

TO. : BLUME

NO. : A240829



# APPROVAL SHEET

## MULTILAYER CERAMIC CAPACITOR

Automotive Grade, Soft Termination Type

(AEC-Q200 Qualified)

Approved by customer : (signing or stamping here)

| SAMWHA CAPACITOR CO., LTD.                                                          |                                                                                     |                                                                                       |
|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
| Prepared by                                                                         | Checked by                                                                          | Approved by                                                                           |
|  |  |  |

2024. 08. 29.



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## < SPECIFICATION SUMMARY >

|                       |                                 |        |                                                                                                                           |
|-----------------------|---------------------------------|--------|---------------------------------------------------------------------------------------------------------------------------|
| SAMWHA Part no.       | CQ2012X7R473K500ORE             |        |                                                                                                                           |
| Type                  | MLCC for Automotive Application |        |                                                                                                                           |
| Items                 | Specification                   | Unit   | Test Conditions                                                                                                           |
| Capacitance           | 47                              | nF     | Testing Frequency : 1 ±0.1 kHz<br>Testing Voltage : 1 ±0.2 Vrms<br>Should be measured at 25℃.                             |
| Capacitance Tolerance | ± 10                            | %      |                                                                                                                           |
| Dissipation Factor    | Max. 2.5                        | %      |                                                                                                                           |
| Insulation Resistance | Min. 10,000                     | MΩ     | Should be measured with a DC voltage not exceeding rated voltage at 25℃ for 2 minutes of charging.                        |
| Chip Size             | 2.00 -0.20/+0.30                | L (mm) | Capacitance Tolerance Code ----- page 1/9<br>Chip size ----- page 2/9<br>Characteristics & Test Method ----- page 3/9~6/9 |
|                       | 1.25 ±0.20                      | W (mm) |                                                                                                                           |
|                       | 1.25 ±0.20                      | T (mm) |                                                                                                                           |

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|                             |                                                                                       |      |              |
|-----------------------------|---------------------------------------------------------------------------------------|------|--------------|
| Enactment :<br>Feb. 1, 2010 | <b>STANDARD</b>                                                                       | NO   | SW - Q - 01A |
|                             | <b>MULTILAYER CERAMIC CAPACITOR</b><br><b>Automotive Grade, Soft Termination Type</b> | Page | 1 / 9        |

\*Caution : Reflow soldering only

## 1. General Code

### (1) Type Designation

**CQ**   **2012**   **X7R**   **473**   **K**   **500**   **O**   **R**   **E**  
(1)        (2)        (3)        (4)        (5)        (6)        (7)        (8)        (9)

1) Multilayer Ceramic Capacitor (Automotive Grade)

2) Size Code :

This is expressed in tens of a millimeter.

The first two digits are the length, The last two digits are width.

3) Temperature Coefficient Code

| Classification | Code | Temperature Range | Capacitance Tolerance |
|----------------|------|-------------------|-----------------------|
| Class I        | C0G  | -55 to +125℃      | ±30 ppm/℃             |
| Class II       | X7R  | -55 to +125℃      | ±15%                  |
|                | X7S  | -55 to +125℃      | ±22%                  |
|                | X7T  | -55 to +125℃      | +22% ~ -33%           |
|                | X6S  | -55 to +105℃      | ±22%                  |

4) Capacitance Code(Pico farads) :

The nominal Capacitance Value in pF is expressed by three digit numbers.

The first two digits represents significant figures and the last digit denotes the number of zero

ex) 104 = 100000 pF

R denotes decimal

8R2 = 8.2 pF

5) Capacitance Tolerance Code

| Code | Tolerance |
|------|-----------|
| B    | ± 0.1 pF  |
| C    | ± 0.25 pF |
| D    | ± 0.5 pF  |
| F    | ± 1.0 %   |

| Code | Tolerance |
|------|-----------|
| G    | ± 2.0 %   |
| J    | ± 5 %     |
| K    | ± 10 %    |
| M    | ± 20 %    |

6) Voltage Code

| Code          | 6R3     | 100    | 160    | 250    | 350    | 500    | 101     | 201     | 251     | 501     | 631     | 102    | 202    | 302    |
|---------------|---------|--------|--------|--------|--------|--------|---------|---------|---------|---------|---------|--------|--------|--------|
| Rated Voltage | DC 6.3V | DC 10V | DC 16V | DC 25V | DC 35V | DC 50V | DC 100V | DC 200V | DC 250V | DC 500V | DC 630V | DC 1KV | DC 2KV | DC 3KV |

7) Termination Code

N : Nickel-Tin Plate

A : Nickel-Tin Plate -> Soft Termination Type

O : Open mode Type

8) Packing Code

R : 7" Reel Type,    L : 13" Reel Type,    B : Bulk Type

## 9) Thickness option

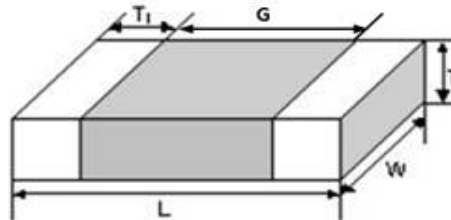
| Thickness (mm) |        | Code  | Thickness (mm) |        | Code |
|----------------|--------|-------|----------------|--------|------|
| t              | Tol(±) |       | t              | Tol(±) |      |
| 0.50           | 0.10   | Blank | 1.35           | 0.20   | H    |
| 0.60           | 0.10   | A     | 1.60           | 0.30   | I    |
| 0.80           | 0.15   | B     | 1.80           | 0.30   | J    |
| 0.85           | 0.15   | B     | 2.00           | 0.30   | K    |
| 1.00           | 0.15   | E     | 2.50           | 0.30   | L    |
| 1.10           | 0.15   | E     | 2.80           | 0.30   | M    |
| 1.15           | 0.20   | E     | 3.20           | 0.40   | N    |
| 1.25           | 0.20   | E     | 5.00           | 0.50   | O    |
| 1.30           | 0.20   | E     |                |        |      |

## 2. Temperature Characteristics

See Page 6/9 (No.21)

## 3. Constructions and Dimensions

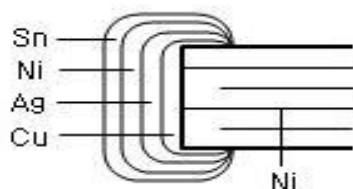
## (1) Dimensions



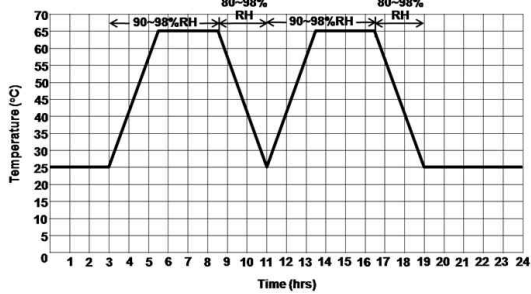
| Size Code | EIA Code | Dimension |        |        |       |        |          |         |
|-----------|----------|-----------|--------|--------|-------|--------|----------|---------|
|           |          | Length    |        |        | Width |        | T1(min.) | G(min.) |
|           |          | L         | Tol(-) | Tol(+) | W     | Tol(±) |          |         |
| 1005      | 0402     | 1.00      | 0.05   | 0.10   | 0.50  | 0.10   | 0.15     | 0.30    |
| 1608      | 0603     | 1.60      | 0.15   | 0.20   | 0.80  | 0.15   | 0.20     | 0.50    |
| 2012      | 0805     | 2.00      | 0.20   | 0.30   | 1.25  | 0.20   | 0.20     | 0.70    |
| 3216      | 1206     | 3.20      | 0.50   | 0.50   | 1.60  | 0.30   | 0.30     | 1.20    |
| 3225      | 1210     | 3.20      | 0.50   | 0.50   | 2.50  | 0.30   | 0.30     | 1.00    |
| 4520      | 1808     | 4.50      | 0.50   | 0.50   | 2.00  | 0.30   | 0.30     | 1.00    |
| 4532      | 1812     | 4.50      | 0.50   | 0.50   | 3.20  | 0.40   | 0.30     | 2.20    |
| 5750      | 2220     | 5.70      | 0.30   | 0.70   | 5.00  | 0.50   | 0.30     | 3.20    |

(Unit : mm)

## (2) Construction of Termination



## Specifications and Test Methods (For Automotive Applications)

| No.                | AEC-Q200 Test Item                                                      |                                                                   | Specification                                                                                                    |                                                                   | Test Methods and Conditions                                                                                                                                                                                                                                                                                                                                                                                                     |          |      |   |   |   |          |          |      |          |      |           |      |   |      |   |
|--------------------|-------------------------------------------------------------------------|-------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|------|---|---|---|----------|----------|------|----------|------|-----------|------|---|------|---|
|                    |                                                                         |                                                                   | Class I                                                                                                          | Class II                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                 |          |      |   |   |   |          |          |      |          |      |           |      |   |      |   |
| 1                  | Pre-and Post-Stress Electrical Test                                     |                                                                   | -                                                                                                                |                                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                 |          |      |   |   |   |          |          |      |          |      |           |      |   |      |   |
| 2                  | High Temperature Exposure                                               | Appearance                                                        | No defects which may affect performance                                                                          |                                                                   | Temperature : Max. operating temperature±3℃<br>Maintenance Time : 1000+48/-0 hrs<br>Let sit for 24±2 hours at room temperature, then measure.                                                                                                                                                                                                                                                                                   |          |      |   |   |   |          |          |      |          |      |           |      |   |      |   |
|                    |                                                                         | Capacitance Change                                                | Within ±2.5% or ±0.25pF (Whichever is larger)                                                                    | Within ±10.0% (*Within ±12.5%)                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                 |          |      |   |   |   |          |          |      |          |      |           |      |   |      |   |
|                    |                                                                         | Q/D.F.                                                            | 30pF min.: Q≥1000<br>30pF max.: Q≥400+20×C<br>C: Nominal Capacitance (pF)                                        | Rated Voltage 16V min.: 0.05 max.<br>10V: 0.075 max.<br>*0.2 max. |                                                                                                                                                                                                                                                                                                                                                                                                                                 |          |      |   |   |   |          |          |      |          |      |           |      |   |      |   |
|                    |                                                                         | I.R.                                                              | More than 10,000MΩ or 500Ω·F (*50Ω·F) (Whichever is smaller)                                                     |                                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                 |          |      |   |   |   |          |          |      |          |      |           |      |   |      |   |
| 3                  | Temperature Cycling                                                     | Appearance                                                        | No defects which may affect performance                                                                          |                                                                   | Perform the 1000 cycles according to the four heat treatments listed in the following table.<br>Let sit for 24±2 hours at room temperature, then measure. <table><tr><td>Step</td><td>1</td><td>2</td><td>3</td><td>4</td></tr><tr><td>Temp.(℃)</td><td>-55+0/-3</td><td>25±2</td><td>125+3/-0</td><td>25±2</td></tr><tr><td>Time(min)</td><td>15±3</td><td>1</td><td>15±3</td><td>1</td></tr></table>                          | Step     | 1    | 2 | 3 | 4 | Temp.(℃) | -55+0/-3 | 25±2 | 125+3/-0 | 25±2 | Time(min) | 15±3 | 1 | 15±3 | 1 |
|                    |                                                                         | Step                                                              | 1                                                                                                                | 2                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                 | 3        | 4    |   |   |   |          |          |      |          |      |           |      |   |      |   |
|                    |                                                                         | Temp.(℃)                                                          | -55+0/-3                                                                                                         | 25±2                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                 | 125+3/-0 | 25±2 |   |   |   |          |          |      |          |      |           |      |   |      |   |
|                    |                                                                         | Time(min)                                                         | 15±3                                                                                                             | 1                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                 | 15±3     | 1    |   |   |   |          |          |      |          |      |           |      |   |      |   |
| Capacitance Change | Within ±2.5% or ±0.25pF (Whichever is larger)                           | Within ±10.0%                                                     |                                                                                                                  |                                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                 |          |      |   |   |   |          |          |      |          |      |           |      |   |      |   |
| Q/D.F.             | 30pF min.:Q≥1000<br>30pF max.:Q≥400+20×C<br>C: Nominal Capacitance (pF) | Rated Voltage 16V min.: 0.05 max.<br>10V: 0.075 max.<br>*0.2 max. |                                                                                                                  |                                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                 |          |      |   |   |   |          |          |      |          |      |           |      |   |      |   |
| I.R.               | More than 10,000MΩ or 500Ω·F (*50Ω·F) (Whichever is smaller)            |                                                                   | Initial measurement<br>Perform the initial measurement according to Note 1 for Class II.                         |                                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                 |          |      |   |   |   |          |          |      |          |      |           |      |   |      |   |
| 4                  | Destructive Physical Analysis                                           |                                                                   | No defects or abnormalities                                                                                      |                                                                   | Per EIA-469                                                                                                                                                                                                                                                                                                                                                                                                                     |          |      |   |   |   |          |          |      |          |      |           |      |   |      |   |
| 5                  | Moisture Resistance                                                     | Appearance                                                        | No defects which may affect performance                                                                          |                                                                   | Temperature : 25~65℃, Humidity : 80~98%<br>Cycle Time : 24 hrs/cycle, 10 cycles<br>Let sit for 24±2 hours at room temperature, then measure.                                                                                                                                                                                                |          |      |   |   |   |          |          |      |          |      |           |      |   |      |   |
|                    |                                                                         | Capacitance Change                                                | Within ±3.0% or±0.30pF (Whichever is larger)                                                                     | Within ±12.5%                                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                 |          |      |   |   |   |          |          |      |          |      |           |      |   |      |   |
|                    |                                                                         | Q/D.F.                                                            | 30pF min.: Q≥350<br>10pF min. and 30pF max.: Q≥275+5/2×C<br>10pF max.: Q≥200+10×C<br>C: Nominal Capacitance (pF) | Rated Voltage 16V min.: 0.05 max.<br>10V: 0.075 max.<br>*0.2 max. |                                                                                                                                                                                                                                                                                                                                                                                                                                 |          |      |   |   |   |          |          |      |          |      |           |      |   |      |   |
|                    |                                                                         | I.R.                                                              | More than 10,000MΩ or 500Ω·F (*50Ω·F) (Whichever is smaller)                                                     |                                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                 |          |      |   |   |   |          |          |      |          |      |           |      |   |      |   |
| 6                  | Humidity Bias                                                           | Appearance                                                        | No defects which may affect performance                                                                          |                                                                   | Temperature : 85±3℃<br>Humidity : 80~85%<br>Applied Voltage : Rated Voltage and 1.3+0.2/-0V<br>Maintenance Time : 1000+48/-0 hrs<br>Let sit for 24±2 hours at room temperature, then measure.<br>The charge/discharge current is less than 50mA.                                                                                                                                                                                |          |      |   |   |   |          |          |      |          |      |           |      |   |      |   |
|                    |                                                                         | Capacitance Change                                                | Within ±3.0% or ±0.30pF (Whichever is larger)                                                                    | Within ±12.5%                                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                 |          |      |   |   |   |          |          |      |          |      |           |      |   |      |   |
|                    |                                                                         | Q/D.F.                                                            | 30pF min.: Q≥200<br>30pF max.: Q≥100+10/3×C<br>C: Nominal Capacitance (pF)                                       | Rated Voltage 16V min.: 0.05 max.<br>10V: 0.075 max.<br>*0.2 max. |                                                                                                                                                                                                                                                                                                                                                                                                                                 |          |      |   |   |   |          |          |      |          |      |           |      |   |      |   |
|                    |                                                                         | I.R.                                                              | More than 1,000MΩ or 50Ω·F (*5Ω·F) (Whichever is smaller)                                                        |                                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                 |          |      |   |   |   |          |          |      |          |      |           |      |   |      |   |
| 7                  | High Temperature Operating Life                                         | Appearance                                                        | No defects which may affect performance                                                                          |                                                                   | Temperature : Max. operating temperature±3℃<br>Applied Voltage : Rated Voltage × 200% (*150%)<br>Maintenance Time : 1000+48/-0 hrs<br>Let sit for 24±2 hours at room temperature, then measure.<br>The charge/discharge current is less than 50mA.<br><br>Initial Measurement for Class II<br>Applied 200% of the rated voltage for one hour at 125±3℃.<br>Remove and let sit for 24±2 hours at room temperature, then measure. |          |      |   |   |   |          |          |      |          |      |           |      |   |      |   |
|                    |                                                                         | Capacitance Change                                                | Within ±3.0% or ±0.30pF (Whichever is larger)                                                                    | Within ±12.5%                                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                 |          |      |   |   |   |          |          |      |          |      |           |      |   |      |   |
|                    |                                                                         | Q/D.F.                                                            | 30pF min.:Q≥350<br>10pF min. and 30pF max.: Q≥275+5/2×C<br>10pF max.: Q≥200+10×C<br>C: Nominal Capacitance (pF)  | Rated Voltage 16V min.: 0.05 max.<br>10V: 0.075 max.<br>*0.2 max. |                                                                                                                                                                                                                                                                                                                                                                                                                                 |          |      |   |   |   |          |          |      |          |      |           |      |   |      |   |
|                    |                                                                         | I.R.                                                              | More than 1,000MΩ or 50Ω·F (*5Ω·F) (Whichever is smaller)                                                        |                                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                 |          |      |   |   |   |          |          |      |          |      |           |      |   |      |   |

## Specifications and Test Methods (For Automotive Application)

| No. | AEC-Q200<br>Test Item           | Specification                   |                                                                                                | Test Methods and Conditions                                                                         |
|-----|---------------------------------|---------------------------------|------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------|
|     |                                 | Class I                         | Class II                                                                                       |                                                                                                     |
| 8   | External Visual                 | No defects or abnormalities     |                                                                                                | Visual inspection                                                                                   |
| 9   | Physical Dimension              | Within the specified dimensions |                                                                                                | Using calipers                                                                                      |
| 10  | Resistance<br>to Solvents       | Appearance                      | No defects which may affect performance                                                        |                                                                                                     |
|     |                                 | Capacitance<br>Change           | Within the specified tolerance                                                                 |                                                                                                     |
|     |                                 | Q/D.F.                          | 30pF min.: $Q \geq 1000$<br>30pF max.: $Q \geq 400+20 \times C$<br>C: Nominal Capacitance (pF) | Rated Voltage 50V: 0.025 max.<br>25V: 0.03 max.<br>16V: 0.035 max.<br>10V: 0.05 max.<br>*0.125 max. |
|     |                                 | I.R.                            | More than 10,000M $\Omega$ or 500 $\Omega$ -F (*50 $\Omega$ -F)<br>(Whichever is smaller)      |                                                                                                     |
| 11  | Mechanical<br>Shock             | Appearance                      | No defects which may affect performance                                                        |                                                                                                     |
|     |                                 | Capacitance<br>Change           | Within the specified tolerance                                                                 |                                                                                                     |
|     |                                 | Q/D.F.                          | 30pF min.: $Q \geq 1000$<br>30pF max.: $Q \geq 400+20 \times C$<br>C: Nominal Capacitance (pF) | Rated Voltage 50V: 0.025 max.<br>25V: 0.03 max.<br>16V: 0.035 max.<br>10V: 0.05 max.<br>*0.125 max. |
|     |                                 | I.R.                            | More than 10,000M $\Omega$ or 500 $\Omega$ -F (*50 $\Omega$ -F)<br>(Whichever is smaller)      |                                                                                                     |
| 12  | Vibration                       | Appearance                      | No defects or abnormalities                                                                    |                                                                                                     |
|     |                                 | Capacitance<br>Change           | Within the specified tolerance                                                                 |                                                                                                     |
|     |                                 | Q/D.F.                          | 30pF min.: $Q \geq 1000$<br>30pF max.: $Q \geq 400+20 \times C$<br>C: Nominal Capacitance (pF) | Rated Voltage 50V: 0.025 max.<br>25V: 0.03 max.<br>16V: 0.035 max.<br>10V: 0.05 max.<br>*0.125 max. |
|     |                                 | I.R.                            | More than 10,000M $\Omega$ or 500 $\Omega$ -F (*50 $\Omega$ -F)<br>(Whichever is smaller)      |                                                                                                     |
| 13  | Resistance<br>to Solder<br>Heat | Appearance                      | No defects which may affect performance                                                        |                                                                                                     |
|     |                                 | Capacitance<br>Change           | Within the specified tolerance                                                                 |                                                                                                     |
|     |                                 | Q/D.F.                          | 30pF min.: $Q \geq 1000$<br>30pF max.: $Q \geq 400+20 \times C$<br>C: Nominal Capacitance (pF) | Rated Voltage 50V: 0.025 max.<br>25V: 0.03 max.<br>16V: 0.035 max.<br>10V: 0.05 max.<br>*0.125 max. |
|     |                                 | I.R.                            | More than 10,000M $\Omega$ or 500 $\Omega$ -F (*50 $\Omega$ -F)<br>(Whichever is smaller)      |                                                                                                     |
| 14  | Thermal<br>Shock                | Appearance                      | No defects which may affect performance                                                        |                                                                                                     |
|     |                                 | Capacitance<br>Change           | Within $\pm 2.5\%$ or $\pm 0.25\text{pF}$<br>(Whichever is larger)                             | Within $\pm 15.0\%$                                                                                 |
|     |                                 | Q/D.F.                          | 30pF min.: $Q \geq 1000$<br>30pF max.: $Q \geq 400+20 \times C$<br>C: Nominal Capacitance (pF) | Rated Voltage 50V: 0.025 max.<br>25V: 0.03 max.<br>16V: 0.035 max.<br>10V: 0.05 max.<br>*0.125 max. |
|     |                                 | I.R.                            | More than 10,000M $\Omega$ or 500 $\Omega$ -F (*50 $\Omega$ -F)<br>(Whichever is smaller)      |                                                                                                     |

Per MIL-STD-202 Method 215

Three shocks in each direction should be applied along 3 mutually perpendicular axes of the test specimen (18 shocks)  
 Test Pulse  
 Wave form : Half-sine  
 Duration : 0.5ms  
 Peak value : 1,500G  
 Velocity change : 4.7m/s

The specimens should be subjected to a simple harmonic motion having a total amplitude of 1.5mm. The entire frequency range of 10 to 2,000 Hz and return to 10 Hz should be traversed in 20 minutes. This cycle should be performed 12 times in each of three mutually perpendicular directions (total of 36 times).

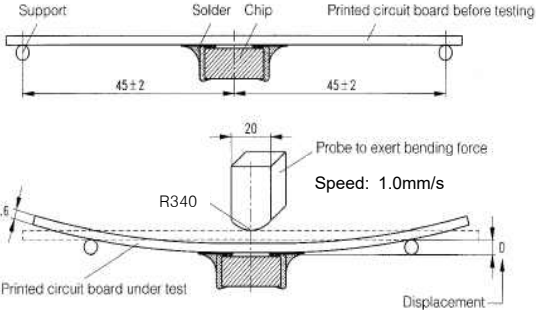
Temperature (Eutectic solder solution) :  $260 \pm 5^\circ\text{C}$   
 Dipping Time :  $10 \pm 1\text{s}$   
 Let sit for  $24 \pm 2$  hours at room temperature, then measure.  
 Initial measurement  
 Perform the initial measurement according to Note 1 for Class II.

Perform the 300 cycles according to the two heat treatments listed in the following table.  
 Transfer Time : 20sec. max.

|                           |            |            |
|---------------------------|------------|------------|
| Step                      | 1          | 2          |
| Temp.( $^\circ\text{C}$ ) | $-55+0/-3$ | $125+3/-0$ |
| Time(min.)                | $15 \pm 3$ | $15 \pm 3$ |

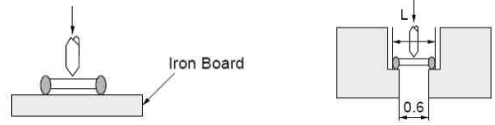
Initial measurement  
 Perform the initial measurement according to Note 1 for Class II.

## Specifications and Test Methods (For Automotive Application)

| No.           | AEC-Q200<br>Test Item                                  |                                                           | Specification                                                                                               |                                                                                                         | Test Methods and Conditions                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |       |                 |           |         |         |          |          |           |          |          |           |          |        |          |             |        |          |             |
|---------------|--------------------------------------------------------|-----------------------------------------------------------|-------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|-----------------|-----------|---------|---------|----------|----------|-----------|----------|----------|-----------|----------|--------|----------|-------------|--------|----------|-------------|
|               |                                                        |                                                           | Class I                                                                                                     | Class II                                                                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |       |                 |           |         |         |          |          |           |          |          |           |          |        |          |             |        |          |             |
| 15            | ESD                                                    | Appearance                                                | No defects which may affect performance                                                                     |                                                                                                         | Per AEC-Q200-002                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |       |                 |           |         |         |          |          |           |          |          |           |          |        |          |             |        |          |             |
|               |                                                        | Capacitance Change                                        | Within the specified tolerance                                                                              |                                                                                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |       |                 |           |         |         |          |          |           |          |          |           |          |        |          |             |        |          |             |
|               |                                                        | Q/D.F.                                                    | 30pF min.: $Q \geq 1000$<br>30pF max.: $Q \geq 400+20 \times C$<br>C: Nominal Capacitance (pF)              | Rated Voltage 50V: 0.025 max.<br>25V: 0.03 max.<br>16V: 0.035 max.<br>10V: 0.05 max.<br><br>*0.125 max. |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |       |                 |           |         |         |          |          |           |          |          |           |          |        |          |             |        |          |             |
|               |                                                        | I.R.                                                      | More than 10,000MΩ or 500Ω·F (*50Ω·F)<br>(Whichever is smaller)                                             |                                                                                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |       |                 |           |         |         |          |          |           |          |          |           |          |        |          |             |        |          |             |
| 16            | Solderability                                          |                                                           | 95% of the terminations is to be soldered evenly and continuously.                                          |                                                                                                         | (a) Preheat at 155℃ for 4 hours, and then immerse the capacitor in a solution of ethanol and rosin. Immerse in eutectic solder solution for 5+0/-0.5 seconds at 235±5℃.<br>(b) Steam aging for 8 hours, and then immerse the capacitor in a solution of ethanol and rosin. Immerse in eutectic solder solution for 5+0/-0.5 seconds at 235±5℃.<br>(c) Steam aging for 8 hours, and then immerse the capacitor in a solution of ethanol and rosin. Immerse in eutectic solder solution for 120±5 seconds at 260±5℃.                                                                                           |       |                 |           |         |         |          |          |           |          |          |           |          |        |          |             |        |          |             |
| 17            | Electrical Characterization                            | Appearance                                                | No defects or abnormalities                                                                                 |                                                                                                         | The capacitance/Q/D.F. should be measured at 25℃ at the frequency and voltage shown in the table.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |       |                 |           |         |         |          |          |           |          |          |           |          |        |          |             |        |          |             |
|               |                                                        | Capacitance Change                                        | Within the specified tolerance                                                                              |                                                                                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |       |                 |           |         |         |          |          |           |          |          |           |          |        |          |             |        |          |             |
|               |                                                        | Q/D.F.                                                    | 30pF min.: $Q \geq 1000$<br>30pF max.: $Q \geq 400+20 \times C$<br>C: Nominal Capacitance (pF)              | Rated Voltage 50V: 0.025 max.<br>25V: 0.03 max.<br>16V: 0.035 max.<br>10V: 0.05 max.<br><br>*0.125 max. | <table><tr><th>Class</th><th>Capacitance (C)</th><th>Frequency</th><th>Voltage</th></tr><tr><td rowspan="2">Class I</td><td>C&lt;1000pF</td><td>1±0.1MHz</td><td>0.5~5Vrms</td></tr><tr><td>C≥1000pF</td><td>1±0.1kHz</td><td>1±0.2Vrms</td></tr><tr><td rowspan="2">Class II</td><td>C≤10μF</td><td>1±0.1kHz</td><td>0.5~1.0Vrms</td></tr><tr><td>C&gt;10μF</td><td>120±24Hz</td><td>0.5±0.1Vrms</td></tr></table><br>· Initial measurement<br>Perform the initial measurement according to Note1 for Class II<br>· Measurement after test<br>Take it out and set it for 24±2 hours (Class II) then measure | Class | Capacitance (C) | Frequency | Voltage | Class I | C<1000pF | 1±0.1MHz | 0.5~5Vrms | C≥1000pF | 1±0.1kHz | 1±0.2Vrms | Class II | C≤10μF | 1±0.1kHz | 0.5~1.0Vrms | C>10μF | 120±24Hz | 0.5±0.1Vrms |
|               |                                                        | Class                                                     | Capacitance (C)                                                                                             | Frequency                                                                                               | Voltage                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |       |                 |           |         |         |          |          |           |          |          |           |          |        |          |             |        |          |             |
|               |                                                        | Class I                                                   | C<1000pF                                                                                                    | 1±0.1MHz                                                                                                | 0.5~5Vrms                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |       |                 |           |         |         |          |          |           |          |          |           |          |        |          |             |        |          |             |
|               |                                                        |                                                           | C≥1000pF                                                                                                    | 1±0.1kHz                                                                                                | 1±0.2Vrms                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |       |                 |           |         |         |          |          |           |          |          |           |          |        |          |             |        |          |             |
| Class II      | C≤10μF                                                 | 1±0.1kHz                                                  | 0.5~1.0Vrms                                                                                                 |                                                                                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |       |                 |           |         |         |          |          |           |          |          |           |          |        |          |             |        |          |             |
|               | C>10μF                                                 | 120±24Hz                                                  | 0.5±0.1Vrms                                                                                                 |                                                                                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |       |                 |           |         |         |          |          |           |          |          |           |          |        |          |             |        |          |             |
| I.R. at 25℃   | More than 100,000MΩ or 1,000Ω·F (Whichever is smaller) | More than 10,000MΩ 500Ω·F (*50Ω·F) (Whichever is smaller) | Should be measured with a DC voltage not exceeding rated voltage at 25℃ and 125℃ for 2 minutes of charging. |                                                                                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |       |                 |           |         |         |          |          |           |          |          |           |          |        |          |             |        |          |             |
| I.R. at 125℃  | More than 10,000MΩ or 100Ω·F (Whichever is smaller)    | More than 1,000MΩ or 10Ω·F (*1Ω·F) (Whichever is smaller) |                                                                                                             |                                                                                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |       |                 |           |         |         |          |          |           |          |          |           |          |        |          |             |        |          |             |
| Voltage proof | No dielectric breakdown or mechanical breakdown        |                                                           | Applied 250% of the rated voltage for 1~5 seconds<br>The charge/discharge current is less than 50mA.        |                                                                                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |       |                 |           |         |         |          |          |           |          |          |           |          |        |          |             |        |          |             |
| 18            | Board Flex                                             | Appearance                                                | No defects which may affect performance                                                                     |                                                                                                         | <br><br>Flexure for Class I: 3mm max.<br>for Class II: 3mm max.<br>– Reflow soldering only                                                                                                                                                                                                                                                                                                                                                                                                                              |       |                 |           |         |         |          |          |           |          |          |           |          |        |          |             |        |          |             |
|               |                                                        | Capacitance Change                                        | Within ±5.0% or ±0.5pF (Whichever is larger)                                                                | Within the specified tolerance                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |       |                 |           |         |         |          |          |           |          |          |           |          |        |          |             |        |          |             |
| 19            | Terminal Strength                                      | Appearance                                                | No defects which may affect performance                                                                     |                                                                                                         | Apply 18N <sup>1)</sup> force in parallel with the test jig for 60±1 seconds.<br><sup>1)</sup> 10N for 1608(EIA:0603) size<br>2N for 1005(EIA:0402) size                                                                                                                                                                                                                                                                                                                                                                                                                                                     |       |                 |           |         |         |          |          |           |          |          |           |          |        |          |             |        |          |             |
|               |                                                        | Capacitance Change                                        | Within ±5.0% or ±0.5pF (Whichever is larger)                                                                | Within the specified tolerance                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |       |                 |           |         |         |          |          |           |          |          |           |          |        |          |             |        |          |             |



## Specifications and Test Methods (For Automotive Application)

| No.                        | AEC-Q200<br>Test Item                              |                       | Specification                                                                                                                                                                                                                                                                                                                                         |                                                                                         | Test Methods and Conditions                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |               |       |            |         |    |         |           |            |          |      |        |       |                                                                                                                                                                                                                                                                                        |
|----------------------------|----------------------------------------------------|-----------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|-------|------------|---------|----|---------|-----------|------------|----------|------|--------|-------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                            |                                                    |                       | Class I                                                                                                                                                                                                                                                                                                                                               | Class II                                                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |               |       |            |         |    |         |           |            |          |      |        |       |                                                                                                                                                                                                                                                                                        |
| 20                         | Beam Load                                          |                       | <div>The chip endure following force.</div> <table><tr><th>Chip Length</th><th>Thickness (T)</th><th>Force</th></tr><tr><td rowspan="2">2.5mm max.</td><td>T≤0.5mm</td><td>8N</td></tr><tr><td>T&gt;0.5mm</td><td>20N</td></tr><tr><td rowspan="2">3.2mm min.</td><td>T&lt;1.25mm</td><td>15N</td></tr><tr><td>T≥1.25</td><td>54.5N</td></tr></table> |                                                                                         | Chip Length                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Thickness (T) | Force | 2.5mm max. | T≤0.5mm | 8N | T>0.5mm | 20N       | 3.2mm min. | T<1.25mm | 15N  | T≥1.25 | 54.5N | <div>Apply a force as shown in the following figure.</div> <div>(i) Chip Length : 2.5mm max.      (ii) Chip Length : 3.2mm min.<br/>Beam Speed : 0.5mm/s      Beam Speed : 2.5mm/s</div> <div></div> |
| Chip Length                | Thickness (T)                                      | Force                 |                                                                                                                                                                                                                                                                                                                                                       |                                                                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |               |       |            |         |    |         |           |            |          |      |        |       |                                                                                                                                                                                                                                                                                        |
| 2.5mm max.                 | T≤0.5mm                                            | 8N                    |                                                                                                                                                                                                                                                                                                                                                       |                                                                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |               |       |            |         |    |         |           |            |          |      |        |       |                                                                                                                                                                                                                                                                                        |
|                            | T>0.5mm                                            | 20N                   |                                                                                                                                                                                                                                                                                                                                                       |                                                                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |               |       |            |         |    |         |           |            |          |      |        |       |                                                                                                                                                                                                                                                                                        |
| 3.2mm min.                 | T<1.25mm                                           | 15N                   |                                                                                                                                                                                                                                                                                                                                                       |                                                                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |               |       |            |         |    |         |           |            |          |      |        |       |                                                                                                                                                                                                                                                                                        |
|                            | T≥1.25                                             | 54.5N                 |                                                                                                                                                                                                                                                                                                                                                       |                                                                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |               |       |            |         |    |         |           |            |          |      |        |       |                                                                                                                                                                                                                                                                                        |
| 21                         | Capacitance<br>Temperature<br>Characteris-<br>tics | Capacitance<br>Change |                                                                                                                                                                                                                                                                                                                                                       | X7R : Within ±15%<br>X7S : Within ±22%<br>X6S : Within ±22%<br>X7T : Within +22% ~ -33% | <div>(i) Class I</div> <div>The temperature coefficient is determined using the capacitance measured in step 3 as a reference. When cycling the temperature sequentially from step 1 through 5, the capacitance should be within the specified tolerance for the temperature coefficient. The capacitance drift is calculated by dividing the differences between the maximum and minimum measured values in steps 1, 3 and 5 by the capacitance value in step 3.</div> <table><tr><th>Step</th><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td></tr><tr><th>Temp.(°C)</th><td>25±2</td><td>-55±3</td><td>25±2</td><td>125±3</td><td>25±2</td></tr></table> <div>(ii) Class II</div> <div>The ranges of capacitance change compared with the 25°C value over the temperature range from -55°C to 125°C.</div> <div>Initial measurement</div> <div>Perform the initial measurement according to Note 1 for Class II.</div> | Step          | 1     | 2          | 3       | 4  | 5       | Temp.(°C) | 25±2       | -55±3    | 25±2 | 125±3  | 25±2  |                                                                                                                                                                                                                                                                                        |
|                            |                                                    | Step                  | 1                                                                                                                                                                                                                                                                                                                                                     | 2                                                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 3             | 4     | 5          |         |    |         |           |            |          |      |        |       |                                                                                                                                                                                                                                                                                        |
|                            |                                                    | Temp.(°C)             | 25±2                                                                                                                                                                                                                                                                                                                                                  | -55±3                                                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 25±2          | 125±3 | 25±2       |         |    |         |           |            |          |      |        |       |                                                                                                                                                                                                                                                                                        |
| Temperature<br>Coefficient | 0±30 ppm/°C                                        |                       |                                                                                                                                                                                                                                                                                                                                                       |                                                                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |               |       |            |         |    |         |           |            |          |      |        |       |                                                                                                                                                                                                                                                                                        |
| Capacitance<br>Drift       | Within ±0.2% or ±0.05pF<br>(Whichever is larger)   |                       |                                                                                                                                                                                                                                                                                                                                                       |                                                                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |               |       |            |         |    |         |           |            |          |      |        |       |                                                                                                                                                                                                                                                                                        |

In the case of "" is specifications for "Thin Layer Large Capacitance Type"

Note 1. Initial Measurement for Class II

Perform a heat treatment at 150+0/-10°C for one hour, and then let sit for 24±2 hours at room temperature, then measure.

"Following the International standards, the title of each test item is subject to change."

## Packing

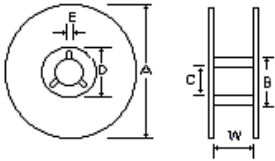
### (1) Bulk Packing

- ① 1000 pcs per polybag
- ② 5 polybags per inner box
- ③ 10 inner boxes per out box

### (2) Reel Packing

- ① 8~10 reels per inner box
- ② 6 inner boxes per out box

### (3) Reel Dimensions



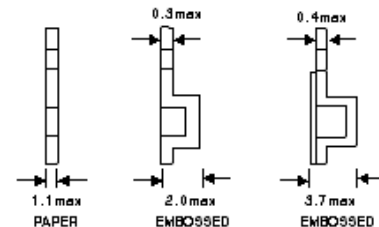
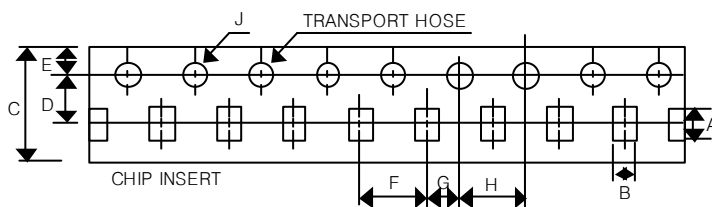
(Unit : mm)

| Mark      | Size Code | EIA Code  | A                 | B                    | C                 | D                 | E           | W            |
|-----------|-----------|-----------|-------------------|----------------------|-------------------|-------------------|-------------|--------------|
| 7 " Reel  | 1005~3225 | 0402~1210 | $\Phi 178 \pm 2$  | $\Phi 50 \text{Min}$ | $\Phi 13 \pm 0.5$ | $\Phi 21 \pm 0.8$ | $2 \pm 0.5$ | $10 \pm 1.5$ |
|           | 4520~4532 | 1808~1812 | $\Phi 180 +0, -3$ | $\Phi 60 -0, +1$     | $\Phi 13 \pm 0.2$ | $\Phi 57 -0 +1$   | $3 \pm 0.2$ | $13 \pm 0.5$ |
| 13 " Reel | 1005~3225 | 0402~1210 | $\Phi 330 \pm 2$  | $\Phi 70 \text{Min}$ | $\Phi 13 \pm 0.5$ | $\Phi 21 \pm 0.8$ | $2 \pm 0.5$ | $10 \pm 1.5$ |

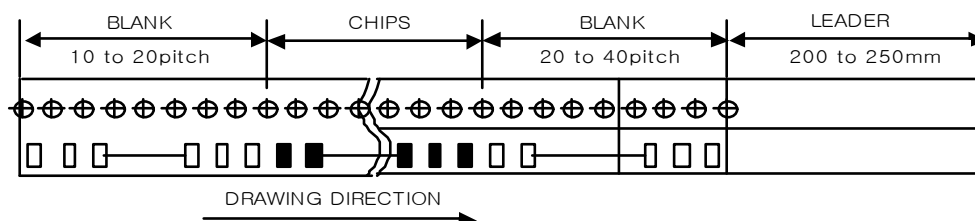
### (4) Number of Package

| Size Code | EIA Code | 7"                 | 13"                |
|-----------|----------|--------------------|--------------------|
|           |          | Quantity(pcs)/Reel | Quantity(pcs)/Reel |
| 1005      | 0402     | 10,000             | 50,000             |
| 1608      | 0603     | 4,000              | 15,000             |
| 2012      | 0805     | 3,000 ~ 4,000      | 8,000 ~ 15,000     |
| 3216      | 1206     | 2,000 ~ 4,000      | 6,000 ~ 10,000     |
| 3225      | 1210     | 1,000 ~ 3,000      | 4,000 ~ 10,000     |
| 4520      | 1808     | 1,500 ~ 3,000      | —                  |
| 4532      | 1812     | 500 ~ 1,000        | 1,500 ~ 5,000      |

### (5) Tape Dimensions



| Size Code | EIA Code | A              | B              | C              | D              | E              | F                              | G             | H             | J             |
|-----------|----------|----------------|----------------|----------------|----------------|----------------|--------------------------------|---------------|---------------|---------------|
| 1005      | 0402     | $1.15 \pm 0.1$ | $0.65 \pm 0.1$ | $8.0 \pm 0.3$  | $3.5 \pm 0.05$ | $1.75 \pm 0.1$ | $2.0 \pm 0.05$                 | $2.0 \pm 0.1$ | $4.0 \pm 0.1$ | $1.5 \pm 0.1$ |
| 1608      | 0603     | $1.9 \pm 0.2$  | $1.10 \pm 0.2$ | $8.0 \pm 0.3$  | $3.5 \pm 0.05$ | $1.75 \pm 0.1$ | $4.0 \pm 0.1$                  | $2.0 \pm 0.1$ | $4.0 \pm 0.1$ | $1.5 \pm 0.1$ |
| 2012      | 0805     | $2.4 \pm 0.2$  | $1.65 \pm 0.2$ | $8.0 \pm 0.3$  | $3.5 \pm 0.05$ | $1.75 \pm 0.1$ | $4.0 \pm 0.1$                  | $2.0 \pm 0.1$ | $4.0 \pm 0.1$ | $1.5 \pm 0.1$ |
| 3216      | 1206     | $3.6 \pm 0.2$  | $2.00 \pm 0.2$ | $8.0 \pm 0.3$  | $3.5 \pm 0.05$ | $1.75 \pm 0.1$ | $4.0 \pm 0.1$                  | $2.0 \pm 0.1$ | $4.0 \pm 0.1$ | $1.5 \pm 0.1$ |
| 3225      | 1210     | $3.6 \pm 0.2$  | $2.80 \pm 0.2$ | $8.0 \pm 0.3$  | $3.5 \pm 0.05$ | $1.75 \pm 0.1$ | $4.0 \pm 0.1$                  | $2.0 \pm 0.1$ | $4.0 \pm 0.1$ | $1.5 \pm 0.1$ |
| 4520      | 1808     | $4.8 \pm 0.2$  | $2.3 \pm 0.2$  | $12.0 \pm 0.3$ | $5.5 \pm 0.1$  | $1.75 \pm 0.1$ | $4.0 \pm 0.1$<br>$8.0 \pm 0.1$ | $2.0 \pm 0.1$ | $4.0 \pm 0.1$ | $1.5 \pm 0.1$ |
| 4532      | 1812     | $4.9 \pm 0.2$  | $3.6 \pm 0.2$  | $12.0 \pm 0.3$ | $5.5 \pm 0.1$  | $1.75 \pm 0.1$ | $8.0 \pm 0.1$                  | $2.0 \pm 0.1$ | $4.0 \pm 0.1$ | $1.5 \pm 0.1$ |



## Caution

### ► Storage Condition

When solderability is considered, capacitor are recommended to be used in 12 months.

(1) Temperature:  $25^{\circ}\text{C} \pm 10^{\circ}\text{C}$

(2) Relative Humidity: Below 70% RH

### ► The Regulation of Environmental Pollution Materials

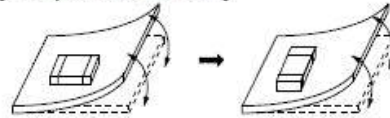
Never use materials mentioned below in MLCC products regulated this document.

Pb, Cd, Hg,  $\text{Cr}^{+6}$ , PBB(Polybrominated biphenyl), PBDE(Polybrominated diphenyl ethers), asbestos

### ► Mounting Position

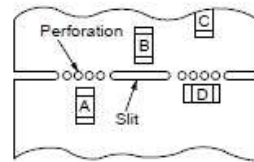
Choose a mounting position that minimizes the stress imposed on the chip during flexing or bending of the board.

[Component direction]



Locate chip horizontal to the direction in which stress acts.

[Chip Mounting Close to Board Separation Point]



Chip arrangement Worst A-C- (B, D) Best

### ► Reflow Soldering

1. The sudden temperature change easily causes mechanical damages to ceramic components. Therefore, the preheating procedures should be required for the soldering of ceramic components.
2. Please refer to the recommended soldering profiles as shown in figures, and keep the temperature difference( $\Delta T$ ) within the range recommended in Table 1.

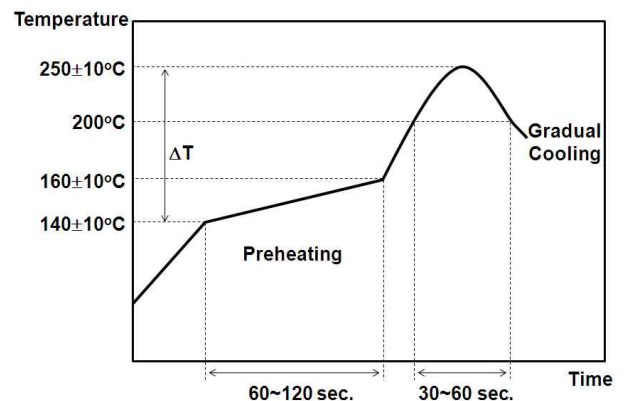
Table 1

| Size code (EIA Code)  | Temperature Difference              |
|-----------------------|-------------------------------------|
| 1005~3216 (0402~1206) | $\Delta T \leq 190^{\circ}\text{C}$ |
| 3225 (1210)           | $\Delta T \leq 130^{\circ}\text{C}$ |

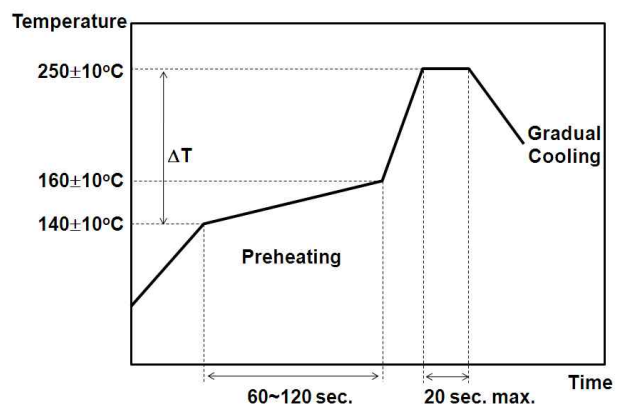
3. Capacitors designated as for only reflow soldering must not apply to wave soldering.

### Recommended Reflow Soldering Profile for Lead Free Solder

Infrared Reflow



Vapor Reflow



**Note**

- 'Aging'/'De-aging' behavior of high dielectric constant type MLCCs  
(Typically represented by X7R temperature characteristic of which main composition is BaTiO<sub>3</sub>)

'Aging' / 'De-aging' Behavior of high dielectric MLCCs Please note that high dielectric type dielectric ceramic capacitors have a "normal" 'aging' behavior / characteristic, that is; their capacitance value decreases with time from its value when it was first manufactured. From that date, the capacitance value begins to decrease at a logarithmic rate defined by:

$$C_t = C_{24} (1 - k \log_{10} t)$$

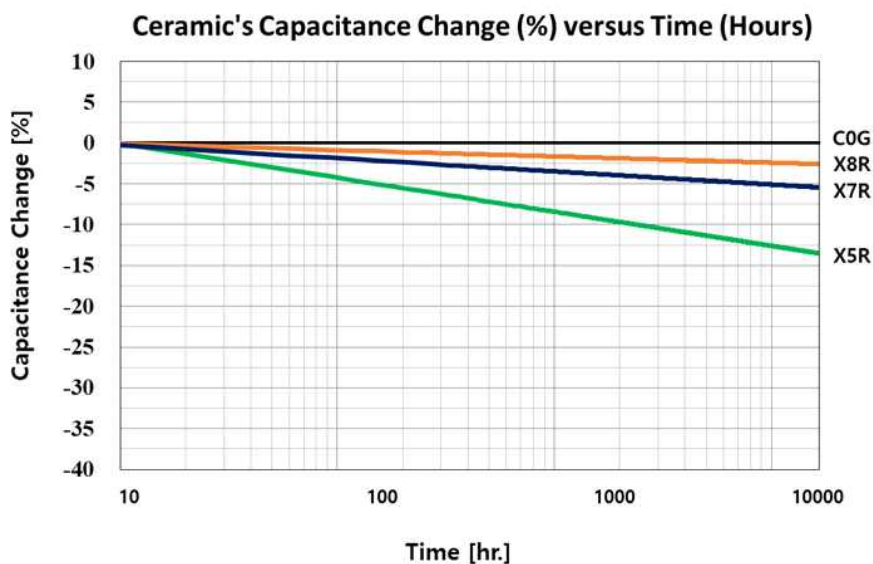
where,

$C_t$  : Capacitance value, t hours after the start of 'aging'

$C_{24}$  : Capacitance value, 24 hours after its manufacture

k : Aging constant (capacitance decrease per decade-hour)

t : time, in hours, from the start of 'aging'



The capacitance value can be restored (also known as 'de-aged') by exposing the component to elevated temperatures approaching its curie temperature (approximately 120°C). This 'de-aging' can occur during the component's solder-assembly onto the PCB, during life or temperature cycle testing, or by baking at 150°C for about 1 hour.