

# DATA SHEET

## SURFACE-MOUNT CERAMIC MULTILAYER CAPACITORS

C-Array

NP0/X7R/Y5V

16 V TO 50 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  
 X7R  
 Y5V

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**(5) RATED VOLTAGE**

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

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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.

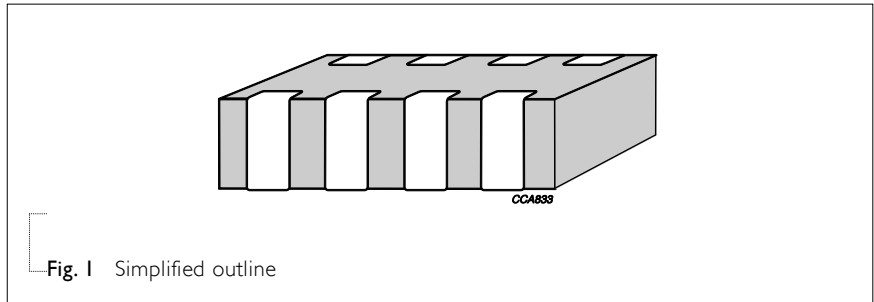


Fig. 1 Simplified outline

**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)	0.50	0.70
T <sub>max.</sub> (mm)	0.70	0.90
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**

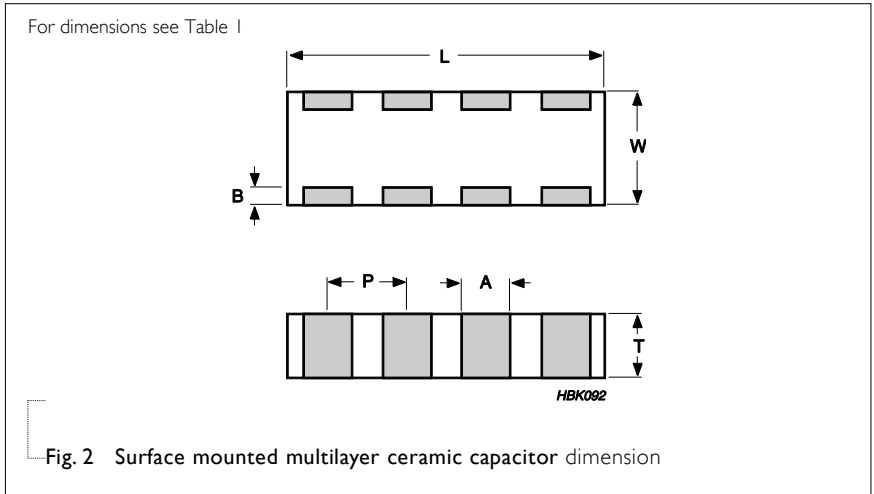


Fig. 2 Surface mounted multilayer ceramic capacitor dimension

CAPACITANCE RANGE & THICKNESS FOR 4C-ARRAY

Table 2 Temperature characteristic material from NP0

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

**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		
22 nF		
47 nF		0.6±0.1
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		Ø180 MM / 13 INCH	
				Paper		Paper	
0508	0.6 ±0.1 mm	8 mm	8 mm	4,000		20,000	
0612	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
	X7R 0508: 16 V, 0612: 16 V to 50 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 $16\text{ V} \leq 3.5\%$ , $25\text{ V} \leq 2.5\%$ , $50\text{ V} \leq 2.5\%$ $12\text{ nF} \sim 100\text{ nF}$ , $\text{Df} \leq 5\%$
	Y5V $0508 \leq 9\%$ , $0612 \leq 7\%$
Insulation resistance after 1 minute at $U_r$ (DC)	$R_{\text{ins}} \geq 10\text{ G}\Omega$ or $R_{\text{ins}} \times C_r \geq 500$ 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 $-55\text{ }^\circ\text{C}$ to $+125\text{ }^\circ\text{C}$
	X7R $-55\text{ }^\circ\text{C}$ to $+125\text{ }^\circ\text{C}$
	Y5V $-30\text{ }^\circ\text{C}$ to $+85\text{ }^\circ\text{C}$

**NP0 0508/0612 50 V**

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

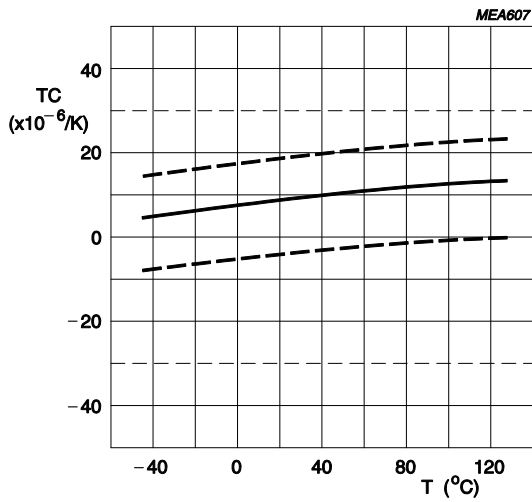


Fig. 3 Typical temperature coefficient as a function of temperature

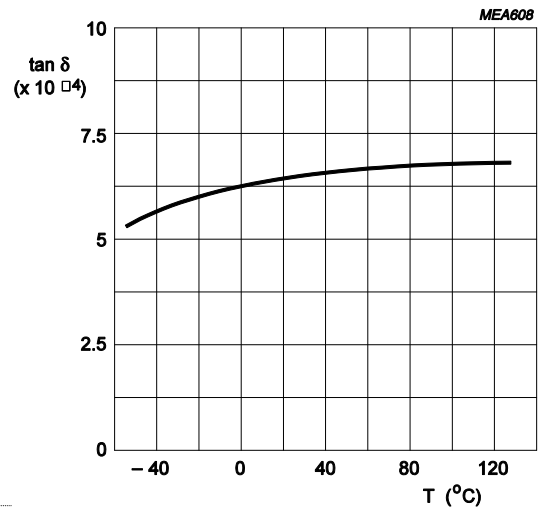


Fig. 4 Typical tan  $\delta$  as a function of temperature

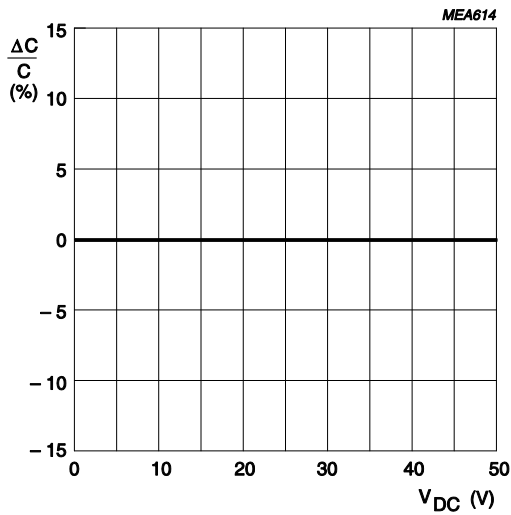
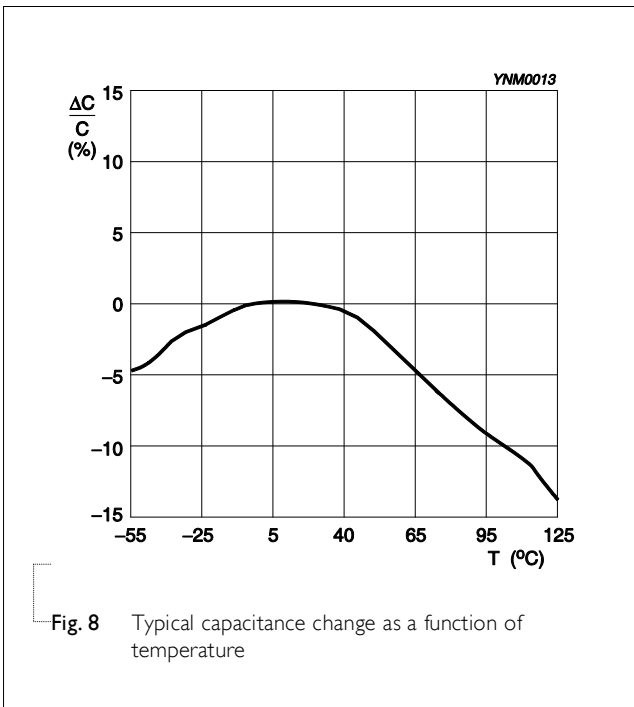
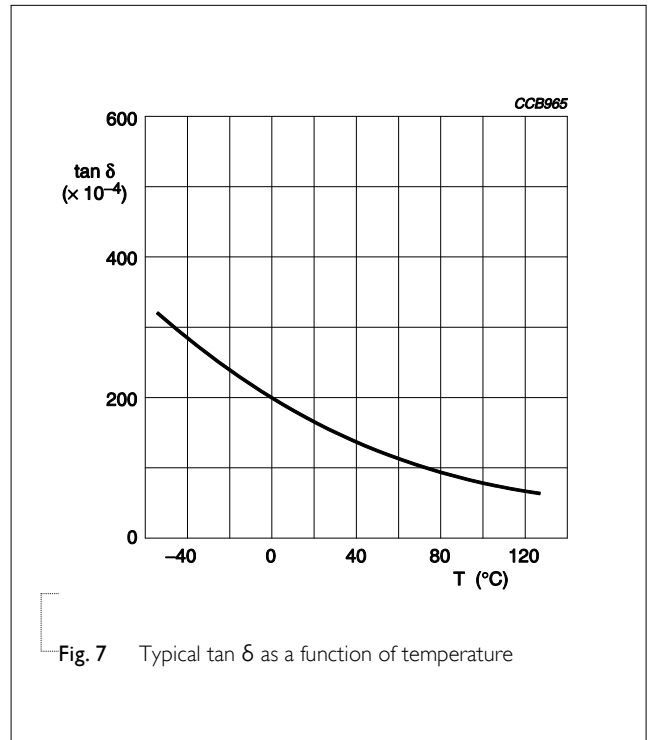
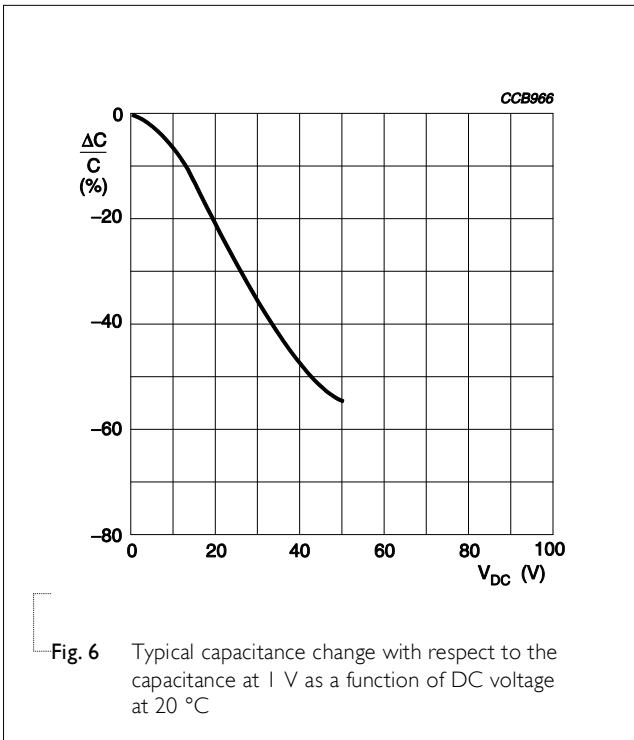


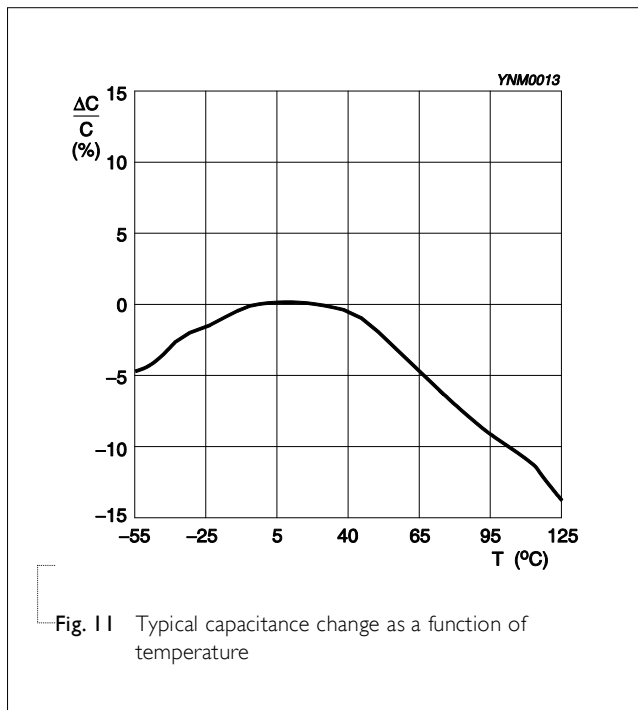
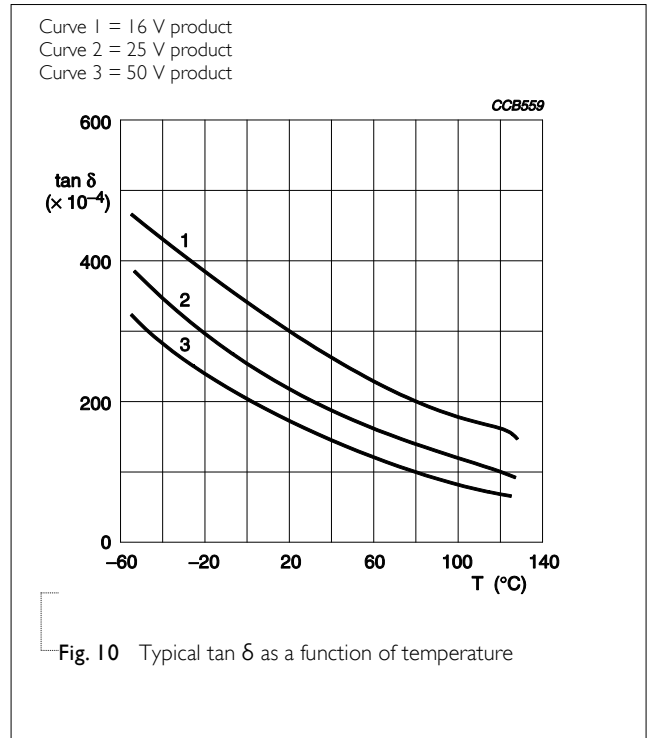
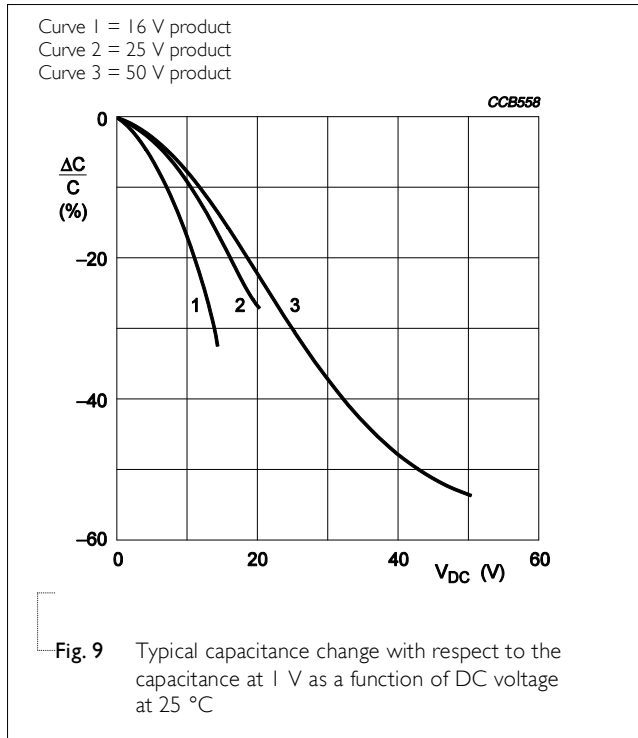
Fig. 5 Typical capacitance change with respect to the capacitance at 1 V as a function of DC voltage



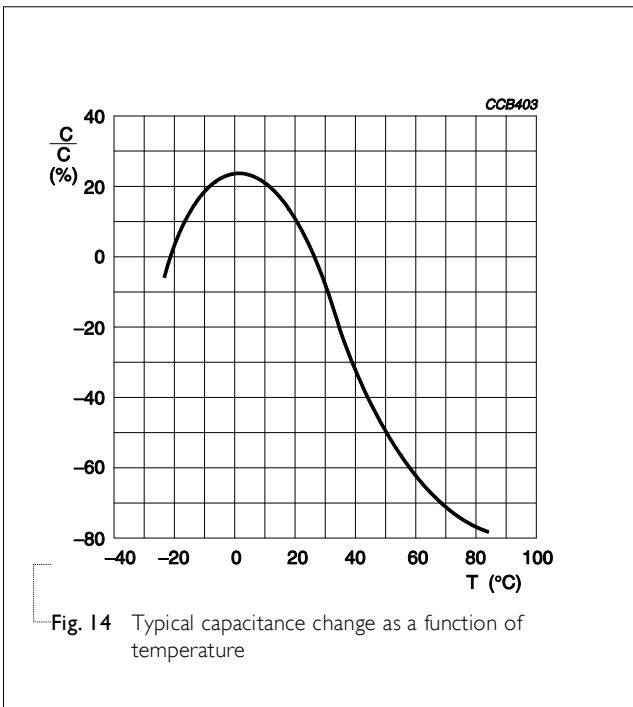
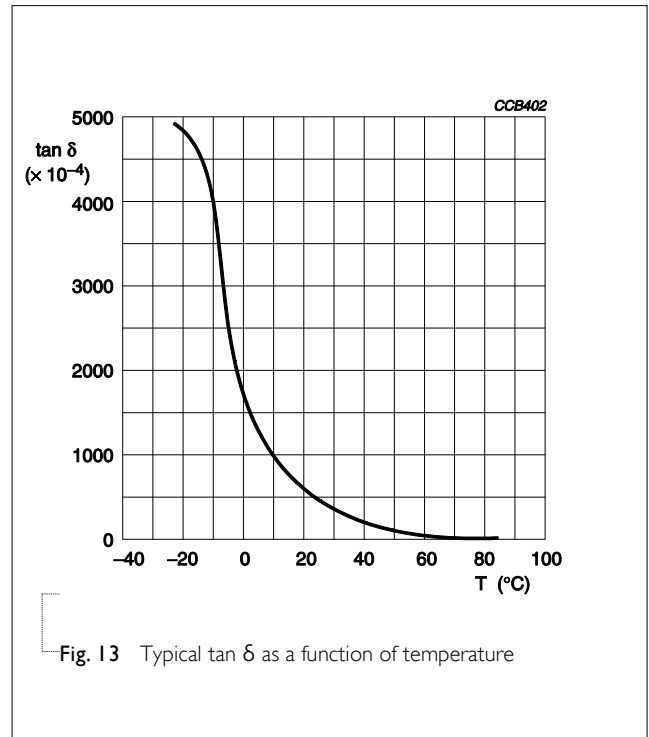
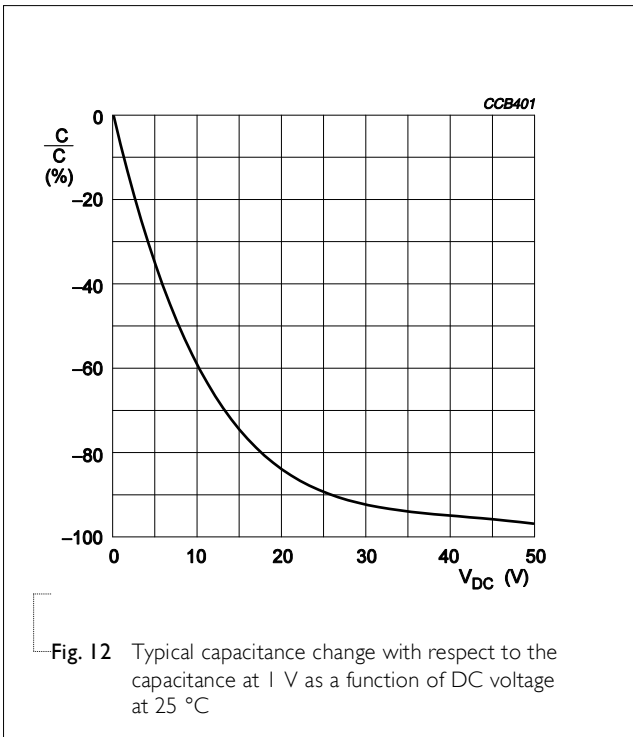
**X7R 0508 16 V**



**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.	<General purpose series> Class1: $\Delta C/C: \pm 30\text{ppm}$  Class2: X7R: $\Delta C/C: \pm 15\%$ Y5V: $\Delta C/C: 22\sim 82\%$  <High Capacitance series> Class2: X7R/X5R: $\Delta C/C: \pm 15\%$ Y5V: $\Delta C/C: 22\sim 82\%$									
		<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>		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											
		(1) Class I  Temperature Coefficient shall be calculated from the formula as below  $\text{Temp, Coefficient} = \frac{C2 - C1}{C1 \times \Delta T} \times 10^6 \text{ [ppm/°C]}$ C1: Capacitance at step c C2: Capacitance at 125°C $\Delta T: 100^\circ\text{C}(=125^\circ\text{C}-25^\circ\text{C})$										
		(2) Class II  Capacitance Change shall be calculated from the formula as below  $\Delta C = \frac{C2 - C1}{C1} \times 100\%$ C1: Capacitance at step c C2: Capacitance at step b or d										
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 ≥ 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 340 mm	<p>&lt;General purpose series&gt;</p> <p><math>\Delta C/C</math></p> <p>Class 1: NP0: within <math>\pm 1\%</math> or 0.5 pF, whichever is greater</p> <p>Class2: X5R/X7R/Y5V: <math>\pm 10\%</math></p> <p>&lt;High Capacitance series&gt;</p> <p><math>\Delta C/C</math></p> <p>Class2: X5R/X7R/Y5V: <math>\pm 10\%</math></p>
Resistance to Soldering Heat	4.9	Precondition: 150 $\pm 10$ °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
		Preheating: for size $\leq 1206$ : 120 °C to 150 °C for 1 minute Preheating: for size $> 1206$ : 100 °C to 120 °C for 1 minute and 170 °C to 200 °C for 1 minute Solder bath temperature: 260 $\pm 5$ °C Dipping time: 10 $\pm 0.5$ seconds Recovery time: 24 $\pm 2$ hours	
			<p>&lt;General purpose series&gt;</p> <p><math>\Delta C/C</math></p> <p>Class 1: NP0: within <math>\pm 0.5\%</math> or 0.5 pF, whichever is greater</p> <p>Class2: X5R/X7R: <math>\pm 10\%</math> Y5V: <math>\pm 20\%</math></p> <p>&lt;High Capacitance series&gt;</p> <p><math>\Delta C/C</math></p> <p>Class2: 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
		Test conditions for lead containing solder alloy Temperature: 235 $\pm 5$ °C Dipping time: 2 $\pm 0.2$ seconds Depth of immersion: 10 mm Alloy Composition: 60/40 Sn/Pb Number of immersions: 1  Test conditions for leadfree containing solder alloy Temperature: 245 $\pm 5$ °C Dipping time: 3 $\pm 0.3$ seconds Depth of immersion: 10 mm Alloy Composition: SAC305 Number of immersions: 1	

D.F. within initial specified value  
 R<sub>ins</sub> within initial specified value

TEST	TEST METHOD	PROCEDURE	REQUIREMENTS
Rapid Change of Temperature	IEC 60384-21/22 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  <General purpose series> $\Delta C/C$ Class 1: NP0: within ±1% or 1 pF, whichever is greater Class2: X5R/X7R: ±15% Y5V: ±20%  <High Capacitance series> $\Delta C/C$ Class2: X5R/X7R: ±15% Y5V: ±20%  D.F. meet initial specified value R <sub>ins</sub> meet initial specified value
Damp Heat with U <sub>r</sub> Load	4.13	<ol style="list-style-type: none"> <li>1. Preconditioning class 2 only: 150 +0/-10 °C /1 hour, then keep for 24 ±1 hour at room temp</li> <li>2. Initial measure: Spec: refer initial spec C, D, IR</li> <li>3. Damp heat test: 500 ±12 hours at 40 ±2 °C; 90 to 95% R.H. 1.0 U<sub>r</sub> applied</li> <li>4. Recovery: Class 1: 6 to 24 hours Class 2: 24 ±2 hours</li> <li>5. Final measure: C, D, IR</li> </ol> <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>	No visual damage after recovery  <General purpose series> $\Delta C/C$ Class 1: NP0: within ±2% or 1 pF, whichever is greater Class2: X5R/X7R: ±15%; Y5V: ±30% D.F. Class 1: NP0: ≤ 2 × specified value Class2: X5R/X7R: ≤ 16V: ≤ 7% ≥ 25V: ≤ 5% Y5V: ≤ 15% R <sub>ins</sub> Class 1: NP0: ≥ 2,500 MΩ or R <sub>ins</sub> × C <sub>r</sub> ≥ 25s whichever is less Class2: X5R/X7R/Y5V: ≥ 500 MΩ or R <sub>ins</sub> × C <sub>r</sub> ≥ 25s whichever is less  <High Capacitance series> $\Delta C/C$ Class2: X5R/X7R: ±20%; Y5V: ±30% D.F. Class2: 2 × initial value max R <sub>ins</sub> Class2: 500 MΩ or R <sub>ins</sub> × C <sub>r</sub> ≥ 25s, whichever is less

TEST	TEST METHOD	PROCEDURE	REQUIREMENTS
Endurance	IEC 60384-21/22 4.14	1. Preconditioning, class 2 only: 150 +0/-10 °C /1 hour, then keep for 24 ±1 hour at room temp 2. Initial measure: Spec: refer initial spec C, D, IR 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. Applied 1.5 × U <sub>r</sub> for high cap. product. High voltage series follows with below stress condition: Applied 1.3 × U <sub>r</sub> for 500V series Applied 1.2 × U <sub>r</sub> for 1KV, 2KV, 3KV series 4. Recovery time: 24 ±2 hours 5. Final measure: C, D, IR  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.	No visual damage  <General purpose series> ΔC/C Class1: NP0: within ±2% or 1 pF, whichever is greater Class2: X5R/X7R: ±15%; Y5V: ±30% D.F. Class1: NP0: ≤ 2 × specified value Class2: X5R/X7R: ≤ 16V: ≤ 7% ≥ 25V: ≤ 5% Y5V: ≤ 15% R <sub>ins</sub> Class1: NP0: ≥ 4,000 MΩ or R <sub>ins</sub> × C <sub>r</sub> ≥ 40s whichever is less Class2: X5R/X7R/Y5V: ≥ 1,000 MΩ or R <sub>ins</sub> × C <sub>r</sub> ≥ 50s whichever is less  <High Capacitance series> ΔC/C Class 2: X5R/X7R: ±20%; Y5V: ±30% D.F. Class 2: 2 × initial value max R <sub>ins</sub> Class 2: 1,000 MΩ or R <sub>ins</sub> × C <sub>r</sub> ≥ 50s, whichever is less
Voltage Proof	IEC 60384-1 4.6	Specified stress voltage applied for 1 minute U <sub>r</sub> ≤ 100 V: series applied 2.5 U <sub>r</sub> 100 V < U <sub>r</sub> ≤ 200 V series applied (1.5 U <sub>r</sub> + 100) 200 V < U <sub>r</sub> ≤ 500 V series applied (1.3 U <sub>r</sub> + 100) U <sub>r</sub> > 500 V: 1.3 U <sub>r</sub> I: 7.5 mA	No breakdown or flashover



**REVISION HISTORY**

REVISION	DATE	CHANGE NOTIFICATION	DESCRIPTION
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, 0612_16V to 50V_0, C-Array_NP0_50V_0508_7, C-Array_NP0_50V_0612_7, C-Array_X7R_16V_25V_50V_0612_6, C-Array_X7R_16V_0508_5, C-Array_Y5V_25V_0508_0, C-Array_Y5V_25V_0612_5 - Define global part number - Description of "Halogen Free compliant" added - Test method and procedure updated