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 = $12 \times 10^1$ = 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.

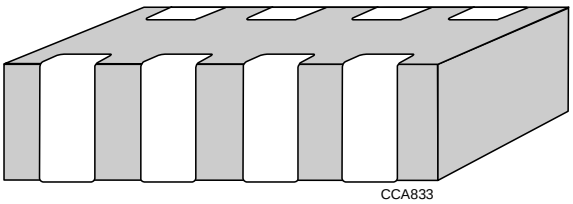



Fig. 1 Simplified outline

## OUTLINES

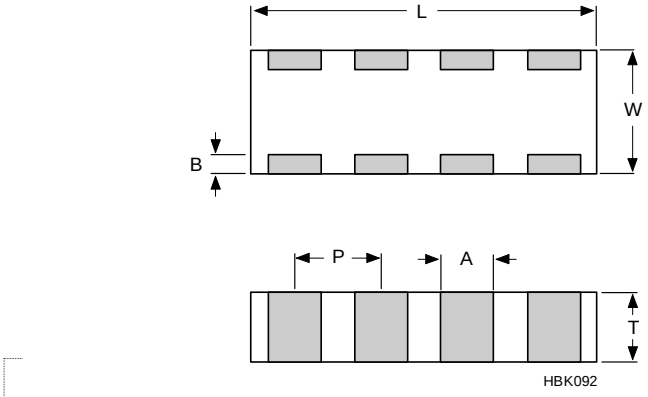



Fig. 2 Surface mounted multilayer ceramic capacitor dimension

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

## 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:<br>At 20 °C, 24 hours after annealing<br>f = 1 MHz for C ≤ 1nF, measuring at voltage 1 $V_{rms}$ at 20 °C<br>f = 1 KHz for C > 1nF, measuring at voltage 1 $V_{rms}$ at 20 °C<br>Class 2:<br>At 20 °C, 24 hours after annealing<br>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:<br>At 20 °C, 24 hours after annealing<br>f = 1 MHz for C ≤ 1nF, measuring at voltage 1 $V_{rms}$ at 20 °C<br>f = 1 KHz for C > 1nF, measuring at voltage 1 $V_{rms}$ at 20 °C<br>Class 2:<br>At 20 °C, 24 hours after annealing<br>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<br>Measurement at 24±2 hours after test conclusion. | No visual damage<br>ΔC/C :<br>Class1:<br>NP0: within ±0.5% or 0.5 pF whichever is greater<br>Class2:<br>X7R: ±10%<br>D.F.:<br>within initial specified value<br>IR:<br>within initial specified value |

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

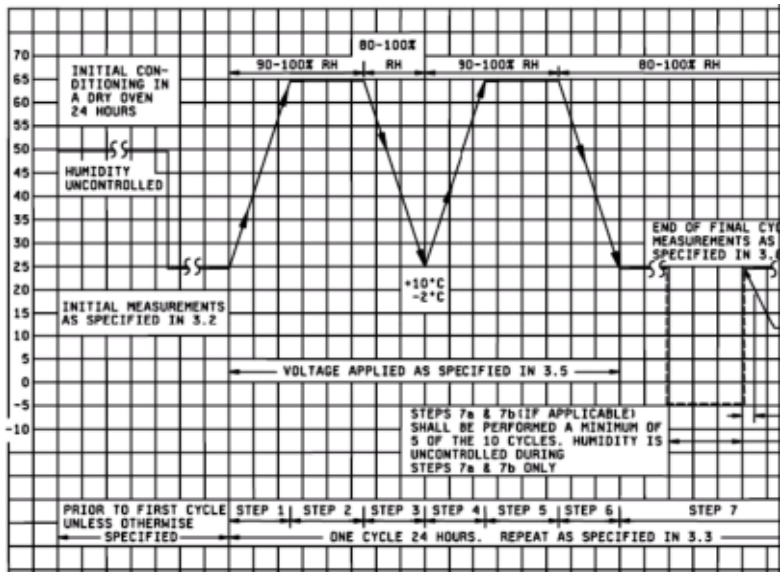
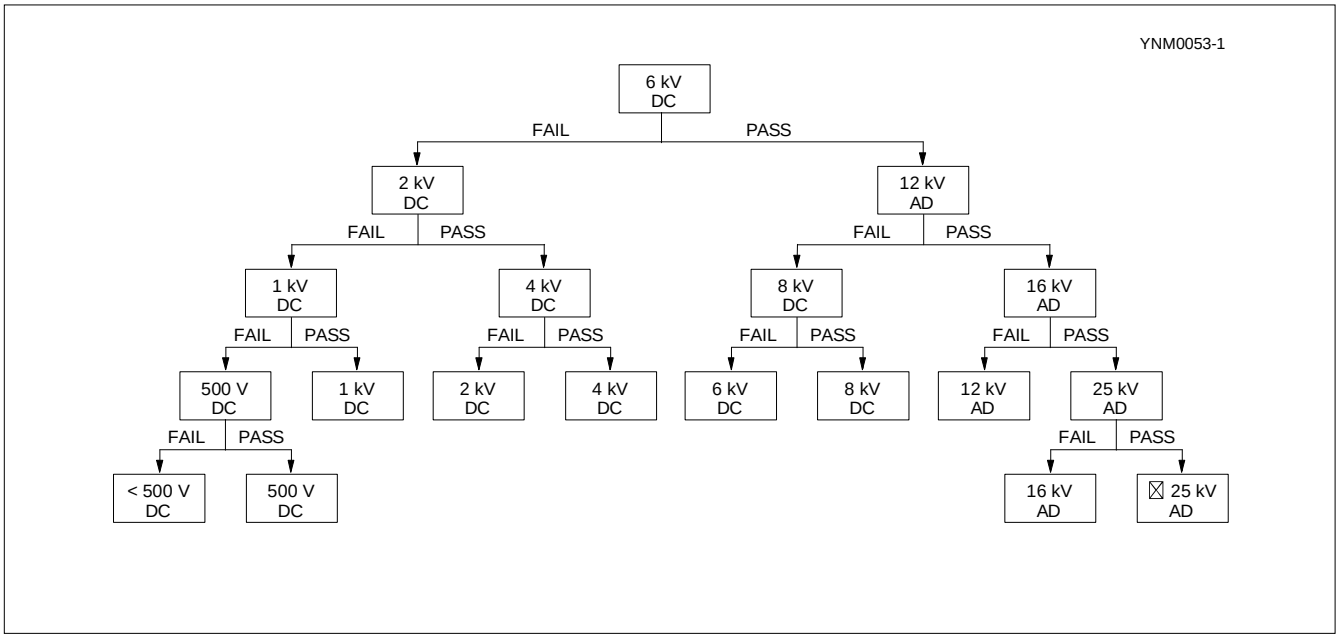



Fig. 4 Moisture resistant

| TEST | TEST METHOD | | PROCEDURE | REQUIREMENTS |
|---|---|---|---|---|
| Biased Humidity | AEC-Q200 | 7 | 1. Preconditioning, class 2 only:<br>150 +0/-10 °C /1 hour, then keep for<br>24 ±1 hour at room temp<br>2. Initial measure:<br>Parameter: IR<br>Measuring voltage: 1.5V ± 0.1 VDC<br>Note: Series with 100 KΩ<br>3. Test condition:<br>85 °C, 85% R.H. connected with 100 KΩ resistor, applied 1.5V/$U_r$ for 1,000 hours.<br>4. Recovery:<br>Class1: 6 to 24 hours<br>Class2: 24 ±2 hours<br>5. Final measure: Cap, D.F., I.R. | No visual damage after recovery<br><br>ΔC/C<br>NPO: Within ± 2% or 1 pF, whichever is greater<br>X7R: ± 15%<br><br>D.F.<br>NPO: ≤ 2 x specified value.<br>X7R/X7S:<br>(1) ≤ 16V: ≤ 7% or specified value whichever is greater<br>(2) ≥ 25V: ≤ 5% or specified value whichever is greater<br><br>I.R.<br>The insulation resistance shall greater than 10% of initial spec. |
| Operational Life | AEC-Q200 | 8 | 1. Preconditioning, class 2 only:<br>150 +0/-10 °C /1 hour, then keep for<br>24 ±1 hour at room temp<br>2. Initial measure:<br>Spec: refer to initial spec C, D, IR<br>3. Endurance test:<br>Temperature: X7R: 125 °C<br>Specified stress voltage applied for 1,000 hours:<br>Applied 2.0 x $U_r$ s<br>4. Recovery time: 24 ±2 hours<br>5. Final measure: C, D, IR<br><br>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<br><br>ΔC/C<br>NP0: Within ±2% or 1 pF, whichever is greater<br>X7R: ±15%<br><br>D.F.<br>NP0: ≤ 2 x specified value.<br>X7R: ≤ 16V: ≤ 7% or specified value whichever is greater<br>≥ 25V: ≤ 5% or specified value whichever is greater<br><br>IR<br>NP0: ≥ 4,000 MΩ or IR x $C_r$ ≥ 40s whichever is less<br>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)<br>Peak value: 1,500 g's<br>Duration: 0.5 ms<br>Velocity change: 15.4 ft/s<br>Waveform: Half-sin | ΔC/C<br>NP0: Within ±0.5% or 0.5 pF, whichever is greater<br>X7R: ±10%<br><br>D.F.<br>Within initial specified value<br>IR<br>Within initial specified value |
| Vibration | AEC-Q200 | 14 | 5 g's for 20 minutes, 12 cycles each of 3 orientations. | ΔC/C<br>NP0: Within ±0.5% or 0.5 pF, whichever is greater<br>X7R: ±10%<br><br>D.F: meet initial specified value<br>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<br>Preheating: 120 °C to 150 °C for 1 minute<br>Solder bath temperature: 260 ±5 °C<br>Dipping time: 10 ±0.5 seconds<br>Recovery time: 24 ±2 hours | Dissolution of the end face plating shall not exceed 25% of the length of the edge concerned<br><br>ΔC/C<br>Class1:<br>NP0: Within ±1% or 0.5 pF, whichever is greater.<br>Class2:<br>X7R: ±10%<br><br>D.F. within initial specified value<br>IR within initial specified value |
| Thermal Shock | AEC-Q200 | 16 | 1. Preconditioning, class 2 only:<br>150 +0/-10 °C /1 hour, then keep for 24 ±1 hour at room temp<br>2. Initial measure:<br>Spec: refer to initial spec C, D, IR<br>3. Rapid change of temperature test:<br>NP0/X7R: -55 °C to +125 °C; 300 cycles<br>15 minutes at lower category temperature; 15 minutes at upper category temperature.<br>4. Recovery time:<br>Class1: 6 to 24 hours<br>Class2: 24 ±2 hours<br>5. Final measure: C, D, IR | No visual damage<br><br>ΔC/C<br>NP0: Within ±1% or 1 pF, whichever is greater<br>X7R: ±15%<br><br>D.F: meet initial specified value<br>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.<br>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.<br>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.<br><br>Class 1:<br>NP0: -55 °C to +125 °C<br>Normal temperature: 20 °C<br>Class 2:<br>X7R: -55 °C to +125 °C<br>Normal temperature: 20 °C | ΔC/C<br>Class 1:<br>NP0: ±30 ppm/°C<br>Class2:<br>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<br>Part should be mounted using the following soldering reflow profile.<br>Conditions:<br>Class1:<br>Bending 3 mm at a rate of 1 mm/s, radius jig 340 mm<br>Class2:<br>Bending 2 mm at a rate of 1 mm/s, radius jig 340 mm | No visible damage<br>ΔC/C<br>Class1:<br>NP0: Within ±1% or 0.5 pF, whichever is greater<br>Class2:<br>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.<br>This force shall be applied for 60+1 seconds.<br>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.<br>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<br>0612: 15N |
| Voltage Proof | | | 1. Specified stress voltage applied for 1~5 seconds<br>2. Ur ≤ 100 V: applied 2.5 Ur<br><br>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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