Innovative Service Around the Globe YAGEO

DATA SHEET

SURFACE MOUNT MULTILAYER CERAMIC CAPACITORS

Automotive grade Array

NP0/X7R

16 V TO 50 V

sizes 0508 (4 x 0402) / 0612 (4 x 0603)

RoHS compliant & Halogen Free

YAGEO

Product Specification – July 09, 2021 V.0

SCOPE

This specification describes Automotive grade NP0/X7R series chip capacitors with lead-free terminations and used for automotive equipments.

APPLICATIONS

- Professional electronics
- High density consumer electronics

FEATURES

- AEC-Q200 qualified
- MSL class: MSL 1
- AC series soldering is compliant with J-STD-020D
- 0508 (4x0402) / 0612 (4x0603) capacitors (of the same capacitance value) per array
- Less than 50% board space of an equivalent discrete component
- Increased throughout, by time saved in mounting
- RoHS compliant & Halogen free
- The capacitors are 100% performed by automatic optical inspection prior to taping.

ORDERING INFORMATION - GLOBAL PART NUMBER

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)

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

(1) SIZE – INCH BASED (METRIC)

0508 (1220)

0612 (1632)

(2) TOLERANCE

J = ±5%

K = ±10%

M = ±20%

(3) PACKING STYLE

R = Paper/PE taping reel; Reel 7 inch

P = Paper/PE taping reel; Reel 13 inch

(4) TC MATERIAL

NPO

X7R

(5) RATED VOLTAGE

7 = 16 V

8 = 25 V

9 = 50 V

(6) PROCESS

N = NP0

B = class 2 material, X7R

(7) CAPACITANCE VALUE

2 significant digits+number of zeros

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

Example: 121 = 12×10^1 = 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. An outline of the structure is shown in Fig.1.

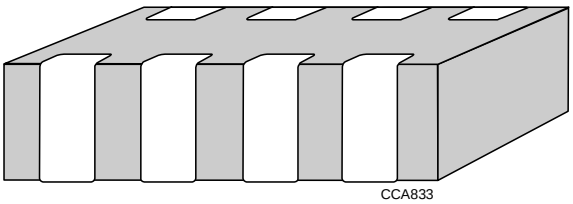


Fig. 1 Simplified outline

OUTLINES

Table 1 For outlines see fig. 2

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
$T_{min.}$ (mm)	*	*
$T_{max.}$ (mm)	*	*
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

NOTE
* Refer to Table 2 ~Table 3

For dimensions see Table 1

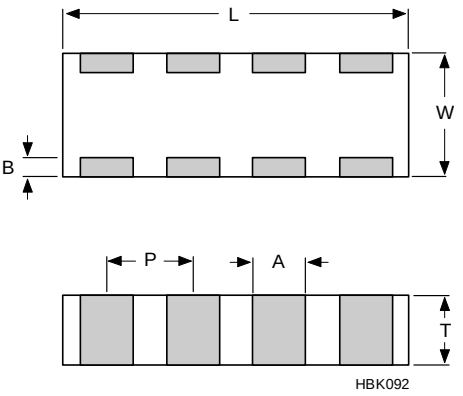


Fig. 2 Surface mounted multilayer ceramic capacitor dimension

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
10 pF	0.6±0.1	0.8±0.1
15 pF	0.6±0.1	0.8±0.1
18 pF	0.6±0.1	0.8±0.1
22 pF	0.6±0.1	0.8±0.1
33 pF	0.6±0.1	0.8±0.1
39 pF	0.6±0.1	0.8±0.1
47 pF	0.6±0.1	0.8±0.1
56 pF	0.6±0.1	0.8±0.1
68 pF	0.6±0.1	0.8±0.1
82 pF	0.6±0.1	0.8±0.1
100 pF	0.6±0.1	0.8±0.1
120 pF		0.8±0.1
150 pF		0.8±0.1
180 pF		0.8±0.1
220 pF		0.8±0.1
270 pF		0.8±0.1
330 pF		0.8±0.1
390 pF		0.8±0.1
470 pF		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
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
1.5 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
3.3 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
6.8 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
22 nF	0.6±0.1					
47 nF	0.6±0.1			0.8±0.1	0.8±0.1	
100 nF	0.6±0.1					

NOTE

Values in shaded cells indicate thickness class in mm

THICKNESS CLASSES AND PACKING QUANTITY

Table 4

SIZE CODE	THICKNESS CLASSIFICATION	TAPE WIDTH QUANTITY PER REEL	Ø180 MM / 7 INCH		Ø330 MM / 13 INCH	
			Paper	Blister	Paper	Blister
0508	0.6 ±0.1 mm	8 mm	4,000	---	20,000	---
0612	0.8 ±0.1 mm	8 mm	4,000	---	15,000	---

ELECTRICAL CHARACTERISTICS

NP0/X7R DIELECTRIC CAPACITORS; NI/SIN 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 5

DESCRIPTION		VALUE
Capacitance range		10 pF to 100 nF
Capacitance tolerance		
NP0	C ≥ 10 pF	±5%
X7R		±10%, ±20%
Dissipation factor (D.F.)		
NP0	C < 30 pF	≤ 1 / (400 + 20C)
	C ≥ 30 pF	≤ 0.1%

X7R	0508 (Array)	0612 (Array)	
16V	1nF to 10nF	220pF to 47nF	≤ 3.5%
	15nF to 100nF		≤ 5%
25V	1nF to 10nF	220pF to 47nF	≤ 2.5%
50V	1nF	220pF to 10nF	≤ 2.5%
Insulation resistance after 1 minute at U_r (DC)	IR ≥ 10GΩ or I.R x C ≥ 500 seconds whichever is less		

SOLDERING CONDITIONS

The lead free MLCCs are able to stand the reflow soldering conditions as below:

- Temperature: above 220 °C
- Endurance: 95 to 120 seconds
- Cycles: 3 times

The test of "soldering heat resistance" is carried out in accordance with the schedule of "MIL-STD-202G-method 210F", "The robust construction of chip capacitors allows them to be completely immersed in a solder bath of 260 °C for 10 seconds". Therefore, it is possible to mount MLCCs on one side of a PCB and other discrete components on the reverse (mixed PCBs). Surface Mount Capacitors are tested for solderability at 245 °C during 2 seconds. The test condition for no leaching is 260°C for 30 seconds.

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
Capacitance	IEC 60384-21/22	4.5.1	Class 1: At 20 °C, 24 hours after annealing f = 1 MHz for C ≤ 1nF, measuring at voltage 1 V_{rms} at 20 °C f = 1 KHz for C > 1nF, measuring at voltage 1 V_{rms} at 20 °C Class 2: At 20 °C, 24 hours after annealing f = 1 KHz, measuring at voltage 1 V_{rms} at 20 °C	Within specified tolerance
Dissipation Factor (D.F.)	IEC 60384-21/22	4.5.2	Class 1: At 20 °C, 24 hours after annealing f = 1 MHz for C ≤ 1nF, measuring at voltage 1 V_{rms} at 20 °C f = 1 KHz for C > 1nF, measuring at voltage 1 V_{rms} at 20 °C Class 2: At 20 °C, 24 hours after annealing f = 1 KHz, measuring at voltage 1 V_{rms} at 20 °C	In accordance with specification
Insulation Resistance	IEC 60384-21/22	4.5.3	At U_r (DC) for 1 minute	In accordance with specification
High Temperature Exposure	AEC-Q200	3	Unpowered ; 1000hours @ T=150 °C Measurement at 24±2 hours after test conclusion.	No visual damage ΔC/C : Class1: NP0: within ±0.5% or 0.5 pF whichever is greater Class2: X7R: ±10% D.F.: within initial specified value IR: within initial specified value

TEST	TEST METHOD		PROCEDURE	REQUIREMENTS
Temperature Cycling	AEC-Q200	4	Preconditioning; 150 +0/–10 °C for 1 hour, then keep for 24 ±1 hours at room temperature 1000 cycles with following detail: 30 minutes at lower category temperature 30 minutes at upper category temperature Recovery time 24 ±2 hours	No visual damage ΔC/C Class1: NP0: Within ±1% or 0.5pF, whichever is greater. Class2: X7R: ±10% D.F. meet initial specified value IR meet initial specified value
Destructive Physical Analysis	AEC-Q200	5	Note: Only applies to SMD ceramics. Electrical test not required.	
Moisture Resistance	AEC-Q200	6	T=24 hrs/per cycle; 10 continuous cycles unpowered. Measurement at 24 ±2 hours after test condition.	No visual damage ΔC/C NP0: Within ±3% or 3 pF, whichever is greater X7R: ±15% D.F. Within initial specified value IR NP0: ≥ 10,000 MΩ X7R: Meet initial specified value

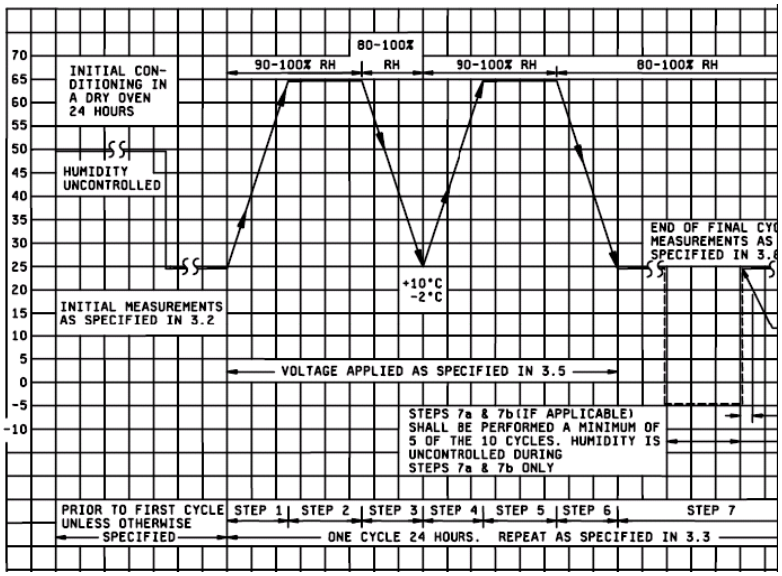
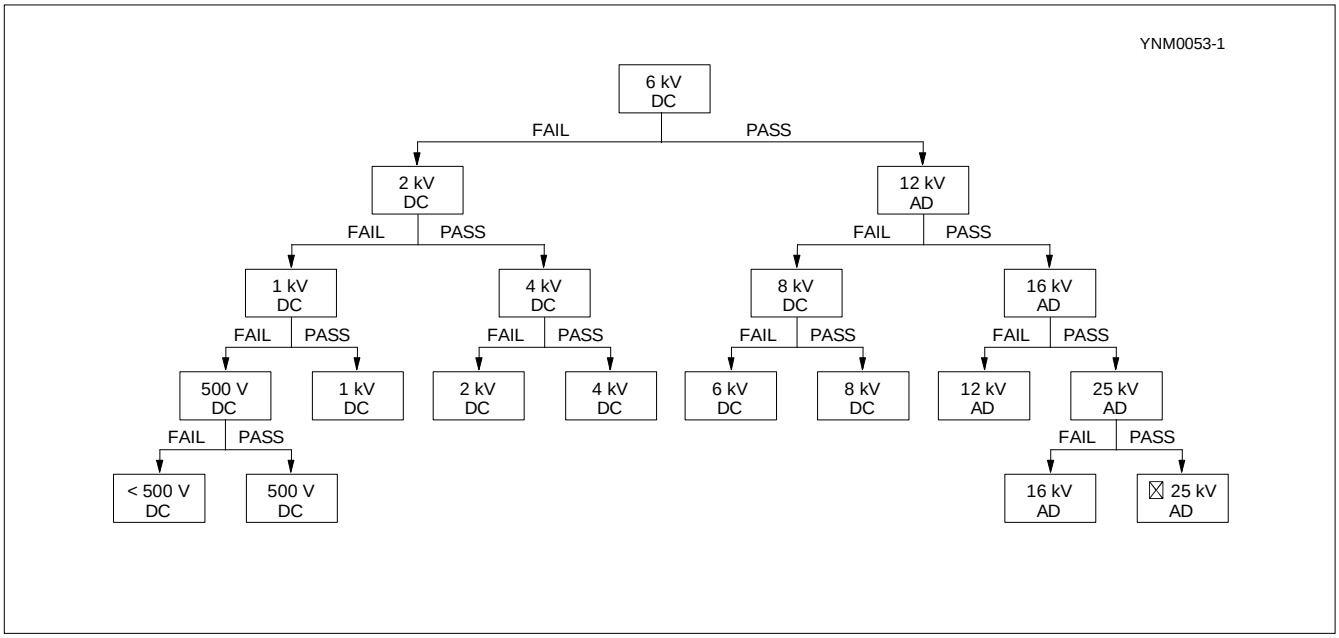


Fig. 4 Moisture resistant

TEST	TEST METHOD		PROCEDURE	REQUIREMENTS
Biased Humidity	AEC-Q200	7	1. Preconditioning, class 2 only: 150 +0/-10 °C /1 hour, then keep for 24 ±1 hour at room temp 2. Initial measure: Parameter: IR Measuring voltage: 1.5V ± 0.1 VDC Note: Series with 100 KΩ 3. Test condition: 85 °C, 85% R.H. connected with 100 KΩ resistor, applied 1.5V/U_r for 1,000 hours. 4. Recovery: Class1: 6 to 24 hours Class2: 24 ±2 hours 5. Final measure: Cap, D.F., I.R.	No visual damage after recovery ΔC/C NPO: Within ± 2% or 1 pF, whichever is greater X7R: ± 15% D.F. NPO: ≤ 2 x specified value. X7R/X7S: (1) ≤ 16V: ≤ 7% or specified value whichever is greater (2) ≥ 25V: ≤ 5% or specified value whichever is greater I.R. The insulation resistance shall greater than 10% of initial spec.
Operational Life	AEC-Q200	8	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 to initial spec C, D, IR 3. Endurance test: Temperature: X7R: 125 °C Specified stress voltage applied for 1,000 hours: Applied 2.0 x U_r s 4. Recovery time: 24 ±2 hours 5. Final measure: C, D, IR Note: If the capacitance value is less than the minimum value permitted, then after the other measurements have been made the capacitor shall be preconditioned according to *"IEC 60384 4.1"* and then the requirement shall be met.	No visual damage ΔC/C NP0: Within ±2% or 1 pF, whichever is greater X7R: ±15% D.F. NP0: ≤ 2 x specified value. X7R: ≤ 16V: ≤ 7% or specified value whichever is greater ≥ 25V: ≤ 5% or specified value whichever is greater IR NP0: ≥ 4,000 MΩ or IR x C_r ≥ 40s whichever is less X7R: ≥ 1,000 MΩ or IRx C_r ≥ 50s whichever is less
External Visual	AEC-Q200	9	Any applicable method using × 10 magnification	In accordance with specification
Physical Dimension	AEC-Q200	10	Verify physical dimensions to the applicable device specification.	In accordance with specification

TEST	TEST METHOD	PROCEDURE	REQUIREMENTS
Mechanical Shock	AEC-Q200 13	Three shocks in each direction shall be applied along the three mutually perpendicular axes of the test specimen (18 shocks) Peak value: 1,500 g's Duration: 0.5 ms Velocity change: 15.4 ft/s Waveform: Half-sin	ΔC/C NP0: Within ±0.5% or 0.5 pF, whichever is greater X7R: ±10% D.F. Within initial specified value IR Within initial specified value
Vibration	AEC-Q200 14	5 g's for 20 minutes, 12 cycles each of 3 orientations.	ΔC/C NP0: Within ±0.5% or 0.5 pF, whichever is greater X7R: ±10% D.F: meet initial specified value IR meet initial specified value
Resistance to Soldering Heat	AEC-Q200 15	Precondition: 150 +0/–10 °C for 1 hour, then keep for 24 ±1 hours at room temperature Preheating: 120 °C to 150 °C for 1 minute Solder bath temperature: 260 ±5 °C Dipping time: 10 ±0.5 seconds Recovery time: 24 ±2 hours	Dissolution of the end face plating shall not exceed 25% of the length of the edge concerned ΔC/C Class1: NP0: Within ±1% or 0.5 pF, whichever is greater. Class2: X7R: ±10% D.F. within initial specified value IR within initial specified value
Thermal Shock	AEC-Q200 16	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 to initial spec C, D, IR 3. Rapid change of temperature test: NP0/X7R: -55 °C to +125 °C; 300 cycles 15 minutes at lower category temperature; 15 minutes at upper category temperature. 4. Recovery time: Class1: 6 to 24 hours Class2: 24 ±2 hours 5. Final measure: C, D, IR	No visual damage ΔC/C NP0: Within ±1% or 1 pF, whichever is greater X7R: ±15% D.F: meet initial specified value IR meet initial specified value

TEST	TEST METHOD	PROCEDURE	REQUIREMENTS
ESD	AEC-Q200 17	Per AEC-Q200-002	A component passes a voltage level if all components stressed at that voltage level pass.



Solderability	AEC-Q200	18	1. Preheat at 155°C for 4 hours. After preheating, immerse the capacitor in a solution of ethanol and rosin (25% rosin in weight proportion). Immerse in eutectic solder solution for 5+0/-0.5 seconds at 235±5°C. 2. Should be placed into steam aging for 8 hours±15 minutes. After preheating, immerse the capacitor in a solution of ethanol and rosin (25% rosin in weight proportion). Immerse in eutectic solder solution for 5+0/-0.5 seconds at 235±5°C. 3. Should be placed into steam aging for 8 hours±15 minutes. After preheating, immerse the capacitor in a solution of Ethanol and rosin (25% rosin in weight proportion). Immerse in eutectic solder solution for 120±5 seconds at 260±5°C.	The solder should cover over 95% of the critical area of each termination.

Electrical Characterization	AEC-Q200	19	Parametrically test per lot and sample size requirements, summary to show Min, Max, Mean and Standard deviation at room as well as Min and Max operating temperatures. Class 1: NP0: -55 °C to +125 °C Normal temperature: 20 °C Class 2: X7R: -55 °C to +125 °C Normal temperature: 20 °C	ΔC/C Class 1: NP0: ±30 ppm/°C Class2: X7R: ±15%
Board Flex	AEC-Q200	21	Part mounted on a 100 mm X 40 mm FR4 PCB board, which is 1.6 ±0.2 mm thick Part should be mounted using the following soldering reflow profile. Conditions: Class1: Bending 3 mm at a rate of 1 mm/s, radius jig 340 mm Class2: Bending 2 mm at a rate of 1 mm/s, radius jig 340 mm	No visible damage ΔC/C Class1: NP0: Within ±1% or 0.5 pF, whichever is greater Class2: X7R: ±10%
Terminal Strength	AEC-Q200	22	With the component mounted on a PCB obtained with the device to be tested, apply a 17.7N (1.8Kg) force to the side of a device being tested. This force shall be applied for 60+1 seconds. Also the force shall be applied gradually as not to apply a shock to the component being tested.	Magnification of 20X or greater may be employed for inspection of the mechanical integrity of the device body, terminals and body/terminal junction. Before and after the test, the device shall comply with all electrical requirements stated in this specification.
Beam Load Test	AEC-Q200	23	Place the part in the beam load fixture. Apply a force until the part breaks or the minimum acceptable force level required in the user specification(s) is attained.	0508: 20N 0612: 15N
Voltage Proof			1. Specified stress voltage applied for 1~5 seconds 2. Ur ≤ 100 V: applied 2.5 Ur Charge/Discharge current is less than 50 mA	No breakdown or flashover

REVISION HISTORY

REVISION	DATE	CHANGE NOTIFICATION	DESCRIPTION
Version 0	Jul. 09, 2021	-	- New Datasheet

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