤ 1/(400+20C), C in pF	<table border="1"> <thead> <tr> <th>Item</th> <th>C ≤ 1,000pF</th> <th>C &gt; 1,000pF</th> </tr> </thead> <tbody> <tr> <td>Frequency</td> <td>1.0±0.2MHz</td> <td>1.0±0.2KHz</td> </tr> <tr> <td>Voltage</td> <td>1.0±0.2Vrms</td> <td>1.0±0.2Vrms</td> </tr> </tbody> </table>	Item	C ≤ 1,000pF	C > 1,000pF	Frequency	1.0±0.2MHz	1.0±0.2KHz	Voltage	1.0±0.2Vrms	1.0±0.2Vrms									
			Item	C ≤ 1,000pF	C > 1,000pF																
Frequency	1.0±0.2MHz	1.0±0.2KHz																			
Voltage	1.0±0.2Vrms	1.0±0.2Vrms																			
9	Capacitance Temperature Characteristics	Capacitance change within 0±30ppm/°C under operating temperature range.	Temperature compensating type: The capacitance value at 25°C and 85°C shall be measured and calculated from the formula given below. T.C.=(C <sub>85</sub> -C <sub>25</sub> )/C <sub>25</sub> *ΔT*10 <sup>6</sup> (PPM/°C)																		
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.																		
11	Deflection (Bending Strength)	Appearance: No cracking or marking defects. Capacitance change: within ±5% or ± 0.5pF. (whichever is larger)	Solder the capacitor to the test jig (glass epoxy boards) shown in Fig. a. using a eutectic solder. 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>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	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
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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 is 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 molten solder of 230 ± 5°C for 5±1seconds.																		
13	Resistance to Soldering Heat	Appearance	No marking defects																		
		Cap. Change	NP0 within ±2.5% or ±0.25pF. (whichever is larger)																		
		D.F.	If C > 30pF, DF ≤ 0.1% If C ≤ 30pF, DF ≤ 1/(400+20C), C in pF																		
		I.R.	I.R. ≥ 10,000MΩ or R <sub>C</sub> R ≥ 500Ω·F. ( whichever is smaller)																		
			Preheat the capacitor at 120 to 150°C* for 1 minute. Immerse the capacitor in an eutectic solder solution at 270±5°C for 10±1 seconds. Let sit at room temperature for 24±2 hours, then measure. * Preheat 150 to 200°C for size ≥3216.																		

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14	Temperature Cycle (Thermal Shock)	Appearance	No marking defects	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±2hrs at room temperature, then measure.  Step 1: Minimum operating temperature 30±3min Step 2: Room temperature 2~3 min Step 3: Maximum operating temperature 30±3min Step 4: Room temperature 2~3min
		Cap. Change	NP0 within ±2.5% or ±0.25pF. (whichever is larger)	
		D.F.	If C > 30pF, DF ≤ 0.1% If C ≤ 30pF, DF ≤ 1/(400+20C), C in pF	
		I.R.	More than 10,000MΩ or R <sub>C</sub> R <sub>R</sub> > 500Ω-F (whichever is smaller)	
15	Humidity Test (Steady State)	Appearance	No marking defects	Sits the capacitor at 40±2°C and 90 to 95% humidity for 500±12 hours. Remove and let sit for 24±2 hours at room temperature, then measure. The charge/discharge current is less than 50mA.
		Cap. Change	NP0 within ±7.5% or ±0.75pF. (whichever is larger)	
		D.F.	If C > 30pF, DF ≤ 0.5% If C ≤ 30pF, DF ≤ 1/(100+10xC/3), C in pF	
		I.R.	More than 500MΩ or R <sub>C</sub> R <sub>R</sub> ≥ 25Ω-F. (whichever is smaller)	
16	High Temperature Load (Life Test)	Appearance	No marking defects	Apply 200%* of the rated voltage for 500±12 hours at the maximum operating temperature ± 3°C. Let sit for 24± 2 hours at room temperature, then measure. The charge/discharge current is less than 50mA. * 150% for 500VDC; 120% for 1000VDC, 2000VDC, 3000VDC
		Cap. Change	NP0 within ±7.5% or ±0.75pF (whichever is large)	
		D.F.	If C > 30pF, DF ≤ 0.3% If 10pF < C ≤ 30pF, DF ≤ 1/(275+5xC/2) If C ≤ 10pF, DF ≤ 1/(200+10C), C in pF	
		I.R.	More than 1 GΩ or R <sub>C</sub> R <sub>R</sub> ≥ 50Ω-F (whichever is smaller)	

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■ **Mid-High Voltage X7R Specifications**

No.	Item	Specification	Test Method																		
1	Operating Temperature Range	-55°C to 125°C	-																		
2	Rated Voltage	200/250VDC, 500/630VDC, 1000VDC, 2000VDC	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 (Flash)	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. *150% for 500VDC. 120% for 1000VDC&2000VDC																		
6	Insulation Resistance ( I.R.)	Rated Voltage: <500V	To apply rated voltage.	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.																	
		Rated Voltage: ≥500V	To apply 500V.																		
7	Capacitance	Within the specified tolerance at 1,000 hours	The capacitance/D.F. shall be measured at 25°C at frequency 1.0±0.2KHz and voltage 1.0±0.2Vrms.																		
8	Dissipation Factor ( D.F.)	2.5% maximum																			
9	Capacitance Temperature Characteristics	Capacitance change within the specified tolerance as following table. Reference temperature 25°C.		The ranges of capacitance change compared with 25°C value over the temperature ranges shown in the table should be within the specified ranges.																	
		Char.	Temp. Range		Cap. Change																
		X7R	-55°C to 125°C	± 15%																	
10	Termination Strength	No removal of the terminations or marking defect.	Apply a parellel force of 5N to a PCB mounted sample for 10±1sec.																		
11	Deflection (Bending Strength)	Appearance: No cracking or marking defects. Capacitance change within ±12.5%.		Solder the capacitor to the test jig (glass epoxy boards) shown in Fig. a. using a eutectic solder then let sit for 48±4 hours. 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.																	
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4532	3.5	7.0	3.7																		
12	Solderability of Termination	90% of the terminations is 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 molten solder of 230 ± 5°C for 5±1seconds.																		
13	Resistance to Soldering Heat	Appearance	No marking defects	Preheat the capacitor at 120 to 150°C* for 1 minute. Immerse the capacitor in an eutectic solder solution at 270±5°C for 10±1 seconds. Let sit at room temperature for 48±4 hours, then measure. * Preheat 150 to 200°C for size ≥3216.  Initial measurement : perform a heat treatment at 150+0/-10°C for one hour and then let sit for 48±4 hours at room temperature. Perform the initial measurement.																	
		Cap. Change	Within ±7.5%																		
		D.F.	2.5% maximum																		
		I.R.	I.R. ≥ 10,000MΩ or RiCr ≥ 500Ω-F. ( whichever is smaller)																		

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14	Temperature Cycle (Thermal Shock)	Appearance	No marking defects	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 48±4hrs at room temperature, then measure.  Step 1: Minimum operating temperature 30±3min Step 2: Room temperature 2~3 min Step 3: Maximum operating temperature 30±3min Step 4: Room operating temperature 2~3min  Initial measurement : perform a heat treatment at 150+0/-10°C for one hour and then let sit for 48±4 hours at room temperature. Perform the initial measurement.
		Cap. Change	Within ±7.5%	
		D.F.	2.5% maximum	
		I.R.	More than 10,000MΩ or $R_i C_R > 500 \Omega \cdot F$ ( whichever is smaller )	
15	Humidity Test (Steady State)	Appearance	No marking defects	Sits the capacitor at 40±2°C and 90 to 95% humidity for 500±12 hours. Remove and let sit for 48±4 hours at room temperature, then measure. The charge/discharge current is less than 50mA. Initial measurement : perform a heat treatment at 150+0/-10°C for one hour and then let sit for 48±4 hours at room temperature. Perform the initial measurement.
		Cap. Change	Within ±12.5%	
		D.F.	5% maximum	
		I.R.	More than 500MΩ or $R_i C_R \geq 25 \Omega \cdot F$ (whichever is smaller)	
		Dielectric Strength	No failure	
16	High Temperature Load (Life Test)	Appearance	No marking defects	Apply 200%* of the rated voltage for 500±12 hours at the maximum operating temperature ±3°C. Let sit for 48±4 hours at room temperature, then measure. The charge/discharge current is less than 50mA. * 150% for 500V. 120% for 1000VDC&2000VDC  Pre-treatment: Apply the rated voltage for 1 hr at maximum operating temperature ±3°C. Remove and let sit for 48±4 hours, then perform the initial measurement.
		Cap. Change	Within ±12.5%	
		D.F.	5% maximum	
		I.R.	More than 1 GΩ or $R_i C_R \geq 50 \Omega \cdot F$ (whichever is smaller)	

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