

# DATA SHEET

## SURFACE-MOUNT CERAMIC MULTILAYER CAPACITORS

C-Array  
NP0/X7R/Y5V  
16 V TO 100 V

sizes 0508 (4 x 0402) / 0612 (4 x 0603)  
RoHS compliant & Halogen Free



SCOPE

This specification describes NP0/X7R/Y5V 4-capacitor Array with lead-free terminations.

APPLICATIONS

- Professional electronics
- High density consumer electronics

FEATURES

- Supplied in tape on reel
- Nickel-barrier end termination
- 0508 (4x0402) / 0612 (4x0603) capacitors (of the same capacitance value) per array
- Less than 50% board space of an equivalent discrete component
- High volumetric efficiency
- Increased throughput, by time saved in mounting
- 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)**

**CA** xxxx x x xxx x **B** x xxx  
 (1) (2) (3) (4) (5) (6) (7)

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**(1) SIZE – INCH BASED (METRIC)**

0508 (1220)  
 0612 (1632)

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**(2) TOLERANCE**

J = ±5%  
 K = ±10%  
 M = ±20%  
 Z = -20% to +80%

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**(3) PACKING STYLE**

R = Paper/PE taping reel; Reel 7 inch  
 P = Paper/PE taping reel; Reel 13 inch

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**(4) TC MATERIAL**

NPO  
 X5R  
 X7R  
 Y5V

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**(5) RATED VOLTAGE**

7 = 16 V  
 8 = 25 V  
 9 = 50 V  
 0 = 100V

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**(6) PROCESS**

N = NP0  
 B = class 2 material

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**(7) CAPACITANCE VALUE**

2 significant digits+number of zeros  
 The 3rd digit signifies the multiplying factor, and letter R is decimal point  
 Example: 121 = 12 × 10<sup>1</sup> = 120 pF

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**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. An outline of the structure is shown in Fig.1.

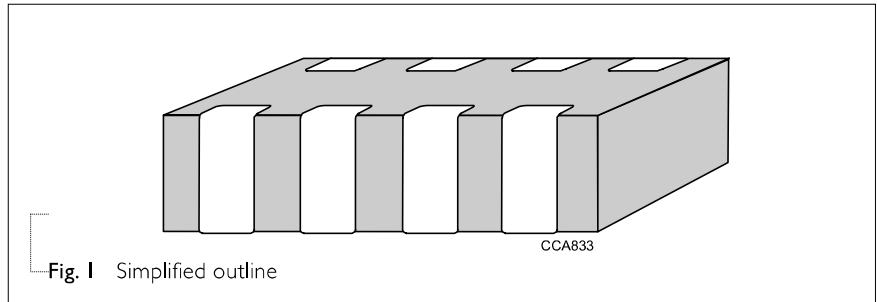


Fig. 1 Simplified outline

**DIMENSIONS**

Table I

TYPE	0508 (4 X 0402)	0612 (4 X 0603)
L (mm)	2.0 ±0.15	3.2 ±0.15
W (mm)	1.25 ±0.15	1.60 ±0.15
T <sub>min.</sub> (mm)	Refer to Table 2 ~ Table 4	
T <sub>max.</sub> (mm)	Refer to Table 2 ~ Table 4	
A (mm)	0.28 ±0.10	0.4 ±0.10
B (mm)	0.2 ±0.10	0.3 ±0.20
P (mm)	0.5 ±0.10	0.8 ±0.10

**OUTLINES**

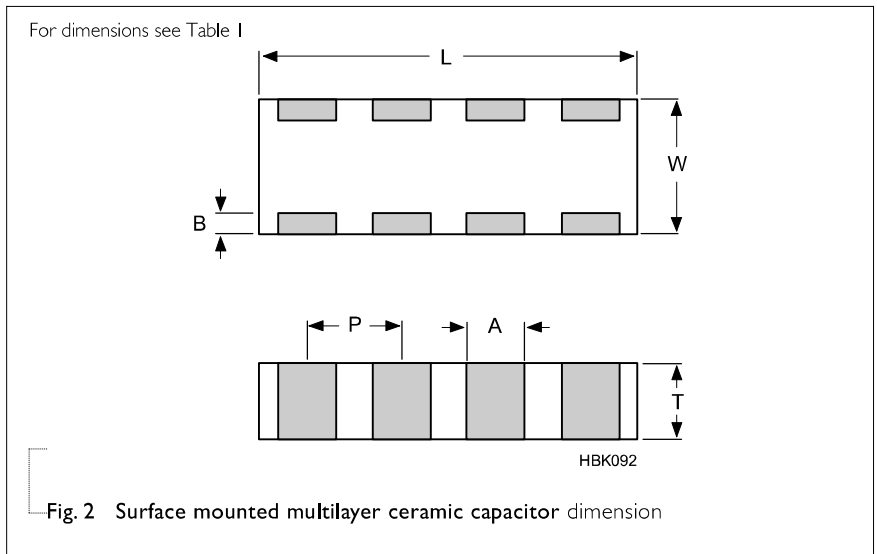


Fig. 2 Surface mounted multilayer ceramic capacitor dimension

**CAPACITANCE RANGE & THICKNESS FOR 4C-ARRAY**

Table 2 Temperature characteristic material from NP0

CAPACITANCE	0508 (4 x 0402)		0612 (4 x 0603)	
	50 V	100V	50 V	100V
10 pF	0.6±0.1	0.6±0.1	0.8±0.1	0.8±0.1
15 pF	0.6±0.1	0.6±0.1	0.8±0.1	0.8±0.1
18 pF	0.6±0.1	0.6±0.1	0.8±0.1	0.8±0.1
22 pF	0.6±0.1	0.6±0.1	0.8±0.1	0.8±0.1
33 pF	0.6±0.1	0.6±0.1	0.8±0.1	0.8±0.1
39 pF	0.6±0.1	0.6±0.1	0.8±0.1	0.8±0.1
47 pF	0.6±0.1	0.6±0.1	0.8±0.1	0.8±0.1
56 pF	0.6±0.1	0.6±0.1	0.8±0.1	0.8±0.1
68 pF	0.6±0.1	0.6±0.1	0.8±0.1	0.8±0.1
82 pF	0.6±0.1	0.6±0.1	0.8±0.1	0.8±0.1
100 pF	0.6±0.1	0.6±0.1	0.8±0.1	0.8±0.1
120 pF	0.6±0.1		0.8±0.1	0.8±0.1
150 pF	0.6±0.1		0.8±0.1	0.8±0.1
180 pF	0.6±0.1		0.8±0.1	0.8±0.1
220 pF	0.6±0.1		0.8±0.1	0.8±0.1
270 pF			0.8±0.1	0.8±0.1
330 pF			0.8±0.1	0.8±0.1
390 pF			0.8±0.1	0.8±0.1
470 pF			0.8±0.1	0.8±0.1
560 pF				
680 pF				
820 pF				
1.0 nF				

**NOTE**

Values in shaded cells indicate thickness class in mm

**CAPACITANCE RANGE & THICKNESS FOR 4C-ARRAY**

Table 3 Temperature characteristic material from X7R

CAPACITANCE	0508 (4 x 0402)			0612 (4 x 0603)			
	16 V	25 V	50 V	16 V	25 V	50 V	100V
220 pF				0.8±0.1	0.8±0.1	0.8±0.1	
330 pF				0.8±0.1	0.8±0.1	0.8±0.1	
470 pF				0.8±0.1	0.8±0.1	0.8±0.1	
680 pF				0.8±0.1	0.8±0.1	0.8±0.1	
1.0 nF	0.6±0.1	0.6±0.1	0.6±0.1	0.8±0.1	0.8±0.1	0.8±0.1	
1.2 nF	0.6±0.1	0.6±0.1		0.8±0.1	0.8±0.1	0.8±0.1	
1.5 nF	0.6±0.1	0.6±0.1		0.8±0.1	0.8±0.1	0.8±0.1	
1.8 nF	0.6±0.1	0.6±0.1		0.8±0.1	0.8±0.1	0.8±0.1	
2.2 nF	0.6±0.1	0.6±0.1		0.8±0.1	0.8±0.1	0.8±0.1	
2.7 nF	0.6±0.1	0.6±0.1		0.8±0.1	0.8±0.1	0.8±0.1	
3.3 nF	0.6±0.1	0.6±0.1		0.8±0.1	0.8±0.1	0.8±0.1	
3.9 nF	0.6±0.1	0.6±0.1		0.8±0.1	0.8±0.1	0.8±0.1	
4.7 nF	0.6±0.1	0.6±0.1		0.8±0.1	0.8±0.1	0.8±0.1	
5.6 nF	0.6±0.1	0.6±0.1		0.8±0.1	0.8±0.1	0.8±0.1	
6.8 nF	0.6±0.1	0.6±0.1		0.8±0.1	0.8±0.1	0.8±0.1	
8.2 nF	0.6±0.1	0.6±0.1		0.8±0.1	0.8±0.1	0.8±0.1	
10 nF	0.6±0.1	0.6±0.1		0.8±0.1	0.8±0.1	0.8±0.1	0.85±0.1
12 nF	0.6±0.1			0.8±0.1	0.8±0.1	0.8±0.1	0.85±0.1
15 nF	0.6±0.1			0.8±0.1	0.8±0.1	0.8±0.1	0.85±0.1
18 nF	0.6±0.1			0.8±0.1	0.8±0.1	0.8±0.1	0.85±0.1
22 nF	0.6±0.1			0.8±0.1	0.8±0.1	0.8±0.1	0.85±0.1
27 nF	0.6±0.1			0.8±0.1	0.8±0.1	0.8±0.1	
33 nF	0.6±0.1			0.8±0.1	0.8±0.1	0.8±0.1	
47 nF	0.6±0.1			0.8±0.1	0.8±0.1	0.8±0.1	
56 nF	0.6±0.1			0.8±0.1	0.8±0.1	0.8±0.1	
68 nF	0.6±0.1			0.8±0.1	0.8±0.1	0.8±0.1	
82 nF	0.6±0.1			0.8±0.1	0.8±0.1	0.8±0.1	
100 nF	0.6±0.1			0.8±0.1	0.8±0.1	0.8±0.1	
220 nF				0.8±0.1			
470 nF				0.8±0.1			

**NOTE**

Values in shaded cells indicate thickness class in mm

CAPACITANCE RANGE & THICKNESS FOR 4C-ARRAY

Table 4 Temperature characteristic material from Y5V

<b>CAPACITANCE</b>		<b>0612 (4 x 0603)</b>
		<b>25 V</b>
10 nF		0.6±0.1
22 nF		
47 nF		
100 nF		

**NOTE**

Values in shaded cells indicate thickness class in mm

THICKNESS CLASSES AND PACKING QUANTITY

Table 5

SIZE CODE	THICKNESS CLASSIFICATION	TAPE WIDTH	QUANTITY PER REEL	Ø180 MM / 7 INCH Paper	Ø180 MM / 13 INCH Paper
<b>0508</b>	0.6 ±0.1 mm	8 mm	8 mm	4,000	20,000
<b>0612</b>	0.8 ±0.1 mm	8 mm	8 mm	4,000	15,000

ELECTRICAL CHARACTERISTICS

**4C-ARRAY DIELECTRIC CAPACITORS; NISN TERMINATIONS**

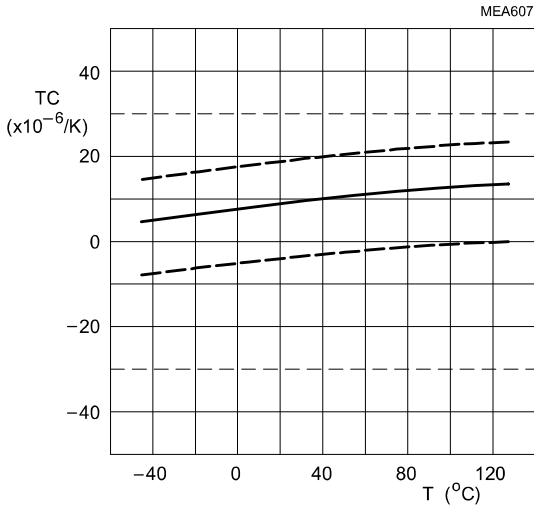
Unless otherwise stated all electrical values apply at an ambient temperature of  $20 \pm 1$  °C, an atmospheric pressure of 86 to 106 kPa, and a relative humidity of 63 to 67%.

Table 6

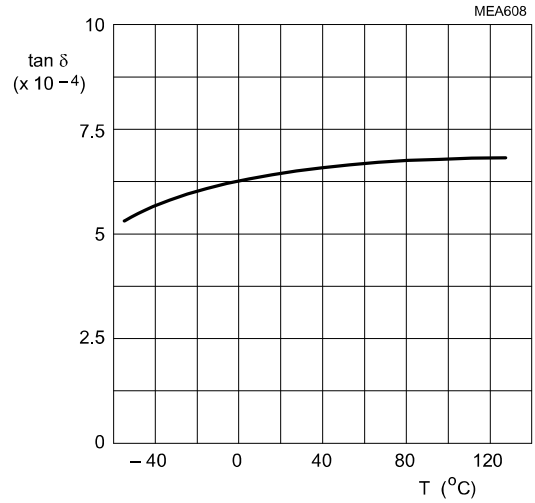
DESCRIPTION	VALUE
Capacitance range	10 pF to 100 nF
Rated voltage	NP0 50 V to 100 V
	X7R 16 V to 100 V
	Y5V 0612: 25 V
Capacitance tolerance	NP0 $\pm 5\%$ , $\pm 10\%$
	X7R $\pm 10\%$ , $\pm 20\%$
	Y5V -20% to +80%
Dissipation factor (D.F.)	NP0 $\leq 0.1\%$
	X7R $16\text{ V} \leq 3.5\%$ , $25\text{ V} \leq 2.5\%$ , $50\text{ V} / 100\text{ V} \leq 2.5\%$ 0508/12nF~100nF/16V, Df $\leq 5\%$
	Y5V 0508 $\leq 9\%$ , 0612 $\leq 7\%$
Insulation resistance after 1 minute at $U_r$ (DC)	$R_{ins} \geq 10\text{ G}\Omega$ or $R_{ins} \times C_r \geq 500$ seconds whichever is less
Maximum capacitance change as a function of temperature (temperature characteristic/coefficient):	NP0 $\pm 30\text{ ppm}/^\circ\text{C}$
	X7R $\pm 15\%$
	Y5V +22% to -82%
Operating temperature range:	NP0 -55 °C to +125 °C
	X7R -55 °C to +125 °C
	Y5V -30 °C to +85 °C

**NP0 0508/06 I2 50 V**

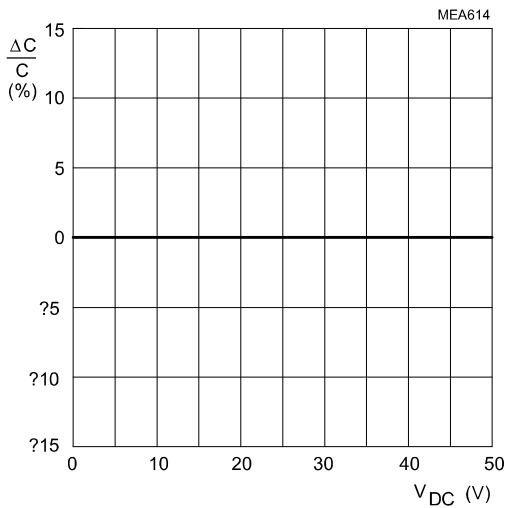
Sample limits (broken lines)  
Requirement levels (dotted lines)



**Fig. 3** Typical temperature coefficient as a function of temperature



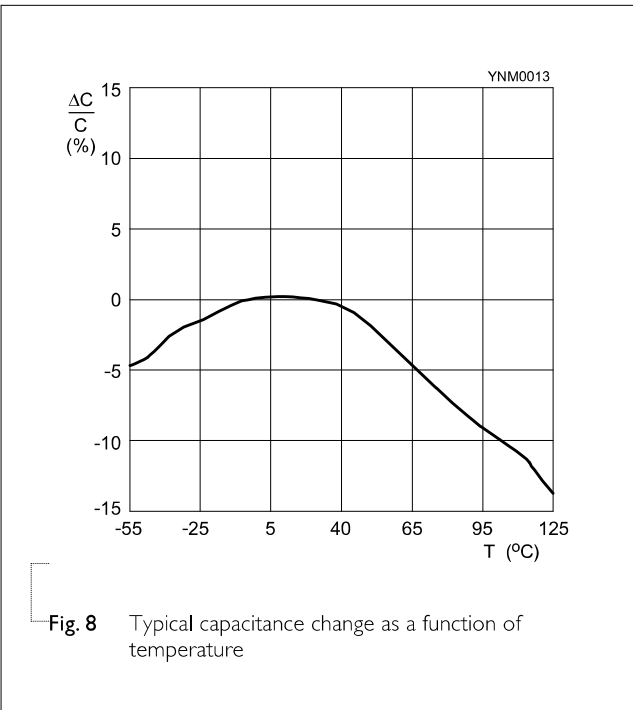
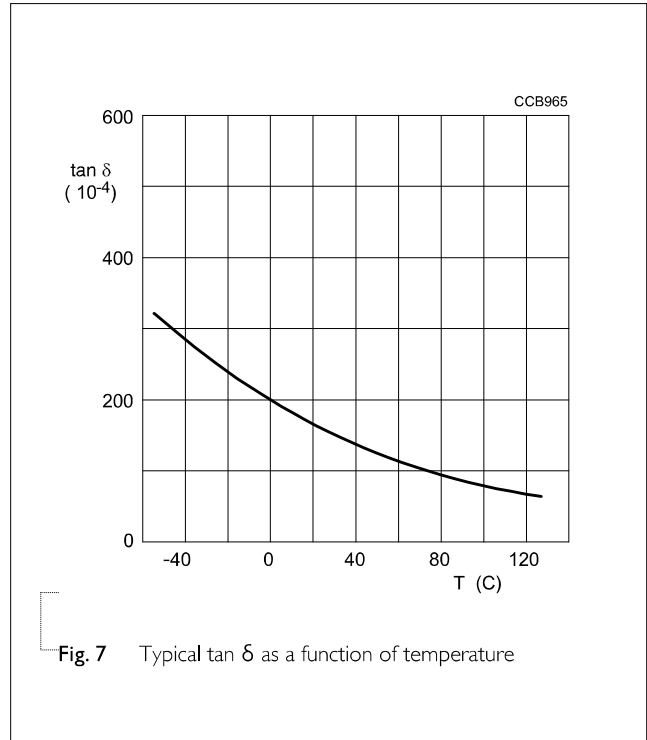
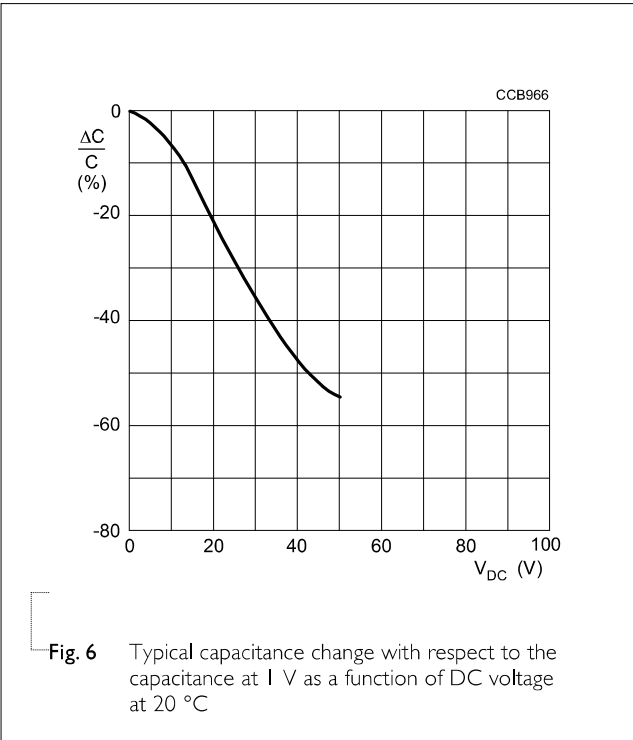
**Fig. 4** Typical tan δ as a function of temperature



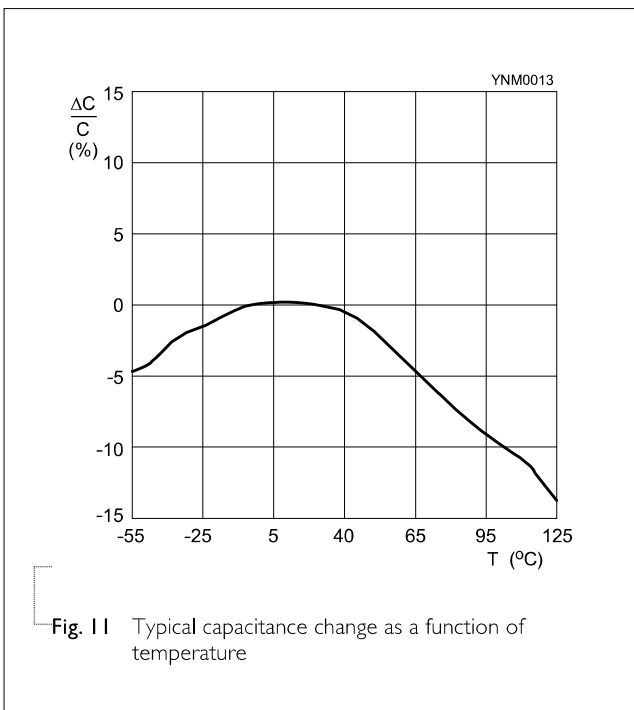
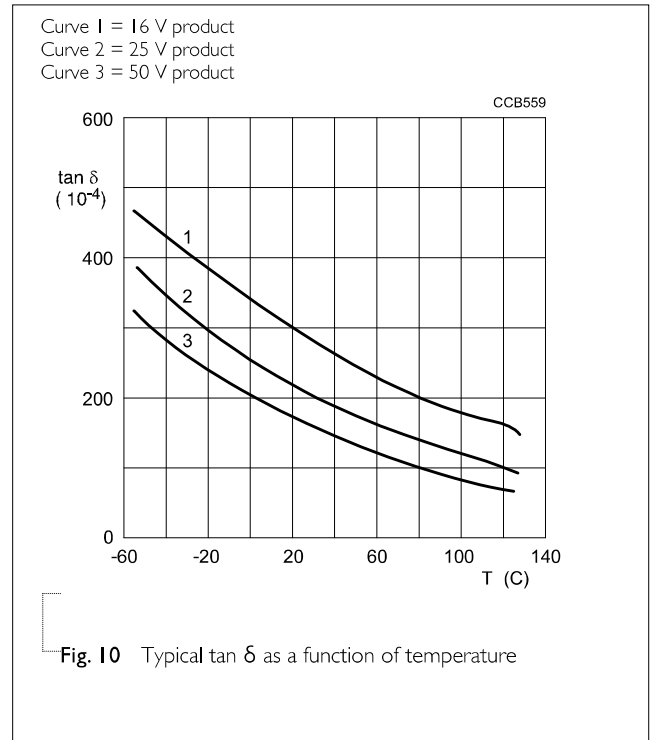
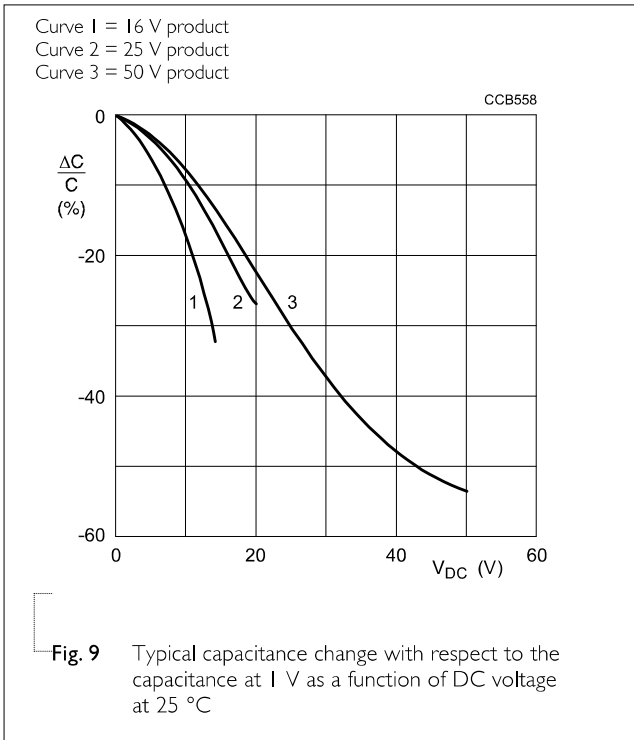
**Fig. 5** Typical capacitance change with respect to the capacitance at 1 V as a function of DC voltage



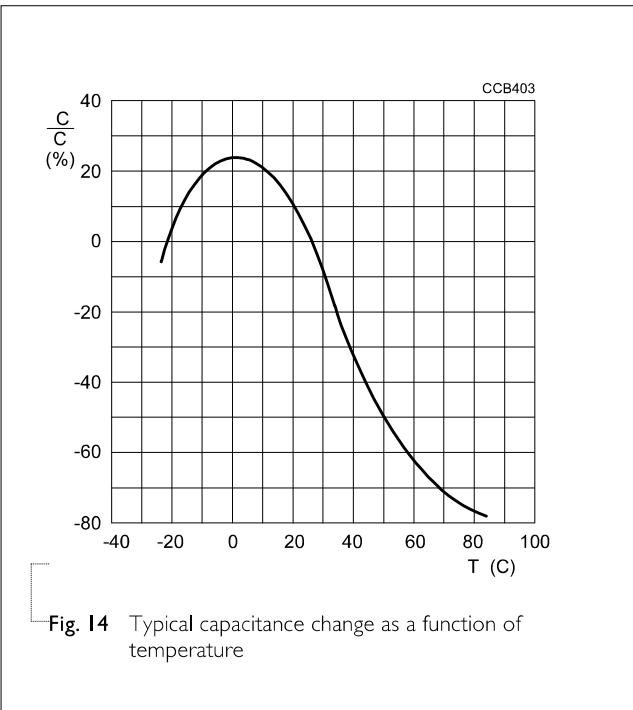
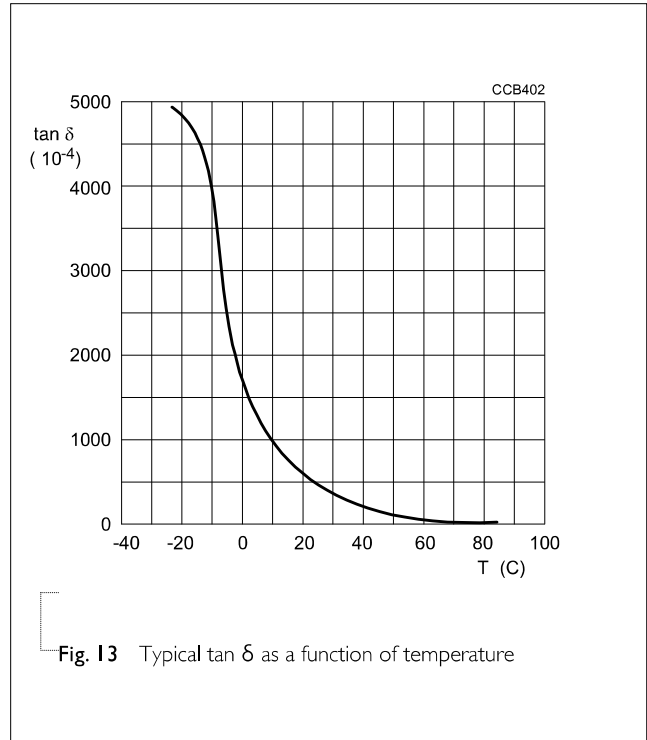
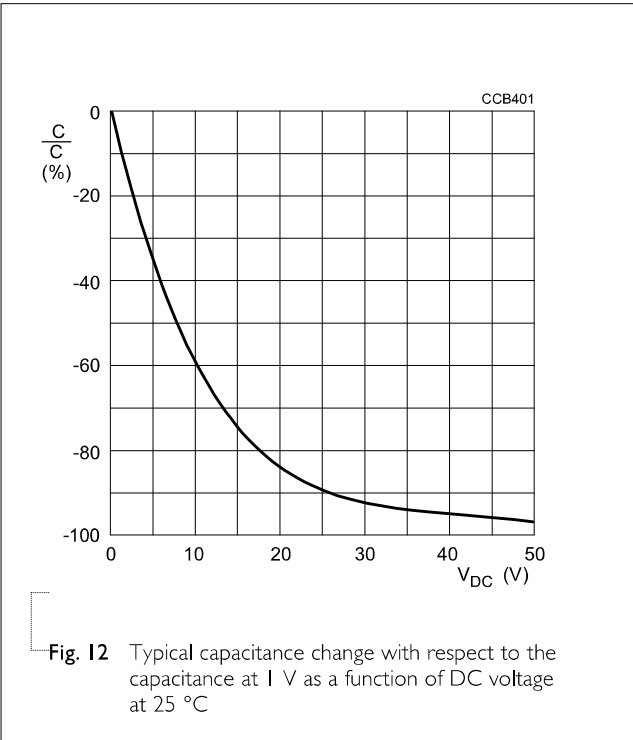
**X7R 0508 16 V**



**X7R 0612 16 V to 50 V**



**Y5V 0612 25 V**



**TESTS AND REQUIREMENTS**

**Table 7** 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 1: $f = 1 \text{ MHz}$ for $C \leq 1 \text{ nF}$ , measuring at voltage $1 V_{\text{rms}}$ at $20 \text{ }^\circ\text{C}$ $f = 1 \text{ KHz}$ for $C > 1 \text{ nF}$ , measuring at voltage $1 V_{\text{rms}}$ at $20 \text{ }^\circ\text{C}$ Class 2: $f = 1 \text{ KHz}$ for $C \leq 10 \text{ } \mu\text{F}$ , measuring at voltage $1 V_{\text{rms}}$ at $20 \text{ }^\circ\text{C}$ $f = 120 \text{ Hz}$ for $C > 10 \text{ } \mu\text{F}$ , measuring at voltage $0.5 V_{\text{rms}}$ at $20 \text{ }^\circ\text{C}$	Within specified tolerance
Dissipation Factor (D.F.)		4.5.2 Class 1: $f = 1 \text{ MHz}$ for $C \leq 1 \text{ nF}$ , measuring at voltage $1 V_{\text{rms}}$ at $20 \text{ }^\circ\text{C}$ $f = 1 \text{ KHz}$ for $C > 1 \text{ nF}$ , measuring at voltage $1 V_{\text{rms}}$ at $20 \text{ }^\circ\text{C}$ Class 2: $f = 1 \text{ KHz}$ for $C \leq 10 \text{ } \mu\text{F}$ , measuring at voltage $1 V_{\text{rms}}$ at $20 \text{ }^\circ\text{C}$ $f = 120 \text{ Hz}$ for $C > 10 \text{ } \mu\text{F}$ , measuring at voltage $0.5 V_{\text{rms}}$ at $20 \text{ }^\circ\text{C}$	In accordance with specification
Insulation Resistance		4.5.3 At $U_r$ (DC) for 1 minute	In accordance with specification

TEST	TEST METHOD	PROCEDURE	REQUIREMENTS									
Temperature Coefficient	4.6	Capacitance shall be measured by the steps shown in the following table.  The capacitance change should be measured after 5 min at each specified temperature stage.	Class I: $\Delta C/C$ : $\pm 30$ ppm Class2: X7R: $\Delta C/C$ : $\pm 15\%$ Y5V: $\Delta C/C$ : 22~-82%									
		<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th>Step</th> <th>Temperature(°C)</th> </tr> </thead> <tbody> <tr> <td>a</td> <td>25±2</td> </tr> <tr> <td>b</td> <td>Lower temperature±3°C</td> </tr> <tr> <td>c</td> <td>25±2</td> </tr> <tr> <td>d</td> <td>Upper Temperature±2°C</td> </tr> <tr> <td>e</td> <td>25±2</td> </tr> </tbody> </table> <p>(1) Class I Temperature Coefficient shall be calculated from the formula as below</p> $\text{Temp, Coefficient} = \frac{C2 - C1}{C1 \times \Delta T} \times 10^6 \text{ [ppm/°C]}$ <p>C1: Capacitance at step c C2: Capacitance at 125°C <math>\Delta T</math>: 100°C(=125°C-25°C)</p> <p>(2) Class II Capacitance Change shall be calculated from the formula as below</p> $\Delta C = \frac{C2 - C1}{C1} \times 100\%$ <p>C1: Capacitance at step c C2: Capacitance at step b or d</p>		Step	Temperature(°C)	a	25±2	b	Lower temperature±3°C	c	25±2	d
Step	Temperature(°C)											
a	25±2											
b	Lower temperature±3°C											
c	25±2											
d	Upper Temperature±2°C											
e	25±2											
Adhesion	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									

TEST	TEST METHOD	PROCEDURE	REQUIREMENTS
Bond Strength of Plating on End Face	IEC 60384-21/22	4.8 Mounting in accordance with IEC 60384-22 paragraph 4.3	No visible damage
		Conditions: bending 1 mm at a rate of 1 mm/s, radius jig 5 mm	<p><math>\Delta C/C</math> Class 1:</p> <p>NP0: within <math>\pm 1\%</math> or 0.5 pF, whichever is greater</p> <p>Class2:</p> <p>X5R/X7R/Y5V: <math>\pm 10\%</math></p>
Resistance to Soldering Heat	4.9	Precondition: 150 $\pm 0/-10$ °C for 1 hour, then keep for 24 $\pm 1$ hours at room temperature	Dissolution of the end face plating shall not exceed 25% of the length of the edge concerned
		<p>Preheating: for size <math>\leq 1206</math>: 120 °C to 150 °C for 1 minute</p> <p>Preheating: for size <math>&gt; 1206</math>: 100 °C to 120 °C for 1 minute and 170 °C to 200 °C for 1 minute</p> <p>Solder bath temperature: 260 <math>\pm 5</math> °C</p> <p>Dipping time: 10 <math>\pm 0.5</math> seconds</p> <p>Recovery time: 24 <math>\pm 2</math> hours</p>	
			<p><math>\Delta C/C</math> Class 1:</p> <p>NP0: within <math>\pm 0.5\%</math> or 0.5 pF, whichever is greater</p> <p>Class2:</p> <p>X5R/X7R: <math>\pm 10\%</math> Y5V: <math>\pm 20\%</math></p>
Solderability	4.10	Preheated the temperature of 80 °C to 140 °C and maintained for 30 seconds to 60 seconds.	The solder should cover over 95% of the critical area of each termination
		<p>Test conditions for lead containing solder alloy</p> <p>Temperature: 235 <math>\pm 5</math> °C</p> <p>Dipping time: 2 <math>\pm 0.2</math> seconds</p> <p>Depth of immersion: 10 mm</p> <p>Alloy Composition: 60/40 Sn/Pb</p> <p>Number of immersions: 1</p> <p>Test conditions for leadfree containing solder alloy</p> <p>Temperature: 245 <math>\pm 5</math> °C</p> <p>Dipping time: 3 <math>\pm 0.3</math> seconds</p> <p>Depth of immersion: 10 mm</p> <p>Alloy Composition: SAC305</p> <p>Number of immersions: 1</p>	

TEST	TEST METHOD	PROCEDURE	REQUIREMENTS
<b>Rapid Change of Temperature</b>	IEC 60384-21/22	<p>4.11</p> <p>Preconditioning; 150 +0/-10 °C for 1 hour, then keep for 24 ± 1 hours at room temperature</p> <p>5 cycles with following detail: 30 minutes at lower category temperature 30 minutes at upper category temperature</p> <p>Recovery time 24 ± 2 hours</p>	<p>No visual damage</p> <hr/> <p><math>\Delta C/C</math> Class 1: NP0: within ±1% or 1 pF, whichever is greater Class2: X5R/X7R: ±15% Y5V: ±20%</p> <hr/> <p>D.F. meet initial specified value <math>R_{ins}</math> meet initial specified value</p>
<b>Damp Heat with <math>U_r</math> Load</b>	4.13	<p>1. Preconditioning, class 2 only: 150 +0/-10 °C /1 hour, then keep for 24 ± 1 hour at room temp</p> <p>2. Initial measure: Spec: refer initial spec C, D, IR</p> <p>3. Damp heat test: 500 ± 12 hours at 40 ± 2 °C; 90 to 95% R.H. 1.0 <math>U_r</math> applied</p> <p>4. Recovery: Class 1: 6 to 24 hours Class 2: 24 ± 2 hours</p> <p>5. Final measure: C, D, IR</p> <p>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.</p>	<p>No visual damage after recovery</p> <hr/> <p><math>\Delta C/C</math> Class 1: NP0: within ±2% or 1 pF, whichever is greater Class2: X5R/X7R: ±15%; Y5V: ±30%</p> <p>D.F. Class 1: NP0: ≤ 2 × specified value Class2: X5R/X7R: ≤ 16V: ≤ 7%                   ≥ 25V: ≤ 5% Y5V: ≤ 15%</p> <p><math>R_{ins}</math> Class 1: NP0: ≥ 2,500 M<math>\Omega</math> or <math>R_{ins} \times C_r \geq 25s</math> whichever is less Class2: X5R/X7R/Y5V: ≥ 500 M<math>\Omega</math> or <math>R_{ins} \times C_r \geq 25s</math> whichever is less</p>

TEST	TEST METHOD	PROCEDURE	REQUIREMENTS
<b>Endurance</b>	IEC 60384-21/22 4.14	<p>1. Preconditioning, class 2 only: 150 +0/-10 °C /1 hour, then keep for 24 ±1 hour at room temp</p> <p>2. Initial measure: Spec: refer initial spec C, D, IR</p> <p>3. Endurance test: Temperature: NP0/X7R: 125 °C X5R/Y5V: 85 °C Specified stress voltage applied for 1,000 hours: Applied 2.0 × U<sub>r</sub> for general product.</p> <p>4. Recovery time: 24 ±2 hours</p> <p>5. Final measure: C, D, IR</p> <p>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.</p>	<p>No visual damage</p> <hr/> <p><b>&lt;General purpose series&gt;</b> ΔC/C <b>Class I:</b> NP0: within ±2% or 1 pF, whichever is greater <b>Class2:</b> X5R/X7R: ±15%; Y5V: ±30% D,F. <b>Class I:</b> NP0: ≤ 2 × specified value <b>Class2:</b> X5R/X7R: ≤ 16V: ≤ 7%                   ≥ 25V: ≤ 5% Y5V: ≤ 15% R<sub>ins</sub> <b>Class I:</b> NP0: ≥ 4,000 MΩ or R<sub>ins</sub> × C<sub>r</sub> ≥ 40s whichever is less <b>Class2:</b> X5R/X7R/Y5V: ≥ 1,000 MΩ or R<sub>ins</sub> × C<sub>r</sub> ≥ 50s whichever is less</p>
<b>Voltage Proof</b>	IEC 60384-1 4.6	<p>Specified stress voltage applied for 1 minute</p> <p>U<sub>r</sub> ≤ 100 V: series applied 2.5 U<sub>r</sub> 100 V &lt; U<sub>r</sub> ≤ 200 V series applied (1.5 U<sub>r</sub> + 100) 200 V &lt; U<sub>r</sub> ≤ 500 V series applied (1.3 U<sub>r</sub> + 100) U<sub>r</sub> &gt; 500 V: 1.3 U<sub>r</sub> I: 7.5 mA</p>	No breakdown or flashover



REVISION HISTORY

REVISION	DATE	CHANGE NOTIFICATION	DESCRIPTION
Version 5	Jun. 16, 2017	-	- X7R/06I2 product range updated
Version 4	Nov. 10, 2015	-	- Product range updated
Version 3	May 21, 2014	-	- Product range updated
Version 2	Jun. 17, 2013	-	- Product range updated
Version 1	Feb 05, 2010	-	- The statement of "Halogen Free" on the cover added
Version 0	Jun 22, 2009	-	- New datasheet for 4C-Array series with RoHS compliant - Replace from pdf files: 0508_16V to 50V_1, 06I2_16V to 50V_0, C-Array_NP0_50V_0508_7, C-Array_NP0_50V_06I2_7, C-Array_X7R_16V_25V_50V_06I2_6, C-Array_X7R_16V_0508_5, C-Array_Y5V_25V_0508_0, C-Array_Y5V_25V_06I2_5 - Define global part number - Description of "Halogen Free compliant" added - Test method and procedure updated