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Innovative Service Around the Globe YAGEO

DATA SHEET

SURFACE MOUNT MULTILAYER CERAMIC CAPACITORS

Automotive grade
with Soft Termination
NPO & X7R

16 V TO 1000 V

1 nF to 4.7 uF

RoHS compliant & Halogento Free

YAGEO

Product Specification – May 21, 2024 V.4



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SCOPE

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

APPLICATIONS

All general purpose applications
Entertainment applications
Comfort / security applications
Information applications

FEATURES

- AEC-Q200 qualified
- MSL class: MSL 1
- Soldering is compliant with J-STD-020D
- Increased mechanical performance
- High component and equipment reliability
- 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.

GLOBAL PART NUMBER

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

(1) SIZE – INCH BASED (METRIC)

0603 (1608) / 0805 (2012) / 1206 (3216)/ 1210 (3225)

(2) TOLERANCE

J = ±5%
K = ±10%
M = ±20%

(3) PACKING STYLE

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

(4) TC MATERIAL

X7R
NPO

(5) RATED VOLTAGE

7 = 16 V
8 = 25 V
9 = 50 V
0 = 100 V
A = 200 V
Y = 250 V
Z = 630 V
C = 1000 V

(6) PROCESS

N = Class I MLCC
B = Class II MLCC

(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 x 10^1 = 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 flexible 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 and Fig.2.

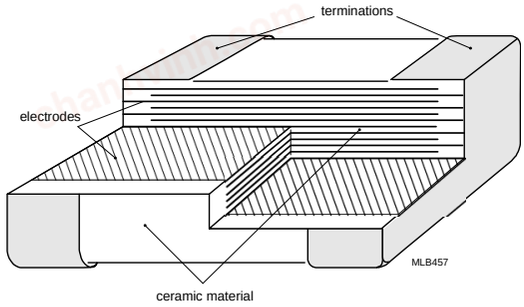


Fig. 1 Surface mounted multilayer ceramic capacitor construction

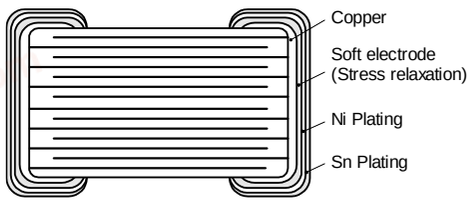


Fig. 2

DIMENSION

Table 1 For outlines see fig. 3

TYPE	L1 (mm)	W (mm)	T (mm)	L2/L3(mm) min	L2/L3(mm) max	L4(mm) min
0603	1.6 ± 0.2	0.8 ± 0.15	0.8 ± 0.15	0.20	0.65	0.50
0805	2.0 ± 0.3	1.25 ± 0.2	0.85 ± 0.15	0.25	0.75	0.70
			1.25 ± 0.20			
1206	3.2 ± 0.4	1.6 ± 0.2	0.85 ± 0.15	0.25	0.85	1.50
			1.25 ± 0.20			
			1.60 ± 0.20			
1210	3.2 ± 0.5	2.5 ± 0.3	1.25 ± 0.2	0.25	1.00	1.20
			1.6 ± 0.3			
			2.0 ± 0.3			
			2.5 ± 0.3			

OUTLINES

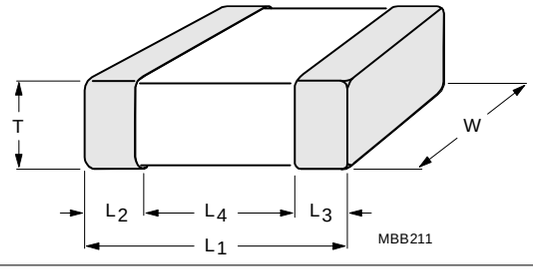


Fig. 3

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CAPACITANCE RANGE & THICKNESS FOR NPO

Table 2

CAP.	1206	1210	
	630 V	630 V	1000 V
1.0 nF			
1.2 nF			
1.5 nF	1.25±0.20		
1.8 nF	1.25±0.20		
2.2 nF	1.25±0.20		
2.7 nF	1.25±0.20		
3.3 nF	1.25±0.20		
3.9 nF	1.25±0.20		
4.7 nF	1.25±0.20	1.6±0.30	2.0±0.30
5.6 nF	1.6±0.20	1.6±0.30	2.0±0.30
6.8 nF	1.6±0.20	1.6±0.30	2.0±0.30
8.2 nF	1.6±0.20	1.6±0.30	2.0±0.30
10 nF	1.6±0.20	1.6±0.30	2.5±0.30
15 nF		1.6±0.30	2.5±0.30
22 nF		2.0±0.30	2.5±0.30
33 nF		2.5±0.30	
47 nF			

NOTE

Values in shaded cells indicate thickness class in mm

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CAPACITANCE RANGE & THICKNESS FOR X7R

Table 3 Size 0805

CAP.	0603				0805		
	16 V	25 V	50 V	100 V	25 V	50 V	100 V
1.0 nF	0.8±0.15	0.8±0.15	0.8±0.15	0.8±0.15	0.85±0.15	0.85±0.15	0.85±0.15
1.5 nF	0.8±0.15	0.8±0.15	0.8±0.15	0.8±0.15	0.85±0.15	0.85±0.15	0.85±0.15
2.2 nF	0.8±0.15	0.8±0.15	0.8±0.15	0.8±0.15	0.85±0.15	0.85±0.15	0.85±0.15
3.3 nF	0.8±0.15	0.8±0.15	0.8±0.15	0.8±0.15	0.85±0.15	0.85±0.15	0.85±0.15
4.7 nF	0.8±0.15	0.8±0.15	0.8±0.15	0.8±0.15	0.85±0.15	0.85±0.15	0.85±0.15
6.8 nF	0.8±0.15	0.8±0.15	0.8±0.15	0.8±0.15	0.85±0.15	0.85±0.15	0.85±0.15
10 nF	0.8±0.15	0.8±0.15	0.8±0.15	0.8±0.15	0.85±0.15	0.85±0.15	0.85±0.15
15 nF	0.8±0.15	0.8±0.15	0.8±0.15	0.8±0.15	0.85±0.15	0.85±0.15	0.85±0.15
22 nF	0.8±0.15	0.8±0.15	0.8±0.15	0.8±0.15	0.85±0.15	0.85±0.15	0.85±0.15
33 nF	0.8±0.15	0.8±0.15	0.8±0.15	0.8±0.15	0.85±0.15	0.85±0.15	1.25±0.2
47 nF	0.8±0.15	0.8±0.15	0.8±0.15	0.8±0.15	0.85±0.15	0.85±0.15	1.25±0.2
68 nF	0.8±0.15	0.8±0.15	0.8±0.15		1.25±0.2	1.25±0.2	1.25±0.2
100 nF	0.8±0.15	0.8±0.15	0.8±0.15	0.8±0.15	1.25±0.2	1.25±0.2	1.25±0.2
1 uF					1.25±0.2		

NOTE

Values in shaded cells indicate thickness class in mm

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CAPACITANCE RANGE & THICKNESS FOR X7R

Table 4 Size 1206

CAP.	1206					1210			
	16V	25V	50 V	100 V	200 V / 250 V	50V	100V	200 V	250 V
22 nF					1.25±0.2				
33 nF					1.25±0.2				
47 nF					1.25±0.2				
68 nF					1.25±0.2				
100 nF		0.85±0.15	0.85±0.15	1.25±0.2	1.6±0.2		1.25±0.2	1.25±0.2	1.25±0.2
150 nF		1.25±0.2	1.25±0.2	1.25±0.2			1.25±0.2	1.25±0.2	1.25±0.2
220 nF	1.25±0.2	1.25±0.2	1.25±0.2	1.25±0.2			1.25±0.2	1.25±0.2	1.25±0.2
4.7 uF						2.5±0.3			

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		Ø330 MM / 13 INCH	
			Paper	Blister	Paper	Blister
0603	0.8 ±0.15 mm	8 mm	4,000	---	15,000	---
0805	0.85 ±0.15 mm	8 mm	4,000	---	15,000	---
	1.25 ±0.2 mm	8 mm	---	3,000	---	10,000
1206	0.6 ±0.1 mm	8 mm	4,000	---	20,000	---
	0.85 ±0.1 mm	8 mm	4,000	---	15,000	---
	1.25 ±0.2 mm	8 mm	---	3,000	---	10,000
	1.6 ±0.2 mm	8 mm	---	2,000	---	10,000
1210	1.25 ±0.2 mm	8 mm	---	3,000	---	---
	1.6 ± 0.3 mm	8 mm	---	2,000	---	---
	2.0 ± 0.3 mm	8 mm	---	2,000	---	---
	2.5 ±0.3 mm	8 mm	---	1,000	---	---

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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 6

DESCRIPTION						VALUE
Capacitance range						1 nF to 4.7 uF
Dissipation factor (D.F.)						
NP0			C < 30 pF			≤ 1 / (400 + 20C)
			C ≥ 30 pF			≤ 0.1 %
Capacitance tolerance						
X7R						±5% [1], ±10%, ±20%
Dissipation factor (D.F.)						
X7R		0603	0805	1206	1210	
	16V	1nF to 100nF		220nF		≤ 3.5%
	25V	1nF to 39nF	1nF to 100nF	100nF to 220nF		≤ 2.5%
		47nF to 100nF				≤ 3.5%
			1µF			≤ 5%
	50V	1nF to 39nF	1nF to 100nF	100nF to 220nF		≤ 2.5%
		47nF to 100nF				≤ 3.5%
					4.7 uF	≤ 10%
	100V	1nF to 10nF	1nF to 100nF	100nF to 220nF		≤ 2.5%
		12nF to 100nF				≤ 5%
	200V / 250V			22nF to 100nF		≤ 2.5%
Insulation resistance after 1 minute at U_r (DC)						IR ≥ 10 GΩ or I.R x C ≥ 500Ω.F whichever is less
Maximum capacitance change as a function of temperature (temperature characteristic/coefficient):						
NP0						±15%
Operating temperature range:						
NP0/X7R						–55 °C to +125 °C

NOTE

1. Capacitance tolerance ±5% doesn't available for X7R full product range, please contact local sales force before order

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SOLDERING RECOMMENDATION

Table 7

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

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 8 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	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	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

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TEST	TEST METHOD		PROCEDURE	REQUIREMENTS
High Temperature Exposure	AEC-Q200	3	Unpowered ; 1000hours @ T=150°C Measurement at 24±2 hours after test conclusion.	No visual damage ΔC/C NPO: Within ±2.5% or 0.25 pF, whichever is greater X7R: Within ±10% D.F.: within initial specified value IR: within initial specified value
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 NPO: Within ±2.5% or 0.25 pF, whichever is greater X7R: Within ±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 NPO: Within ±3% or 3 pF, whichever is greater X7R: Within ±15% D.F. Within initial specified value IR Meet initial specified value

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TEST	TEST METHOD	PROCEDURE	REQUIREMENTS

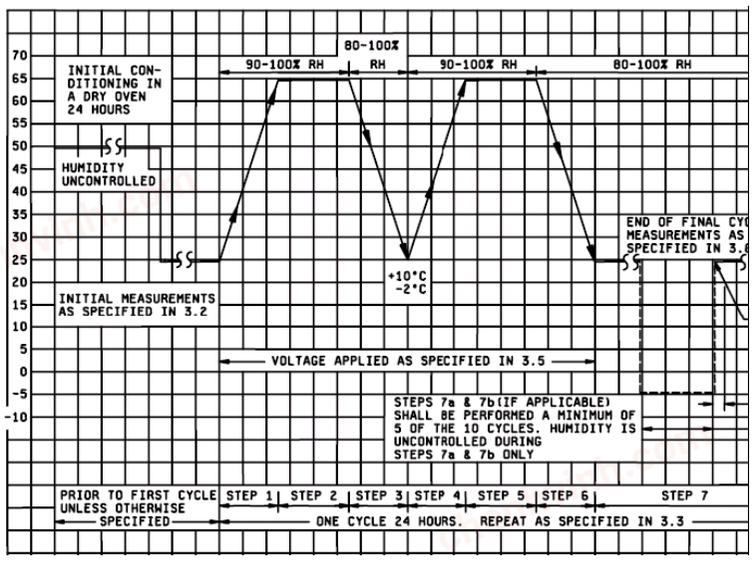


Fig. 4 Moisture resistant

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: Cap, D.F., I.R. 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/Ur for 1,000 hours. 4. Recovery: 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/X7S: ±15% D.F. Less than 200% of initial spec. I.R. The insulation resistance shall greater than 10% of initial spec.

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TEST	TEST METHOD		PROCEDURE	REQUIREMENTS
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 for general products Applied 1.5 x U_r for high cap. Products High voltage series follows with below stress condition: Applied 1.5 x Ur for 200V, 250V series Applied 1.2 x Ur for 630V series Applied 1.0 x Ur for 1KV series 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 NPO: Within ±2% or 1 pF, whichever is greater X7R/X7S: ±15% D.F. Less than 200% of initial spec. IR The insulation resistance shall be greater than 10% of initial spec.
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
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 NPO: Within ± 0.5% or 0.5 pF, whichever is greater X7R/X7S: ± 10% D.F. Within initial specified value IR Within initial specified value

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TEST	TEST METHOD		PROCEDURE	REQUIREMENTS
Vibration	AEC-Q200	14	5 g's for 20 minutes, 12 cycles each of 3 orientations. Note: Use 8" x 5" PCB. 0.31" thick 7 secure points on one long side and 2 secure points at corners of opposite sides. Parts mounted within 2" from any secure point. Test from 10-2000 Hz.	ΔC/C NPO: Within ±0.5% or 0.5 pF, whichever is greater X7R/X7S: ±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: 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	Dissolution of the end face plating shall not exceed 25% of the length of the edge concerned ΔC/C NPO: Within ± 1% or 0.5 pF, whichever is greater. X7R/X7S: ±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: -55 °C to +125 °C; 300 cycles 15 minutes at lower category temperature; 15 minutes at upper category temperature. 4. Recovery time: Class 2: 24 ±2 hours 5. Final measure: C, D, IR	No visual damage ΔC/C NPO: Within ± 1% or 1 pF, whichever is greater X7R/X7S: ±15% D.F: meet initial specified value IR meet initial specified value
ESD	AEC-Q200	17	Per AEC-Q200-004	A component passes a voltage level if all components stressed at that voltage level pass.

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TEST	TEST METHOD	PROCEDURE	REQUIREMENTS

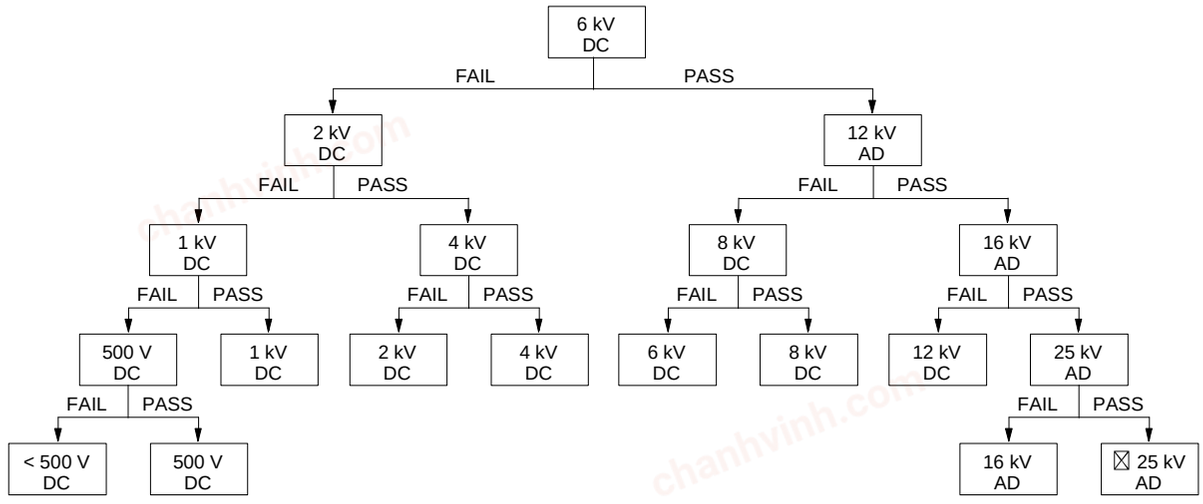


Fig. 5 Passive component HBM ESD test flow diagram (DC = Direct Contact Discharge, AD = Air Discharge)

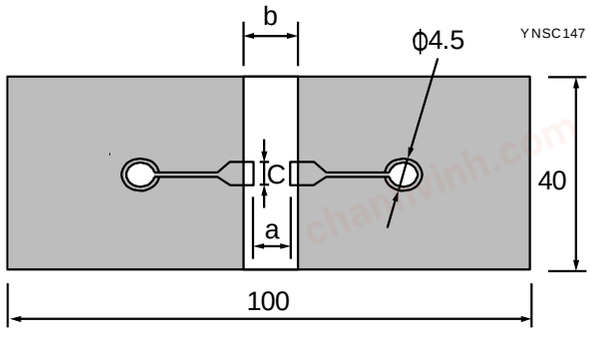
Solderability	AEC-Q200	18	1. Preheat at 155°C for 4 hours. After preheating, immerse the capacitor in a solution of ethanol and rosin (25% rosin in weight proportion). Immerse in eutectic solder solution for 5+0/-0.5 seconds at 235±5°C. 2. Should be placed into steam aging for 8 hours±15 minutes. After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

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TEST	TEST METHOD	PROCEDURE	REQUIREMENTS
Electrical Characterization	AEC-Q200 19	Capacitance	NPO: f = 1 MHz for C ≤ 1nF, measuring at voltage 1 V_{rms} at 25 °C f = 1±0.1 KHz for C > 1nF, measuring at voltage 1±0.2 V_{rms} at 25 °C X7R/X7S: At 25 °C, 24 hours after annealing f = 1±0.1 KHz, measuring at voltage 1±0.2 V_{rms} at 25 °C	Within specified tolerance
		Dissipation Factor (D.F.)	NPO: f = 1 MHz for C ≤ 1nF, measuring at voltage 1 V_{rms} at 25 °C f = 1±0.1 KHz for C > 1nF, measuring at voltage 1±0.2 V_{rms} at 25°C X7R/X7S: At 25 °C, 24 hours after annealing f = 1±0.1 KHz, measuring at voltage 1±0.2 V_{rms} at 25 °C	In accordance with specification on Table 9
		Insulation Resistance (I.R.)	At U_r (DC) for 1 minute	In accordance with specification on Table 9
		Temperature coefficient	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. (1) NPO Temperature Coefficient shall be calculated from the formula as below Temp, Coefficient = $\frac{C2-C1}{C1\times\Delta T}\times10^6$ [ppm/°C] C1: Capacitance at step c C2: Capacitance at 125°C ΔT: 100°C (=125°C -25°C) (2) X7R/X7S Capacitance Change shall be calculated from the formula as below $\Delta C = \frac{C2-C1}{C1}\times100\%$ C1: Capacitance at step c C2: Capacitance at step b or d	ΔC/C NPO: ±30ppm /°C X7R: ±15% X7S: ± 22%
		Voltage Proof	1. Specified stress voltage applied for 1~5 seconds 2. Ur ≤ 100 V: series applied 2.5 Ur 3. 100 V < Ur ≤ 200 V series applied (1.5 Ur + 100) 4. 200 V < Ur ≤ 500 V series applied (1.3 Ur + 100) 5. Ur > 500 V: 1.3 Ur 6. Ur ≥ 1000 V: 1.2 Ur Charge/Discharge current is less than 50 mA	No breakdown or flashover

Step	Temperature(°C)
a	25±2
b	Lower temperature±3°C
c	25±2
d	Upper Temperature±2°C
e	25±2

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TEST	TEST METHOD	PROCEDURE	REQUIREMENTS
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 and has a layer-thickness 35 µm ± 10 µm. Part should be mounted using the following soldering reflow profile. Conditions: Class2: Bending 5 mm at a rate of 1 mm/s, radius jig 230 mm Test Substrate:  unit: mm	No visible damage ΔC/C NPO: Within ±1% or 0.5 pF, whichever is greater X7R: ±10%

	Dimension(mm)		
Type	a	b	c
0201	0.3	0.9	0.3
0402	0.4	1.5	0.5
0603	1.0	3.0	1.2
0805	1.2	4.0	1.65
1206	2.2	5.0	1.65
1210	2.2	5.0	2.0
1808	3.5	7.0	3.7

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. * Apply 2N force for 0402 size.	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.	≤ 0805 Thickness > 0.5 mm: 20N Thickness ≤ 0.5 mm: 8N ≥ 1206 Thickness ≥1.25 mm: 54N Thickness < 1.25 mm: 15N

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REVISION HISTORY

REVISION	DATE	CHANGE NOTIFICATION	DESCRIPTION
Version 4	May 21, 2024	--	- Add 1206/NPO/630V/1.5nF to 10nF - Add 1210/NPO/630V/4.7nF to 33nF - Add 1210/NPO/1000V/4.7nF to 22nF
Version 3	Nov. 28, 2022	-	- Update Biased Humidity and operation life requirements.
Version 2	Dec. 21, 2020	-	- Add X7R product range, 0603, 1nF to 15nF, 16 to 100V
Version 1	Dec. 04, 2018	-	- Add 0603/ 22nF to 100nF
Version 0	Oct. 05, 2017	-	- New

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