

# DATA SHEET

## SURFACE-MOUNT CERAMIC MULTILAYER CAPACITORS

01005

NPO/X5R/X7R

4 V TO 25 V

0.5 pF to 470 nF

RoHS compliant & Halogen Free



SCOPE

This specification describes 01005 NP0/X5R series chip capacitors with lead-free terminations.

APPLICATIONS

- Mobile
- Module

FEATURES

- Supplied in tape on reel
- Nickel-barrier end termination
- 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.

**YAGEO BRAND ordering code**

**GLOBAL PART NUMBER (PREFERRED)**

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

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**(1) SIZE – INCH BASED (METRIC)**

0100(0402)

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**(2) TOLERANCE**

- B = ±0.1pF
- C = ±0.25pF
- D = ±0.5pF
- J = ±5%
- K = ±10%
- M = ±20%

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**(3) PACKING STYLE**

R = Paper/PE taping reel; Reel 7 inch

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**(4) TC MATERIAL**

- NPO
- X5R
- X7R

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**(5) RATED VOLTAGE**

- 4 = 4 V
- 5 = 6.3V
- 6 = 10 V
- 7 = 16 V
- 8 = 25 V

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**(6) PROCESS**

- N = NPO
- B = Class 2 MLCC

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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. A cross section of the structure is shown in Fig.1.

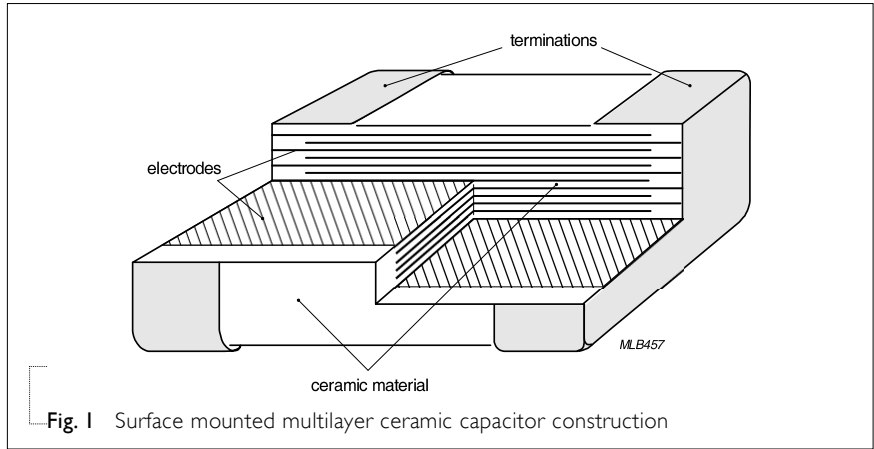


Fig. 1 Surface mounted multilayer ceramic capacitor construction

**DIMENSION**

Table I For outlines see fig. 2

TYPE	L <sub>1</sub> (mm)	W (mm)	T (mm)	L <sub>2</sub> / L <sub>3</sub> (mm)		L <sub>4</sub> (mm)
				min.	max.	min.
01005	0.4 ±0.02	0.2 ±0.02	0.2 ±0.02	0.07	0.14	0.13

**OUTLINES**

For dimension see Table I

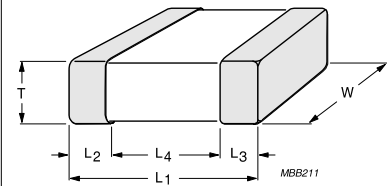


Fig. 2 Surface mounted multilayer ceramic capacitor dimension

**CAPACITANCE RANGE & THICKNESS**

Table 2 01005 Sizes

CAP.		NP0	CAP.			X5R	CAP.			X7R	
		16 V / 25 V				4V	6.3V	10V			
									6.3V / 10V	16V	
0.5 pF	0.2±0.02		100 pF	0.2±0.02	0.2±0.02	0.2±0.02		100 pF	0.2±0.02	0.2±0.02	
0.6 pF	0.2±0.02		150 pF	0.2±0.02	0.2±0.02	0.2±0.02		150 pF	0.2±0.02	0.2±0.02	
0.7 pF	0.2±0.02		220 pF	0.2±0.02	0.2±0.02	0.2±0.02		220 pF	0.2±0.02	0.2±0.02	
0.75 pF	0.2±0.02		330 pF	0.2±0.02	0.2±0.02	0.2±0.02		330 pF	0.2±0.02	0.2±0.02	
0.8 pF	0.2±0.02		470 pF	0.2±0.02	0.2±0.02	0.2±0.02		470 pF	0.2±0.02	0.2±0.02	
0.9 pF	0.2±0.02		680 pF	0.2±0.02	0.2±0.02	0.2±0.02		680 pF	0.2±0.02	0.2±0.02	
1.0 pF	0.2±0.02		1 000 pF	0.2±0.02	0.2±0.02	0.2±0.02		1 000 pF	0.2±0.02	0.2±0.02	
1.2 pF	0.2±0.02		2.2 nF	0.2±0.02	0.2±0.02	0.2±0.02		2.2 nF			
1.5 pF	0.2±0.02		4.7 nF	0.2±0.02	0.2±0.02	0.2±0.02		4.7 nF			
1.8 pF	0.2±0.02		10 nF	0.2±0.02	0.2±0.02	0.2±0.02		10 nF			
2.2 pF	0.2±0.02		22nF	0.2±0.02	0.2±0.02			22nF			
2.7 pF	0.2±0.02		47 nF	0.2±0.02	0.2±0.02			47 nF			
3.3 pF	0.2±0.02		100 nF	0.2±0.02	0.2±0.02	0.2±0.02		100 nF			
3.9 pF	0.2±0.02		220 nF	0.2±0.02	0.2±0.02			220 nF			
4.7 pF	0.2±0.02		470 nF	0.2±0.02	0.2±0.02						
5.6 pF	0.2±0.02										
6.8 pF	0.2±0.02										
8.2 pF	0.2±0.02										
10 pF	0.2±0.02										
12 pF	0.2±0.02										
15 pF	0.2±0.02										
18 pF	0.2±0.02										
22 pF	0.2±0.02										
27 pF	0.2±0.02										
33 pF	0.2±0.02										
39 pF	0.2±0.02										
47 pF	0.2±0.02										
56 pF	0.2±0.02										
68 pF	0.2±0.02										
82 pF	0.2±0.02										
100 pF	0.2±0.02										
Tape width		8 mm	Tape width			8 mm			Tape width		8 mm

THICKNESS CLASSES AND PACKING QUANTITY

Table 3

SIZE CODE	THICKNESS CLASSIFICATION	TAPE WIDTH QUANTITY PER REEL	Ø180 MM / 7 INCH		Ø330 MM / 13 INCH		QUANTITY PER BULK CASE
			Paper/PE	Blister	Paper/	Blister	
01005	0.2 ±0.02 mm	8 mm	20,000	---	---	---	---

ELECTRICAL CHARACTERISTICS

**NP0/X5R DIELECTRIC CAPACITORS; NISN TERMINATIONS**

Unless otherwise specified, all test and measurements shall be made under standard atmospheric conditions for testing as given in 5.3 of IEC 60068-1:

- Temperature: 15 °C to 35 °C
- Relative humidity: 25% to 75%
- Air pressure: 86 kPa to 106 kPa

Before the measurements are made, the capacitor shall be stored at the measuring temperature for a time sufficient to allow the entire capacitor to reach this temperature.

The period as prescribed for recovery at the end of a test is normally sufficient for this purpose.

Table 4

DESCRIPTION	VALUE
Capacitance range	0.5 pF to 470 nF
Capacitance tolerance	
C < 10 pF	±0.1pF, ±0.25pF, ±0.5pF
NP0      C ≥ 10 pF	±5%, ±10%
X5R / X7R	±10%, ±20%
Dissipation factor (D.F.)	
NP0      C < 30 pF	≤ 1 / ( 400 + 20C )
C ≥ 30 pF	≤ 0.1 %
X5R / X7R	≤ 10 %
Insulation resistance after 1 minute at U <sub>r</sub> (DC)	R <sub>ins</sub> ≥ 10 GΩ or R <sub>ins</sub> × C ≥ 500Ω · F whichever is less X5R/X7R > 10nF: R <sub>ins</sub> × C ≥ 50Ω · F
Maximum capacitance change as a function of temperature (temperature characteristic/coefficient):	
NP0	±30 ppm/°C
X5R / X7R	±15%
Operating temperature range:	
NP0	-55 °C to +125 °C
X5R	-55 °C to +85 °C
X7R	-55 °C to +125 °C

**SOLDERING RECOMMENDATION**

Table 5

SOLDERING METHOD	SIZE
	<b>01005</b>
Reflow	Reflow only
Reflow/Wave	---

**TESTS AND REQUIREMENTS**

Table 6 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 × 10 magnification	In accordance with specification
Capacitance	4.5.1	<p>Class 1:                      f = 1 MHz for C ≤ 1 nF, measuring at voltage   V<sub>rms</sub> at 20 °C                      f = 1 KHz for C &gt; 1 nF, measuring at voltage   V<sub>rms</sub> at 20 °C</p> <p>Class 2:                      C ≤ 1 nF                      f = 1 KHz, measuring at voltage   V<sub>rms</sub> at 20 °C</p> <p>C &gt; 1 nF                      f = 1 KHz, rated voltage ≤ 6.3 V, measuring at voltage 0.5 V<sub>rms</sub> at 20 °C                      f = 1 KHz, rated voltage &gt; 10 V, measuring at voltage   V<sub>rms</sub> at 20 °C</p>	Within specified tolerance
Dissipation Factor (D.F.)	4.5.2	<p>Class 1:                      f = 1 MHz for C ≤ 1 nF, measuring at voltage   V<sub>rms</sub> at 20 °C                      f = 1 KHz for C &gt; 1 nF, measuring at voltage   V<sub>rms</sub> at 20 °C</p> <p>Class 2:                      C ≤ 1 nF                      f = 1 KHz, measuring at voltage   V<sub>rms</sub> at 20 °C</p> <p>C &gt; 1 nF                      f = 1 KHz, rated voltage ≤ 6.3 V, measuring at voltage 0.5 V<sub>rms</sub> at 20 °C                      f = 1 KHz, rated voltage &gt; 10 V, measuring at voltage   V<sub>rms</sub> at 20 °C</p>	In accordance with specification
Insulation Resistance	4.5.3	At Ur (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.	$\Delta C/C$ Class I (NP0): $\pm 30\text{ppm}$  Class 2: (X7R/X5R): $\pm 15\%$  In case of applying voltage, the capacitance change should be measured after 1 more min. with applying voltage in equilibration of each temp. stage.  CC0100MRX5R4(5)BB104(224): $0.2V \pm 0.1V_{rms}$									
		<table border="1"> <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  <math display="block">\text{Temp. Coefficient} = \frac{C2 - C1}{C1 \times \Delta T} \times 10^6 \text{ [ppm/°C]}</math>                     C1: Capacitance at step c                      C2: Capacitance at 125°C  <math>\Delta T: 100^\circ\text{C}(=125^\circ\text{C}-25^\circ\text{C})</math>                      Measuring Voltage: 0.5 to 5 Vrms</p> <p>(2) Class II Capacitance Change shall be calculated from the formula as below  <math display="block">\Delta C = \frac{C2 - C1}{C1} \times 100\%</math>                     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	IEC 60384-21/22	4.7 A force applied for 10 seconds to the line joining the terminations and in a plane parallel to the substrate	Force size 01005 : 1N									
Bending Strength		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 5 mm	No visible damage  <hr/> $\Delta C/C$ Class I (NP0): within $\pm 1\%$ or 0.5 pF, whichever is greater  Class2 (X5R/X7R): $\pm 10\%$									

TEST	TEST METHOD	PROCEDURE	REQUIREMENTS
Resistance to Soldering Heat	4.9	<p>Precondition: 150 +0/-10 °C for 1 hour, then keep for 24 ±1 hours at room temperature</p> <p>Preheating: 120 °C to 150 °C for 1 minute and 170 °C to 200 °C for 1 minute.</p> <p>Solder bath temperature: 260 ±5 °C</p> <p>Dipping time: 10 ±0.5 seconds</p> <p>Recovery time: 24 ±2 hours</p>	<p>Dissolution of the end face plating shall not exceed 25% of the length of the edge concerned</p> <hr/> <p><math>\Delta C/C</math></p> <p>Class I (NP0): within ±0.5% or 0.5 pF, whichever is greater</p> <p>Class2 (X5R/X7R): ±10%</p> <hr/> <p>D.F. within initial specified value</p> <p><math>R_{ins}</math> within initial specified value</p>
Solderability	4.10	<p>Preheated the temperature of 80 °C to 140 °C and maintained for 30 seconds to 60 seconds.</p> <p>Test conditions for leadfree containing solder alloy</p> <p>Temperature: 245 ±5 °C</p> <p>Dipping time: 3 ±0.3 seconds</p> <p>Depth of immersion: 10 mm</p>	<p>The solder should cover over 95% of the critical area of each termination</p>
Rapid Change of Temperature	IEC 60384-21/22 4.11	<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></p> <p>Class I (NP0): within ±2.5% or 0.25 pF, whichever is greater</p> <p>Class2 (X5R/X7R): ±15%</p> <hr/> <p>D.F. meet initial specified value</p> <p><math>R_{ins}</math> meet initial specified value</p>



TEST	TEST METHOD	PROCEDURE	REQUIREMENTS
Damp Heat	with Ur load	4.13 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. Damp heat test: 500 ± 12 hours at 40 ± 2 °C; 90 to 95% R.H; 1.0 Ur applied. 4. Recovery: Class 1: 6 to 24 hours Class 2: 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 after recovery
			<p><b>Class 1 (NP0):</b>  <math>\Delta C/C</math>                      within ±7.5% or 0.75 pF, whichever is greater                      D.F.  <math>\leq 2 \times</math> specified value                      I.R.  <math>\geq 2,500 M\Omega</math> or <math>R_{ins} \times Cr \geq 25\Omega \cdot F</math> whichever                      is less</p> <p><b>Class2 (X5R/X7R):</b>  <math>C \leq 1nF</math>  <math>\Delta C/C</math>  <math>\pm 15\%</math>                      D.F.  <math>\leq 10\%</math>                      I.R.  <math>\geq 500 M\Omega</math></p> <p><math>10nF \geq C &gt; 1nF</math>  <math>\Delta C/C</math>  <math>\pm 20\%</math>                      D.F.  <math>\leq 10\%</math>                      I.R.  <math>\geq 500 M\Omega</math></p> <p><math>C &gt; 10nF</math>  <math>\Delta C/C</math>  <math>\pm 25\%</math>                      D.F.  <math>\leq 20\%</math>                      I.R.  <math>R_{ins} \times Cr \geq 5\Omega \cdot F</math></p>

TEST	TEST METHOD	PROCEDURE	REQUIREMENTS
<b>Endurance</b>	IEC 60384-21/22 4.14	<ol style="list-style-type: none"> <li>Preconditioning, class 2 only: 150 +0/-10 °C /1 hour, then keep for 24 ±1 hour at room temp</li> <li>Initial measure: Spec: refer initial spec C, D, IR</li> <li>Endurance test: Temperature: NP0: 125 °C Specified stress voltage applied for 1,000 hours: Applied 2.0 × U<sub>r</sub> for general product Temperature: X5R: 85°C, X7R: 125°C Specified stress voltage applied for 1,000 hours: Applied 1.5 × U<sub>r</sub> for general product</li> <li>Recovery time: 24 ±2 hours</li> <li>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>	<p>No visual damage</p> <hr/> <p><b>Class 1 (NP0):</b>  <math>\Delta C/C</math>                      within ±3% or 0.3 pF, whichever is greater                      D.F.  <math>\leq 2 \times</math> specified value                      I.R.  <math>\geq 4,000 \text{ M}\Omega</math> or <math>R_{\text{ins}} \times Cr \geq 40\Omega \cdot F</math> whichever is less</p> <p><b>Class2 (X5R/X7R):</b>  <math>C \leq 1\text{nF}</math>  <math>\Delta C/C</math>  <math>\pm 15\%</math>                      D.F.  <math>\leq 10\%</math>                      I.R.  <math>\geq 1G\Omega</math></p> <p><math>10\text{nF} \geq C &gt; 1\text{nF}</math>  <math>\Delta C/C</math>  <math>\pm 15\%</math>                      D.F.  <math>\leq 10\%</math>                      I.R.  <math>\geq 1G\Omega</math></p> <p><math>C &gt; 10\text{nF}</math>  <math>\Delta C/C</math>  <math>\pm 25\%</math>                      D.F.  <math>\leq 20\%</math>                      I.R.  <math>R_{\text{ins}} \times Cr \geq 10\Omega \cdot F</math></p>
<b>Voltage Proof</b>	IEC 60384-1 4.5.4	<p>Specified stress voltage applied for 1~5 seconds  <math>U_r \leq 100 \text{ V}</math>: series applied 2.5 U<sub>r</sub>                      Charge/Discharge current is less than 50 mA</p>	No breakdown or flashover

REVISION HISTORY

REVISION	DATE	CHANGE NOTIFICATION	DESCRIPTION
Version 10	May 5, 2017	-	- Rated voltage of NPO series extend to 25 V - Add X5R, 470nF, 4V to 6.3V and 100nF, 10V
Version 9	Jan. 17, 2017	-	- Test condition updated
Version 8	Jan. 12, 2016	-	- Capacitance range & thickness update
Version 7	Oct. 31, 2015	-	- Capacitance range & thickness update
Version 6	Jun. 29, 2015	-	- Test procedures and requirements
Version 5	Jun. 06, 2013	-	- Test procedures and requirements
Version 4	Mar. 27, 2013	-	- Change Tolerance
Version 3	Jan. 15, 2013	-	- Change Range
Version 2	Oct. 23, 2012	-	- Change Range
Version 1	July 03, 2012	-	- Change Range
Version 0	Apr 16, 2012	-	- New