Innovative Service Around the Globe YAGEO

DATA SHEET

SURFACE-MOUNT CERAMIC MULTILAYER CAPACITORS

High-voltage SC type: NP0/X7R

X1/Y2 & X2

10pF to 56nF

Product Specification – April 14, 2025 V.1

YAGEO

SCOPE

This specification describes safety certification NP0/X7R series chip capacitors with lead-free terminations.

APPLICATIONS

- PCs, Notebook
- Networking
- Power supplies

FEATURES

- Supplied in tape on reel
- Nickel-barrier end termination
- RoHS compliant
- Halogen Free compliant

MARKING

- SC: Safety Cap
- ST: Safety Cap with Soft-Termination

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 codes

GLOBAL PART NUMBER (PREFERRED)

XX	XXXX	X	X	XXX	X	B	X	XXX
(1)	(2)	(3)	(4)	(5)	(6)		(7)	(8)

(1) SERIES

SC : Safety Capacitor

ST : Safety Capacitor with Soft-Termination

(2) SIZE – INCH BASED (METRIC)

1808 (4520)

1812(4532)

2211 (5728)

2220 (5750)

(3) TOLERANCE

J = ± 5%

K = ± 10%

M = ± 20%

(4) PACKING STYLE

K = Blister taping reel; Reel 7 inch

(5) TC MATERIAL

NPO

X7R

(6) IMPULSE VOLTAGE

W = X1/Y2 Series for TUV/UL

T = X2 Series for TUV/UL

(7) PROCESS

N = NP0

B = Class 2 product

(8) CAPACITANCE VALUE

2 significant digits+number of zeros

The 3rd digit signifies the multiplying factor, and letter R is decimal point

Example: 121 = 12 x 10^1 = 120 pF

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.

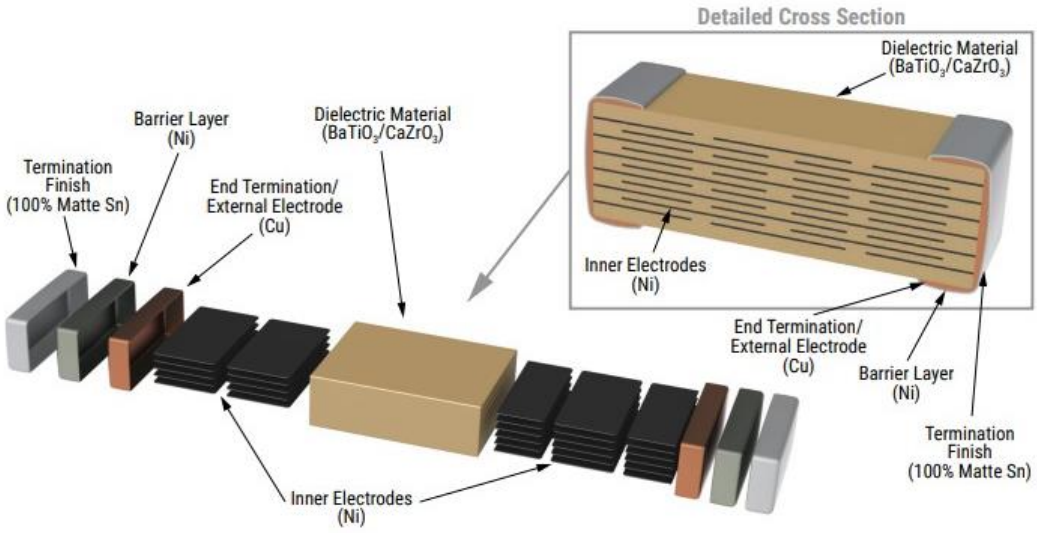

Fig. 1 Surface mounted multilayer ceramic capacitor construction

DIMENSION

Table 1 For outlines see fig. 2

TYPE	L1 (MM)	W (MM)	T (MM)	L2 / L3(MM)		L4(MM)	DIMENSION
				MIN.	MAX.	MIN.	CODE
1808	4.5+0.6/-0.3	2.0 ±0.30	1.25 ±0.20	0.25	0.40	4.0	HA
	4.5+0.6/-0.3	2.0 ±0.30	1.6 ±0.20	0.25	0.40	4.0	HC
	4.5+0.6/-0.3	2.0 ±0.30	2.0 ±0.20	0.25	0.40	4.0	HD
	4.5+0.9/-0.3	2.0 ±0.40	1.25 ±0.20	0.25	0.40	4.0	HE
	4.5+0.9/-0.3	2.0 ±0.40	1.6 ±0.20	0.25	0.40	4.0	HG
	4.5+0.9/-0.3	2.0 ±0.40	2.0 ±0.20	0.25	0.40	4.0	HI
1812	4.5+0.6/-0.3	3.2 ±0.30	1.25 ±0.20	0.25	0.75	4.0	IA
	4.5+0.6/-0.3	3.2 ±0.30	1.6 ±0.20	0.25	0.75	4.0	IB
	4.5+0.6/-0.3	3.2 ±0.30	2.0 ±0.20	0.25	0.75	4.0	IC
	4.5+0.9/-0.3	3.2 ±0.40	1.25 ±0.20	0.25	0.75	4.0	ID
	4.5+0.9/-0.3	3.2 ±0.40	1.6 ±0.20	0.25	0.75	4.0	IE
	4.5+0.9/-0.3	3.2 ±0.40	2.0 ±0.20	0.25	0.75	4.0	IF
2211	5.7 ±0.40	2.8 ±0.30	1.6 ±0.20	0.3	0.75	4.0	GA
	5.7 ±0.40	2.8 ±0.30	2.0 ±0.20	0.3	0.75	4.0	GB
	5.7 ±0.40	2.8 ±0.30	2.5 ±0.30	0.3	0.75	4.0	GC
	5.7 ±0.40	2.8 ±0.30	2.8 ±0.30	0.3	0.75	4.0	GD
	5.7 ±0.50	2.8 ±0.40	1.6 ±0.20	0.3	0.75	4.0	GE
	5.7 ±0.50	2.8 ±0.40	2.0 ±0.20	0.3	0.75	4.0	GF
	5.7 ±0.50	2.8 ±0.40	2.5 ±0.30	0.3	0.75	4.0	GG
	5.7 ±0.50	2.8 ±0.40	2.8 ±0.30	0.3	0.75	4.0	GH
2220	5.7 ±0.40	5.0 ±0.40	2.0 ±0.20	0.3	0.75	4.0	KB
	5.7 ±0.40	5.0 ±0.40	2.5 ±0.30	0.3	0.75	4.0	KC
	5.7 ±0.40	5.0 ±0.40	2.8 ±0.30	0.3	0.75	4.0	KD
	5.7 ±0.50	5.0 ±0.40	2.0 ±0.20	0.3	0.75	4.0	KF
	5.7 ±0.50	5.0 ±0.40	2.5 ±0.30	0.3	0.75	4.0	KG
	5.7 ±0.50	5.0 ±0.40	2.8 ±0.30	0.3	0.75	4.0	KH

OUTLINES

For dimension see Table 1

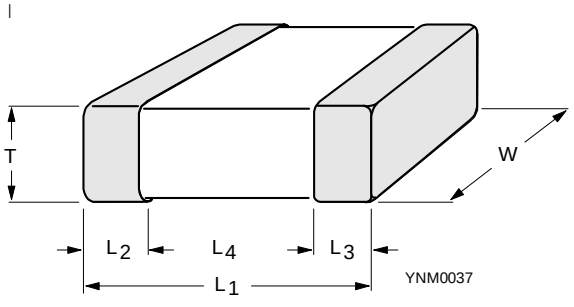

Fig. 2 Surface mounted multilayer ceramic capacitor dimension

CAPACITANCE RANGE & THICKNESS FOR NP0 X1/Y2

Table 2 Sizes from 1808

CAP.	SC 1808, NPO		ST 1808, NPO	
	X1/Y2	X2	X1/Y2	X2
10 pF	HA	HA	HE	HE
12 pF	HA	HA	HE	HE
15 pF	HA	HA	HE	HE
18 pF	HA	HA	HE	HE
22 pF	HA	HA	HE	HE
27 pF	HC	HC	HG	HG
33 pF	HC	HC	HG	HG
39 pF	HC	HC	HG	HG
47 pF	HC	HC	HG	HG
56 pF	HC	HC	HG	HG
68 pF	HC	HC	HG	HG
82 pF	HC	HC	HG	HG
100 pF	HD	HD	HI	HI
120 pF	HD	HD	HI	HI
150 pF	HD	HD	HI	HI
180 pF	HD	HD	HI	HI
220 pF	HD	HD	HI	HI
270 pF	HD	HD	HI	HI
330 pF	HD	HD	HI	HI
390 pF		HD		HI
470 pF		HD		HI
560 pF		HD		HI
680 pF		HD		HI
820 pF		HD		HI
1 nF		HD		HI

Table 3

CASE SIZE	L (MM)	W (MM)	T (MM)	DIMENSION CODE
1808	4.5+0.6/-0.3	2.0 ±0.30	1.25 ±0.20	HA
	4.5+0.6/-0.3	2.0 ±0.30	1.6 ±0.20	HC
	4.5+0.6/-0.3	2.0 ±0.30	2.0 ±0.20	HD
	4.5+0.9/-0.3	2.0 ±0.40	1.25 ±0.20	HE
	4.5+0.9/-0.3	2.0 ±0.40	1.6 ±0.20	HG
	4.5+0.9/-0.3	2.0 ±0.40	2.0 ±0.20	HI

CAPACITANCE RANGE & THICKNESS FOR X7R X1/Y2 AND X2

Table 4 Sizes from 1808 to 2220

CAP.	SC 1808, X7R X1/Y2	X2	ST 1808, X7R X1/Y2	X2	SC 1812, X7R X2	ST 1812, X7R X2	SC 2211, X7R X1/Y2	ST 2211, X7R X1/Y2	SC 2220, X7R X1/Y2	X2	ST 2220, X7R X1/Y2	X2
100 pF	HC		HG				GA	GE	KB		KF	
120 pF	HC		HG				GA	GE	KB		KF	
150 pF	HC	HA	HG	HE			GA	GE	KB		KF	
180 pF	HC	HA	HG	HE			GA	GE	KB		KF	
220 pF	HC	HA	HG	HE			GA	GE	KB		KF	
270 pF	HD	HA	HI	HE			GA	GE	KB		KF	
330 pF	HD	HA	HI	HE	IA	ID	GA	GE	KB		KF	
390 pF	HD	HA	HI	HE	IA	ID	GA	GE	KB		KF	
470 pF	HD	HA	HI	HE	IA	ID	GB	GF	KB		KF	
560 pF	HD	HA	HI	HE	IA	ID	GB	GF	KB		KF	
680 pF	HD	HA	HI	HE	IA	ID	GB	GF	KB		KF	
820 pF	HD	HA	HI	HE	IA	ID	GB	GF	KB		KF	
1.0 nF	HD	HA	HI	HE	IA	ID	GC	GG	KB		KF	
1.2 nF		HA		HE	IA	ID	GC	GG	KC		KG	
1.5 nF		HA		HE	IA	ID	GC	GG	KC		KG	
1.8 nF		HA		HE	IA	ID	GC	GG	KC		KG	
2.2 nF		HA		HE	IA	ID	GC	GG	KC		KG	
2.7 nF					IA	ID	GD	GH	KC		KG	
3.3 nF					IA	ID			KC		KG	
3.9 nF					IA	ID			KC		KG	
4.7 nF					IB	IE			KC		KG	
5.6 nF												
6.8 nF												
8.2 nF												
10 nF										KC		KG
12 nF										KC		KG
15 nF										KC		KG
18 nF										KC		KG
22 nF										KD		KH
27 nF										KD		KH
33 nF										KD		KH
39 nF										KD		KH
47 nF										KD		KH
56 nF										KD		KH

Table 5

CASE SIZE	L (MM)	W (MM)	T (MM)	DIMENSION CODE
1808	4.5+0.6/-0.3	2.0 ±0.30	1.25 ±0.20	HA
	4.5+0.6/-0.3	2.0 ±0.30	1.6 ±0.20	HC
	4.5+0.6/-0.3	2.0 ±0.30	2.0 ±0.20	HD
	4.5+0.9/-0.3	2.0 ±0.40	1.25 ±0.20	HE
	4.5+0.9/-0.3	2.0 ±0.40	1.6 ±0.20	HG
	4.5+0.9/-0.3	2.0 ±0.40	2.0 ±0.20	HI
1812	4.5+0.6/-0.3	3.2 ±0.30	1.25 ±0.20	IA
	4.5+0.6/-0.3	3.2 ±0.30	1.6 ±0.20	IB
	4.5+0.6/-0.3	3.2 ±0.30	2.0 ±0.20	IC
	4.5+0.9/-0.3	3.2 ±0.40	1.25 ±0.20	ID
	4.5+0.9/-0.3	3.2 ±0.40	1.6 ±0.20	IE
	4.5+0.9/-0.3	3.2 ±0.40	2.0 ±0.20	IF
2211	5.7 ±0.40	2.8 ±0.30	1.6 ±0.20	GA
	5.7 ±0.40	2.8 ±0.30	2.0 ±0.20	GB
	5.7 ±0.40	2.8 ±0.30	2.5 ±0.30	GC
	5.7 ±0.40	2.8 ±0.30	2.8 ±0.30	GD
	5.7 ±0.50	2.8 ±0.40	1.6 ±0.20	GE
	5.7 ±0.50	2.8 ±0.40	2.0 ±0.20	GF
	5.7 ±0.50	2.8 ±0.40	2.5 ±0.30	GG
	5.7 ±0.50	2.8 ±0.40	2.8 ±0.30	GH
2220	5.7 ±0.40	5.0 ±0.40	2.0 ±0.20	KB
	5.7 ±0.40	5.0 ±0.40	2.5 ±0.30	KC
	5.7 ±0.40	5.0 ±0.40	2.8 ±0.30	KD
	5.7 ±0.50	5.0 ±0.40	2.0 ±0.20	KF
	5.7 ±0.50	5.0 ±0.40	2.5 ±0.30	KG
	5.7 ±0.50	5.0 ±0.40	2.8 ±0.30	KH

THICKNESS CLASSES AND PACKING QUANTITY

Table 6

DESCRIPTION	SIZE CODE	THICKNESS CLASSIFICATION (mm)	12 mm TAPE WIDTH /AMOUNT PER REEL Ø180 mm, 7" Blister
Safety Certification Capacitor	1808	1.25 ±0.20	3,000
		1.6 ±0.20	2,000
		2.0 ±0.20	2,000
	1812	1.25 ±0.20	1,000
		1.6 ±0.20	1,000
		2.0 ±0.20	1,000
	2211	1.6 ±0.20	1,000
		2.0 ±0.20	1,000
		2.5 ±0.30	500
		2.8 ±0.30	500
	2220	2.0 ±0.20	1,000
		2.5 ±0.30	500
		2.8 ±0.30	500

ELECTRICAL CHARACTERISTICS

NP0/X7R DIELECTRIC CAPACITORS; NISN TERMINATIONS

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

Table 7

DESCRIPTION		VALUE
Capacitance range		10pF to 56nF
Capacitance tolerance		
NP0	C < 10 pF	±0.25 pF, ±0.5 pF
	C ≥ 10 pF	±5%
X7R		±10%
Dissipation factor (D.F.)		
NP0	C < 30 pF	≤ 1 / (400 + 20C)
	C ≥ 30 pF	≤ 0.1 %
X7R		≤ 2.5 %
Insulation resistance after 1 minute at U_r (DC)		R_{ins} ≥ 10 GΩ or R_{ins} × C ≥ 500 seconds whichever is less
Maximum capacitance change as a function of temperature (temperature characteristic/coefficient):		
NP0		±30 ppm/°C
X7R		±15%
Operating temperature range: NP0/X7R		–55 °C to +125 °C

CAPACITOR REQUIREMENT

Table 8

SAFETY RATING	VOLTAGE RATING	WITHSTANDING VOLTAGE	IMPULSE VOLTAGE
X1	250 VAC	1,500 VAC	4,000 V
X2	250 VAC	1,500 VAC	2,500 V
Y2	250 VAC	1,500 VAC	5,000 V

SOLDERING RECOMMENDATION

Table 9

SOLDERING METHOD	SIZE 0402	0603	0805	1206	≥ 1210
Reflow	≥ 0.1μF	≥ 1.0 μF	≥ 2.2 μF	≥ 4.7 μF	Reflow only
Reflow/Wave	< 0.1μF	< 1.0 μF	< 2.2 μF	< 4.7 μF	---

TESTS AND REQUIREMENTS

Table 10 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	NP0: f = 1 MHz for C ≤ 1 nF, measuring at voltage 1 V_{rms} at 20 °C; f = 1 KHz for C > 1 nF, measuring at voltage 1 V_{rms} at 20 °C X7R: f = 1 KHz for C ≤ 10 μF, measuring at voltage 1 V_{rms} at 20 °C	Within specified tolerance
Dissipation Factor (D.F.)		4.5.2	NP0: f = 1 MHz for C ≤ 1 nF, measuring at voltage 1 V_{rms} at 20 °C; f = 1 KHz for C > 1 nF, measuring at voltage 1 V_{rms} at 20 °C X7R: f = 1 KHz for C ≤ 10 μF, measuring at voltage 1 V_{rms} at 20 °C	In accordance with specification
Insulation Resistance		4.5.3	To apply 500 V max for 60 seconds	In accordance with specification

TEST	TEST METHOD		PROCEDURE	REQUIREMENTS
Temperature Characteristic		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. 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 Temp, Coefficient = $\frac{C2 - C1}{C1 \times \Delta T} \times 10^6$ [ppm/°C] C1: Capacitance at step c C2: Capacitance at 125°C ΔT: 100°C (=125°C -25°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	Class1: Δ C/C: ±30ppm Class2: X7R: Δ C/C: ±15%
Adhesion		4.15	a. A force applied for 10 seconds to the line joining the terminations and in a plane parallel to the substrate for size ≥ 0603 : a force of 5N applied b. A force applied until broken For size ≥ 0603: ≥ 5N	No visible damage
Bending	IEC 60384-21/22	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 ΔC/C NP0: ≤ 1% or 0.5 pF whichever is greater X7R: ≤ 10%
Resistance to Soldering Heat		4.9	Precondition: 150 +0/–10 °C for 1 hour, then keep for 24 ±1 hours at room temperature Preheating: for size ≤ 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 ±5 °C Dipping time: 10 ±0.5 seconds Recovery time: 24 ±2 hours	The termination shall be well tinned ΔC/C NP0: ≤ 0.5% or 0.5 pF whichever is greater X7R: ≤ 10% D.F. within initial specified value R_{ins} within initial specified value

TEST	TEST METHOD		PROCEDURE	REQUIREMENTS
Solderability		4.10	Unmounted chips completely immersed in a solder bath at 235 ±5 °C Dipping time: 2 ±0.5 seconds Depth of immersion: 10 mm	The termination shall be well tinned
Damp Heat with U_r Load		4.13	Initial measurements; after 150 +0/-10 °C for 1 hour, then keep for 24 ±1 hours at room temperature Duration and conditions: 500 ±12 hours at 40 ±2 °C; 90 to 95% RH; 1.0 Ur applied Final measurement: perform a heat treatment at 150 +0/–10 °C for 1 hour, final measurements shall be carried out 24 ±1 hours after recovery at room temperature without load	ΔC/C NP0: ≤ 2% or 1 pF whichever is greater X7R: ≤ 15% D.F. NP0: ≤ 2 x specified value X7R: ≥ 100V: ≤ 5% Rins NP0: ≥ 2,500 MΩ or Rins x Cr ≥ 25s whichever is less X7R: ≥ 500 MΩ or Rins x Cr ≥ 25s whichever is less
Endurance	EN132400	4.14 SC	Impulse Voltage : Each individual capacitor shall be subjected to a Vp = 5.0KV (X1Y2 Class Impulse 5KV) or Vp = 2.5KV (X2 Class Impulse 2.5KV) impulse for three times before applied to endurance test. * Test temp. : 125±3°C. * Test time : 1000 +48/-0 hrs. * Applied voltage : X capacitor : 1.25UR (312.5Vac). Y capacitor : 1.70UR (425Vac). Once every hour the voltage shall be increased to 1000Vrms for 0.1 sec. * Measurement to be made after keeping at room temp. for 24±2 hrs (Class I) and 48±4 hrs (Class II).	Visual examination DC/C < ± 20% Voltage proof IR > 3 x10E9 Ω
Robustness of Termination (Pull Strength)		4.3 SC	a. A force applied for 10 sec to the line joining the terminations and in a plane parallel to the substrate. b. A force applied until broken	a. No visible damage b. Force size ≥ 0603: ≥ 5N
Voltage Proof		4.2.1 SC	X capacitor: Applied voltage 1.075K VDC (4.3 Ur) Y capacitor: Applied voltage 1.5K VAC	No breakdown or flashover

REVISION HISTORY

REVISION	DATE	CHANGE NOTIFICATION	DESCRIPTION
Version 1	Apr. 14, 2025	-	- Add NPO, 1808, X2 Series
Version 0	May 21, 2024	-	- New datasheet for high voltage NP0/X7R series with lead-free terminations

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