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**Messrs. :** 一般共用

**Date :** 2020/02/11

# APPROVAL SHEET

**Product Name :** Stacked Capacitors

**Part No. :** FE Series

**Description :** Size 1210~2225, C0G/X7R, 50~630Vdc

| PREPARED BY | APPROVED BY |
|-------------|-------------|
|             |             |

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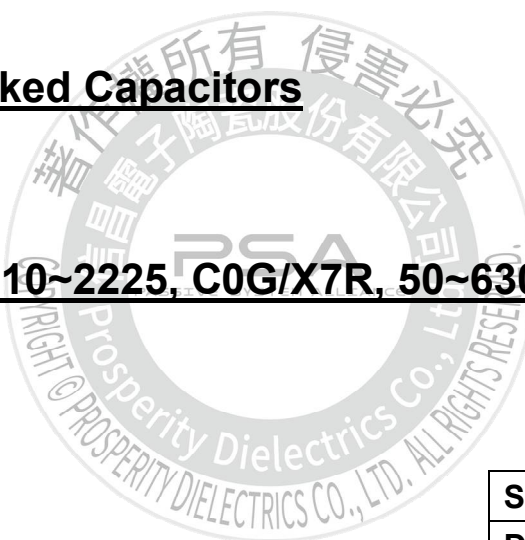
# SPECIFICATION

FOR

Product Name : Stacked Capacitors

Part No. : FE Series

Description : Size 1210~2225, C0G/X7R, 50~630Vdc



**SPEC. No. : FE-000-001-09**

**DATE : 2020/02/11**

| DRAWN BY          | CHECEKED BY       | APPROVED BY        |
|-------------------|-------------------|--------------------|
| <i>Jane Hsiao</i> | <i>Yvens Chou</i> | <i>Joseph Ling</i> |

## 1. INTRODUCTION

FE Series green type capacitors are manufactured by using green materials without lead and cadmium. These capacitors to achieve a unique structure of high reliability. The use of metal lead frame, can absorb the heat and mechanical stress. ESR (equivalent series resistance), ESL (equivalent series inductance) is small, the most suitable for high frequency operation of the rectifier power supply.

## 2. FEATURES

- High reliability and stability.
- Higher mechanical endurance.
- Anti thermal stress and mechanical stress.
- Improved vibration performance.
- More capacitance without changing footprint.
- RoHS & HALOGEN Compliant.

## 3. APPLICATIONS

- DC to DC converter.
- High voltage coupling/DC blocking.
- Back-lighting inverters.
- Snubbers in high frequency power converters.
- Power supplies.
- Surge protection.
- Filtering, smoothing, and decoupling application.

## 4. HOW TO ORDER

| <u>FE</u>  | <u>2H</u> | <u>X</u>   | <u>106</u>  | <u>K</u>  | <u>500</u>    | <u>L</u>  | <u>G</u>  | <u>K</u>     | <u>M</u>     |
|------------|-----------|------------|-------------|-----------|---------------|-----------|-----------|--------------|--------------|
| PDC Family | Size      | Dielectric | Capacitance | Tolerance | Rated Voltage | Packaging | Thickness | Control Code | Special Code |
| Table 1    | Table 2   | Table 3    | Table 4     | Table 5   | Table 6       | Table 7   | Table 8   | Table 9      | Table 10     |

| Table 1 PDC Family |                           |
|--------------------|---------------------------|
| Code               | Description               |
| FE                 | Stacked Capacitors Series |

| Table 2 Stack chip quantity and chip size |             |      |             |      |             |
|---|-------------|------|-------------|------|-------------|
| The first digit : # of chips in stack     |             |      |             |      |             |
| Second digit code : chip size (below)     |             |      |             |      |             |
| Code                                      | Description | Code | Description | Code | Description |
| A   | 1210 (3225) | G    | 1825 (4563) | I    | 2225 (5763) |
| C   | 1812 (4532) | H    | 2220 (5750) |      |             |

| Table 3 Dielectric Material Characteristics |             |      |             |
|---|-------------|------|-------------|
| Code  | Description | Code | Description |
| N   | C0G         | X    | X7R         |

| Table 4 Capacitance Rule Code |                              |      |                                |
|-------------------------------|------------------------------|------|--------------------------------|
| Code                          | Description                  | Code | Description                    |
| R47                           | 0.47pF                       | 102  | 102=10x10 <sup>2</sup> =1000pF |
| 0R5                           | 0.5pF                        | 104  | 104=10x10 <sup>4</sup> =100nF  |
| 100                           | 100=10x10 <sup>0</sup> =10pF | 106  | 106=10x10 <sup>6</sup> =10μF   |

| Table 5 Tolerance |             |      |             |      |             |
|-------------------|-------------|------|-------------|------|-------------|
| Code              | Description | Code | Description | Code | Description |
| A                 | ±0.05 pF    | I    | -10% ~ 0%   | Q    | ±0.03 pF    |
| B                 | ±0.10 pF    | J    | ±5 %        | Z    | -20% ~ +80% |
| C                 | ±0.25 pF    | K    | ±10 %       | X    | +10% ~ +20% |
| D                 | ±0.50 pF    | L    | 0% ~ +10%   |      |             |
| F                 | ±1 %        | M    | ±20 %       |      |             |
| G                 | ±2 %        | N    | -5% ~ +10%  |      |             |
| H                 | ±3 %        | P    | ±0.02 pF    |      |             |

| Table 6 Rated Voltage |             |      |             |      |             |
|-----------------------|-------------|------|-------------|------|-------------|
| Code                  | Description | Code | Description | Code | Description |
| 500                   | 50Vdc       | 251  | 250Vdc      |      |             |
| 101                   | 100Vdc      | 501  | 500Vdc      |      |             |
| 201                   | 200Vdc      | 631  | 630Vdc      |      |             |

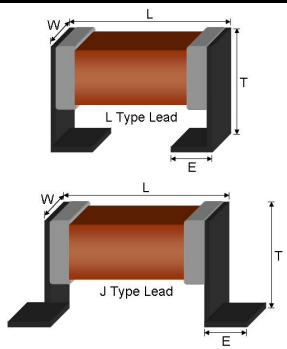
| Table 7 Packaging Type |                                  |      |              |
|------------------------|----------------------------------|------|--------------|
| Code                   | Description                      | Code | Description  |
| B                      | Bulk                             | T    | Tray package |
| L                      | Tape and 13" Reel, Embossed Tape |      |              |

| Table 8 Thickness Description |              |      |               |      |               |
|-------------------------------|--------------|------|---------------|------|---------------|
| Code                          | Description  | Code | Description   | Code | Description   |
| A                             | 3.00±0.35 mm | J    | 7.80±0.35 mm  | S    | 12.60±0.35 mm |
| B                             | 3.60±0.35 mm | K    | 8.40±0.35 mm  | T    | 13.20±0.35 mm |
| C                             | 4.20±0.35 mm | L    | 9.00±0.35 mm  | U    | 1.70±0.25 mm  |
| D                             | 4.80±0.35 mm | M    | 9.60±0.35 mm  | V    | 2.10±0.25 mm  |
| E                             | 5.40±0.35 mm | N    | 10.20±0.35 mm | W    | 2.50±0.25 mm  |
| F                             | 6.00±0.35 mm | P    | 10.80±0.35 mm |      |               |
| G                             | 6.60±0.35 mm | Q    | 11.40±0.35 mm |      |               |
| H                             | 7.20±0.35 mm | R    | 12.00±0.35 mm |      |               |

| Table 9 Control Code |                    |      |                    |
|----------------------|--------------------|------|--------------------|
| Code                 | Description        | Code | Description        |
| L                    | L type lea         | K    | K type lead        |
| J                    | J type lead        | B    | B type lead        |
| S                    | Straight type lead | F    | Straight type lead |

| Table 10 Special Code |             |      |             |
|-----------------------|-------------|------|-------------|
| Code                  | Description | Code | Description |
| Blank                 | ---         | M    | Automotive  |

### 5. EXTERNAL DIMENSIONS

| Size Inch (mm) | L (mm)    | W (mm)    | Code / T (mm)     | E (mm)    |   |
|----------------|-----------|-----------|-------------------|-----------|---|
| 1210 (3225)    | 3.50±0.40 | 2.50±0.40 | Reference Table 8 | 1.70±0.15 |  <p>Fig. 5.1 The outline of Stacked Capacitors</p> |
| 1812 (4532)    | 4.80±0.40 | 3.20±0.40 |                   | 1.70±0.15 |   |
| 1825 (4563)    | 4.80±0.40 | 6.30±0.50 |                   | 1.70±0.15 |   |
| 2220 (5750)    | 6.00±0.50 | 5.00±0.50 |                   | 1.70±0.15 |   |
| 2225 (5763)    | 6.00±0.50 | 6.30±0.50 |                   | 1.70±0.15 |   |

### 6. GENERAL ELECTRICAL DATA

| Dielectric                         | COG   | X7R   |                |             |                         |             |                         |   |            |                |            |                         |                |                        |       |       |
|------------------------------------|---|---|----------------|-------------|-------------------------|-------------|-------------------------|---|------------|----------------|------------|-------------------------|----------------|------------------------|-------|-------|
| Size                               | 1210, 1812, 1825, 2220, 2225  | 1210, 1812, 1825, 2220, 2225  |                |             |                         |             |                         |   |            |                |            |                         |                |                        |       |       |
| Rated voltage (WVDC)               | 50V, 100V, 200V, 250V, 500V, 630V   | 50V, 100V, 200V, 250V, 500V, 630V   |                |             |                         |             |                         |   |            |                |            |                         |                |                        |       |       |
| Capacitance range                  | 220nF Max.  | 47µF Max.   |                |             |                         |             |                         |   |            |                |            |                         |                |                        |       |       |
| Capacitance tolerance              | Reference to Table 5  | Reference to Table 5  |                |             |                         |             |                         |   |            |                |            |                         |                |                        |       |       |
| Tan δ                              | <table border="1"> <thead> <tr> <th>Cap. Range</th> <th>Q Spec.</th> </tr> </thead> <tbody> <tr> <td>Cap.&lt;30pF</td> <td>Q≥400+20C</td> </tr> <tr> <td>Cap.≥30pF</td> <td>Q≥1000</td> </tr> </tbody> </table>   | Cap. Range  | Q Spec.        | Cap.<30pF   | Q≥400+20C               | Cap.≥30pF   | Q≥1000                  | <table border="1"> <thead> <tr> <th>Cap. Range</th> <th>D.F. Spec.</th> </tr> </thead> <tbody> <tr> <td>1210≥3.3µF</td> <td>≤5.0%</td> </tr> <tr> <td>1812~2225≥10µF</td> <td>≤5.0%</td> </tr> <tr> <td>Other</td> <td>≤2.5%</td> </tr> </tbody> </table> | Cap. Range | D.F. Spec.     | 1210≥3.3µF | ≤5.0%                   | 1812~2225≥10µF | ≤5.0%                  | Other | ≤2.5% |
| Cap. Range                         | Q Spec.   |   |                |             |                         |             |                         |   |            |                |            |                         |                |                        |       |       |
| Cap.<30pF                          | Q≥400+20C   |   |                |             |                         |             |                         |   |            |                |            |                         |                |                        |       |       |
| Cap.≥30pF                          | Q≥1000  |   |                |             |                         |             |                         |   |            |                |            |                         |                |                        |       |       |
| Cap. Range                         | D.F. Spec.  |   |                |             |                         |             |                         |   |            |                |            |                         |                |                        |       |       |
| 1210≥3.3µF                         | ≤5.0%   |   |                |             |                         |             |                         |   |            |                |            |                         |                |                        |       |       |
| 1812~2225≥10µF                     | ≤5.0%   |   |                |             |                         |             |                         |   |            |                |            |                         |                |                        |       |       |
| Other                              | ≤2.5%   |   |                |             |                         |             |                         |   |            |                |            |                         |                |                        |       |       |
| Capacitance & Tan δ Test condition | Measured at the condition of 30~70% related humidity<br>For 25°C at ambient temperature   | Measured at the condition of 30~70% related humidity<br>Preconditioning for Class II MLCC : Perform a heat treatment at 150±10°C for 1 hour, then leave in ambient condition (25°C) for 24±2 hours before measurement |                |             |                         |             |                         |   |            |                |            |                         |                |                        |       |       |
|                                    | <table border="1"> <thead> <tr> <th>Cap. Range</th> <th>Test Condition</th> </tr> </thead> <tbody> <tr> <td>Cap.&lt;1000pF</td> <td>1.0±0.2Vrms, 1.0MHz±10%</td> </tr> <tr> <td>Cap.≥1000pF</td> <td>1.0±0.2Vrms, 1.0KHz±10%</td> </tr> </tbody> </table> | Cap. Range  | Test Condition | Cap.<1000pF | 1.0±0.2Vrms, 1.0MHz±10% | Cap.≥1000pF | 1.0±0.2Vrms, 1.0KHz±10% | <table border="1"> <thead> <tr> <th>Cap. Range</th> <th>Test Condition</th> </tr> </thead> <tbody> <tr> <td>Cap.≤10µF</td> <td>1.0±0.2Vrms, 1.0KHz±10%</td> </tr> <tr> <td>Cap.&gt;10µF</td> <td>0.5±0.2Vrms, 120Hz±20%</td> </tr> </tbody> </table>      | Cap. Range | Test Condition | Cap.≤10µF  | 1.0±0.2Vrms, 1.0KHz±10% | Cap.>10µF      | 0.5±0.2Vrms, 120Hz±20% |       |       |
| Cap. Range                         | Test Condition  |   |                |             |                         |             |                         |   |            |                |            |                         |                |                        |       |       |
| Cap.<1000pF                        | 1.0±0.2Vrms, 1.0MHz±10%   |   |                |             |                         |             |                         |   |            |                |            |                         |                |                        |       |       |
| Cap.≥1000pF                        | 1.0±0.2Vrms, 1.0KHz±10%   |   |                |             |                         |             |                         |   |            |                |            |                         |                |                        |       |       |
| Cap. Range                         | Test Condition  |   |                |             |                         |             |                         |   |            |                |            |                         |                |                        |       |       |
| Cap.≤10µF                          | 1.0±0.2Vrms, 1.0KHz±10%   |   |                |             |                         |             |                         |   |            |                |            |                         |                |                        |       |       |
| Cap.>10µF                          | 0.5±0.2Vrms, 120Hz±20%  |   |                |             |                         |             |                         |   |            |                |            |                         |                |                        |       |       |
| Insulation resistance at Ur        | ≥10GΩ or RxC≥500Ω-F, whichever is smaller   | ≥10GΩ or RxC≥100Ω-F, whichever is smaller   |                |             |                         |             |                         |   |            |                |            |                         |                |                        |       |       |
| Operating temperature              | -55 to +125°C   | -55 to +125°C   |                |             |                         |             |                         |   |            |                |            |                         |                |                        |       |       |
| Capacitance characteristic         | ±30ppm / °C   | ±15%  |                |             |                         |             |                         |   |            |                |            |                         |                |                        |       |       |
| Termination                        | L / J / Straight type lead  | L / J / Straight type lead  |                |             |                         |             |                         |   |            |                |            |                         |                |                        |       |       |

**7. CAPACITANCE RANGE (Max.)**

**7-1. C0G**

| Dimension | Code | Rated Voltage |        |        |        |        |        |
|-----------|------|---------------|--------|--------|--------|--------|--------|
|           |      | 50V           | 100V   | 200V   | 250V   | 500V   | 630V   |
| 1210      | 1A   | 393           | 223    | 103    | 103    | 103    | 103    |
| 1812      | 1C   | 104           | 473    | 273    | 273    | 223    | 223    |
|           | 2C   | 224(M)        | 104    | 563    | 563    | 473(M) | 473(M) |
| 1825      | 1G   | 104           | 104    | 683    | 683    | 473    | 223    |
|           | 2G   | 224(M)        | 224(M) | 134    | 134    | 104    | 473(M) |
| 2220      | 1H   | 104           | 104    | 683    | 683    | 473    | 223    |
|           | 2H   | 224(M)        | 224(M) | 134    | 134    | 104    | 473(M) |
| 2225      | 1I   | 104           | 104    | 104    | 104    | 823    | 683    |
|           | 2I   | 224(M)        | 224(M) | 224(M) | 224(M) | 184(M) | 134    |

**7-2. X7R**

| Dimension | Code | Rated Voltage |        |        |        |        |        |
|-----------|------|---------------|--------|--------|--------|--------|--------|
|           |      | 50V           | 100V   | 200V   | 250V   | 500V   | 630V   |
| 1210      | 1A   | 475           | 335    | 684    | 684    | 104    | 104    |
| 1812      | 1C   | 106           | 475    | 105    | 105    | 474    | 224    |
|           | 2C   | 226(M)        | 106    | 225(M) | 225(M) | 105    | 474(M) |
| 1825      | 1G   | 106           | 106    | 105    | 105    | 564    | 564    |
|           | 2G   | 226(M)        | 226(M) | 225(M) | 225(M) | 125(M) | 125(M) |
| 2220      | 1H   | 226           | 106    | 225    | 225    | 474    | 474    |
|           | 2H   | 476(M)        | 226(M) | 475(M) | 475(M) | 105    | 105    |
| 2225      | 1I   | 106           | 106    | 275    | 275    | 564    | 564    |
|           | 2I   | 226(M)        | 226(M) | 565    | 565    | 125(M) | 125(M) |

(M) means M tolerance only.

**7-3. Customizable, Please contact the liaison.**

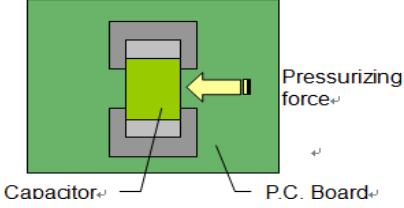
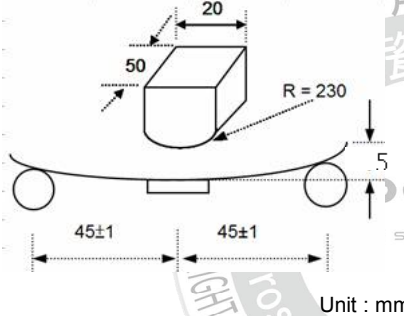
8. RELIABILITY TEST CONDITIONS AND REQUIREMENTS

| No.            | Item                                       | Test Condition   | Requirements   |                 |            |                             |                            |                             |   |                             |                    |                             |  |            |   |            |              |  |  |          |  |
|----------------|--|--|--|-----------------|------------|-----------------------------|----------------------------|-----------------------------|---|-----------------------------|--------------------|-----------------------------|--|------------|---|------------|--------------|--|--|----------|--|
| 1.             | Visual and Dimensions                      | ---  | * No remarkable defect.<br>* Dimensions to confirm to individual specification sheet.  |                 |            |                             |                            |                             |   |                             |                    |                             |  |            |   |            |              |  |  |          |  |
| 2.             | Capacitance                                |  | * Shall not exceed the limits given in the detailed spec.  |                 |            |                             |                            |                             |   |                             |                    |                             |  |            |   |            |              |  |  |          |  |
| 3.             | Q/D.F. (Dissipation Factor)                | * Class I :<br>Cap. ≤1000pF, 1.0±0.2Vrms, 1MHz±10%.<br>Cap. >1000pF, 1.0±0.2Vrms, 1KHz±10%.  | <table border="1"> <thead> <tr> <th>Dielectric</th> <th>Cap. Range</th> <th>Q/D.F.</th> </tr> </thead> <tbody> <tr> <td rowspan="2">Class I (C0G)</td> <td>Cap. ≥30pF</td> <td>Q ≥1000</td> </tr> <tr> <td>Cap. &lt;30pF</td> <td>Q ≥400+20C</td> </tr> <tr> <td rowspan="2">Class II (X7R)</td> <td>1210 ≥3.3μF &amp; 1812 ~2220 ≥10μF</td> <td>D.F. ≤5.0%</td> </tr> <tr> <td>Other</td> <td>D.F. ≤2.5%</td> </tr> </tbody> </table> | Dielectric      | Cap. Range | Q/D.F.                      | Class I (C0G)              | Cap. ≥30pF                  | Q ≥1000   | Cap. <30pF                  | Q ≥400+20C         | Class II (X7R)              | 1210 ≥3.3μF & 1812 ~2220 ≥10μF                     | D.F. ≤5.0% | Other   | D.F. ≤2.5% |              |  |  |          |  |
|                |  | Dielectric   | Cap. Range   | Q/D.F.          |            |                             |                            |                             |   |                             |                    |                             |  |            |   |            |              |  |  |          |  |
| Class I (C0G)  | Cap. ≥30pF                                 | Q ≥1000  |  |                 |            |                             |                            |                             |   |                             |                    |                             |  |            |   |            |              |  |  |          |  |
|                | Cap. <30pF                                 | Q ≥400+20C   |  |                 |            |                             |                            |                             |   |                             |                    |                             |  |            |   |            |              |  |  |          |  |
| Class II (X7R) | 1210 ≥3.3μF & 1812 ~2220 ≥10μF             | D.F. ≤5.0%   |  |                 |            |                             |                            |                             |   |                             |                    |                             |  |            |   |            |              |  |  |          |  |
|                | Other                                      | D.F. ≤2.5%   |  |                 |            |                             |                            |                             |   |                             |                    |                             |  |            |   |            |              |  |  |          |  |
|                |  | * Class II :<br>Cap. ≤10μF, 1.0±0.2Vrms, 1KHz±10%.<br>Cap. >10μF, 0.5±0.2Vrms, 120Hz±20%.  |  |                 |            |                             |                            |                             |   |                             |                    |                             |  |            |   |            |              |  |  |          |  |
| 4.             | Temperature Coefficient                    | <p>* With no electrical load.</p> <table border="1"> <thead> <tr> <th>T.C.</th> <th>Operating Temp.</th> </tr> </thead> <tbody> <tr> <td>C0G</td> <td>-55~125°C at 25°C</td> </tr> <tr> <td>X7R</td> <td>-55~125°C at 25°C</td> </tr> </tbody> </table>  | T.C.   | Operating Temp. | C0G        | -55~125°C at 25°C           | X7R                        | -55~125°C at 25°C           | <table border="1"> <thead> <tr> <th>T.C.</th> <th>Capacitance Change</th> </tr> </thead> <tbody> <tr> <td>C0G</td> <td>Within ±30ppm/°C</td> </tr> <tr> <td>X7R</td> <td>Within ±15%</td> </tr> </tbody> </table> | T.C.                        | Capacitance Change | C0G                         | Within ±30ppm/°C                                   | X7R        | Within ±15%   |            |              |  |  |          |  |
| T.C.           | Operating Temp.                            |  |  |                 |            |                             |                            |                             |   |                             |                    |                             |  |            |   |            |              |  |  |          |  |
| C0G            | -55~125°C at 25°C                          |  |  |                 |            |                             |                            |                             |   |                             |                    |                             |  |            |   |            |              |  |  |          |  |
| X7R            | -55~125°C at 25°C                          |  |  |                 |            |                             |                            |                             |   |                             |                    |                             |  |            |   |            |              |  |  |          |  |
| T.C.           | Capacitance Change                         |  |  |                 |            |                             |                            |                             |   |                             |                    |                             |  |            |   |            |              |  |  |          |  |
| C0G            | Within ±30ppm/°C                           |  |  |                 |            |                             |                            |                             |   |                             |                    |                             |  |            |   |            |              |  |  |          |  |
| X7R            | Within ±15%                                |  |  |                 |            |                             |                            |                             |   |                             |                    |                             |  |            |   |            |              |  |  |          |  |
| 5.             | Insulation Resistance                      | <table border="1"> <thead> <tr> <th>Rated Vol. (V)</th> <th>Apply Voltage</th> <th>Test Time</th> </tr> </thead> <tbody> <tr> <td>≤100</td> <td>1 times of U<sub>R</sub></td> <td>Max. 120 sec.</td> </tr> <tr> <td>100&lt;V≤500</td> <td>1 times of U<sub>R</sub></td> <td>60 sec.</td> </tr> <tr> <td>&gt;500</td> <td>500Vdc</td> <td>60 sec.</td> </tr> </tbody> </table>  | Rated Vol. (V)   | Apply Voltage   | Test Time  | ≤100                        | 1 times of U <sub>R</sub>  | Max. 120 sec.               | 100<V≤500   | 1 times of U <sub>R</sub>   | 60 sec.            | >500                        | 500Vdc   | 60 sec.    | <table border="1"> <thead> <tr> <th>Dielectric</th> <th>Requirements</th> </tr> </thead> <tbody> <tr> <td>Class I</td> <td>≥10GΩ or RxC ≥500Ω-F, whichever is smaller</td> </tr> <tr> <td>Class II</td> <td>≥10GΩ or RxC ≥100Ω-F, whichever is smaller</td> </tr> </tbody> </table> | Dielectric | Requirements | Class I  | ≥10GΩ or RxC ≥500Ω-F, whichever is smaller | Class II | ≥10GΩ or RxC ≥100Ω-F, whichever is smaller |
| Rated Vol. (V) | Apply Voltage                              | Test Time  |  |                 |            |                             |                            |                             |   |                             |                    |                             |  |            |   |            |              |  |  |          |  |
| ≤100           | 1 times of U <sub>R</sub>                  | Max. 120 sec.  |  |                 |            |                             |                            |                             |   |                             |                    |                             |  |            |   |            |              |  |  |          |  |
| 100<V≤500      | 1 times of U <sub>R</sub>                  | 60 sec.  |  |                 |            |                             |                            |                             |   |                             |                    |                             |  |            |   |            |              |  |  |          |  |
| >500           | 500Vdc                                     | 60 sec.  |  |                 |            |                             |                            |                             |   |                             |                    |                             |  |            |   |            |              |  |  |          |  |
| Dielectric     | Requirements                               |  |  |                 |            |                             |                            |                             |   |                             |                    |                             |  |            |   |            |              |  |  |          |  |
| Class I        | ≥10GΩ or RxC ≥500Ω-F, whichever is smaller |  |  |                 |            |                             |                            |                             |   |                             |                    |                             |  |            |   |            |              |  |  |          |  |
| Class II       | ≥10GΩ or RxC ≥100Ω-F, whichever is smaller |  |  |                 |            |                             |                            |                             |   |                             |                    |                             |  |            |   |            |              |  |  |          |  |
| 6.             | Dielectric Strength                        | <table border="1"> <thead> <tr> <th>Rated Voltage</th> <th>Condition</th> </tr> </thead> <tbody> <tr> <td>≤100</td> <td>2.5 times of U<sub>R</sub></td> </tr> <tr> <td>100&lt;V≤250</td> <td>2.0 times of U<sub>R</sub></td> </tr> <tr> <td>250&lt;V≤500</td> <td>1.5 times of U<sub>R</sub></td> </tr> <tr> <td>=630</td> <td>1.2 times of U<sub>R</sub></td> </tr> </tbody> </table> <p>* Duration : 1 to 5 sec.<br/>* Charge and discharge current less than 50mA.</p>  | Rated Voltage  | Condition       | ≤100       | 2.5 times of U <sub>R</sub> | 100<V≤250                  | 2.0 times of U <sub>R</sub> | 250<V≤500   | 1.5 times of U <sub>R</sub> | =630               | 1.2 times of U <sub>R</sub> | * No evidence of damage or flash over during test. |            |   |            |              |  |  |          |  |
| Rated Voltage  | Condition                                  |  |  |                 |            |                             |                            |                             |   |                             |                    |                             |  |            |   |            |              |  |  |          |  |
| ≤100           | 2.5 times of U <sub>R</sub>                |  |  |                 |            |                             |                            |                             |   |                             |                    |                             |  |            |   |            |              |  |  |          |  |
| 100<V≤250      | 2.0 times of U <sub>R</sub>                |  |  |                 |            |                             |                            |                             |   |                             |                    |                             |  |            |   |            |              |  |  |          |  |
| 250<V≤500      | 1.5 times of U <sub>R</sub>                |  |  |                 |            |                             |                            |                             |   |                             |                    |                             |  |            |   |            |              |  |  |          |  |
| =630           | 1.2 times of U <sub>R</sub>                |  |  |                 |            |                             |                            |                             |   |                             |                    |                             |  |            |   |            |              |  |  |          |  |
| 7.             | Temperature Cycle                          | <p>* Conduct the 100 cycles according to the temperatures and time.</p> <table border="1"> <thead> <tr> <th>Step</th> <th>Temp.(°C)</th> <th>Time(min.)</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>Min. operating temp. +0/-3</td> <td>30±3</td> </tr> <tr> <td>2</td> <td>Room temp.</td> <td>2~3</td> </tr> <tr> <td>3</td> <td>Max. operating temp. +3/-0</td> <td>30±3</td> </tr> <tr> <td>4</td> <td>Room temp.</td> <td>2~3</td> </tr> </tbody> </table> <p>* Before initial measurement (Class II only) : To apply de-aging at 150°C for 1hr then set for 24±2 hrs at room temp.<br/>* Measurement to be made after keeping at room temp. for 24±2 hrs (Class I) or 48±4 hrs (Class II).</p> | Step   | Temp.(°C)       | Time(min.) | 1                           | Min. operating temp. +0/-3 | 30±3                        | 2   | Room temp.                  | 2~3                | 3                           | Max. operating temp. +3/-0                         | 30±3       | 4   | Room temp. | 2~3          | <p>* No remarkable damage.<br/>* Cap. change :<br/>C0G Within ±2.5% or ±0.25pF, whichever is larger.<br/>X7R Within ±7.5%.<br/>* Q/D.F. :<br/>C0G : Q ≥100% of initial requirement.<br/>X7R : D.F. ≤150% of initial requirement.<br/>* I.R. : To meet the initial requirement.</p> |  |          |  |
| Step           | Temp.(°C)                                  | Time(min.)   |  |                 |            |                             |                            |                             |   |                             |                    |                             |  |            |   |            |              |  |  |          |  |
| 1              | Min. operating temp. +0/-3                 | 30±3   |  |                 |            |                             |                            |                             |   |                             |                    |                             |  |            |   |            |              |  |  |          |  |
| 2              | Room temp.                                 | 2~3  |  |                 |            |                             |                            |                             |   |                             |                    |                             |  |            |   |            |              |  |  |          |  |
| 3              | Max. operating temp. +3/-0                 | 30±3   |  |                 |            |                             |                            |                             |   |                             |                    |                             |  |            |   |            |              |  |  |          |  |
| 4              | Room temp.                                 | 2~3  |  |                 |            |                             |                            |                             |   |                             |                    |                             |  |            |   |            |              |  |  |          |  |
| 8.             | Humidity (Damp Heat) Steady State          | <p>* Test temp. : 40±2°C.<br/>* Humidity : 90~95%RH.<br/>* Test time : 500 +24/-0hrs.<br/>* Before initial measurement (Class II only) : To apply de-aging at 150°C for 1hr then set for 24±2 hrs at room temp.<br/>* Measurement to be made after keeping at room temp. for 24±2 hrs (Class I) or 48±4 hrs (Class II).</p>  | <p>* No remarkable damage.<br/>* Cap. change :<br/>C0G Within ±5.0% or ±0.5pF, whichever is larger.<br/>X7R Within ±12.5%.<br/>* Q/D.F. :<br/>C0G : Q ≥350.<br/>X7R : D.F. ≤200% of initial requirement.<br/>* I.R. : ≥1GΩ or RxC ≥50Ω-F, whichever is smaller.</p>  |                 |            |                             |                            |                             |   |                             |                    |                             |  |            |   |            |              |  |  |          |  |

8. RELIABILITY TEST CONDITIONS AND REQUIREMENTS

| No.           | Item                                    | Test Condition   | Requirements  |               |               |         |      |                             |            |                             |      |                             |               |      |            |     |     |          |            |      |          |      |      |      |      |      |            |               |             |      |     |       |           |      |            |               |             |      |     |       |            |  |
|---------------|---|--|---|---------------|---------------|---------|------|-----------------------------|------------|-----------------------------|------|-----------------------------|---------------|------|------------|-----|-----|----------|------------|------|----------|------|------|------|------|------|------------|---------------|-------------|------|-----|-------|-----------|------|------------|---------------|-------------|------|-----|-------|------------|--|
| 9.            | Humidity<br>(Damp Heat)<br>Load         | * Test temp. : 40±2°C.<br>* Humidity : 90~95%RH.<br>* Test time : 500 +24/-0hrs.<br>* To apply voltage : Rated voltage (500V max.).<br>* Before initial measurement (Class II only) : To apply de-aging at 150°C for 1hr then set for 24±2 hrs at room temp.<br>* Measurement to be made after keeping at room temp. for 24±2 hrs (Class I) or 48±4 hrs (Class II).  | * No remarkable damage.<br>* Cap. change :<br>COG Within ±7.5% or ±0.75pF, whichever is larger.<br>X7R Within ±12.5%.<br>* Q/D.F. :<br>COG : Q≥200.<br>X7R : D.F.≤200% of initial requirement.<br>* I.R. : ≥500MΩ or RxC≥25Ω-F, whichever is smaller. |               |               |         |      |                             |            |                             |      |                             |               |      |            |     |     |          |            |      |          |      |      |      |      |      |            |               |             |      |     |       |           |      |            |               |             |      |     |       |            |  |
| 10.           | High Temperature<br>Load<br>(Endurance) | * Test temp. : 125±3°C.<br>* To apply voltage : <table border="1" style="margin: 5px 0;"> <thead> <tr> <th>Dielectric</th> <th>Rated Vol.(V)</th> <th>Apply Voltage</th> </tr> </thead> <tbody> <tr> <td rowspan="3">C0G/X7R</td> <td>≤100</td> <td>2.0 times of U<sub>R</sub></td> </tr> <tr> <td>200≤V≤ 500</td> <td>1.5 times of U<sub>R</sub></td> </tr> <tr> <td>≥630</td> <td>1.2 times of U<sub>R</sub></td> </tr> </tbody> </table> * Exception items (X7R only) :<br>(1) 150% of rated voltage for below range : <table border="1" style="margin: 5px 0;"> <thead> <tr> <th>Rated Vol.(V)</th> <th>Size</th> <th>Cap. Range</th> </tr> </thead> <tbody> <tr> <td>ALL</td> <td>ALL</td> <td>Cap.≥10G</td> </tr> <tr> <td rowspan="5">50V &amp; 100V</td> <td>1210</td> <td rowspan="5">Cap.≥105</td> </tr> <tr> <td>1812</td> </tr> <tr> <td>1825</td> </tr> <tr> <td>2220</td> </tr> <tr> <td>2225</td> </tr> </tbody> </table> (2) 120% of rated voltage for below range : <table border="1" style="margin: 5px 0;"> <thead> <tr> <th>Size</th> <th>Dielectric</th> <th>Rated Voltage</th> <th>Capacitance</th> </tr> </thead> <tbody> <tr> <td>2220</td> <td>X7R</td> <td>≥100V</td> <td>Cap.≥15μF</td> </tr> </tbody> </table> (3) 100% of rated voltage for below range : <table border="1" style="margin: 5px 0;"> <thead> <tr> <th>Size</th> <th>Dielectric</th> <th>Rated Voltage</th> <th>Capacitance</th> </tr> </thead> <tbody> <tr> <td>1210</td> <td>X7R</td> <td>≥100V</td> <td>Cap.≥3.3μF</td> </tr> </tbody> </table> * Test time : 1000 +24/-0 hrs.<br>* Before initial measurement (Class II only) : To apply de-aging at 150°C for 1hr then set for 24±2 hrs at room temp.<br>* Measurement to be made after keeping at room temp. for 24±2 hrs (Class I) or 48±4 hrs (Class II). | Dielectric  | Rated Vol.(V) | Apply Voltage | C0G/X7R | ≤100 | 2.0 times of U <sub>R</sub> | 200≤V≤ 500 | 1.5 times of U <sub>R</sub> | ≥630 | 1.2 times of U <sub>R</sub> | Rated Vol.(V) | Size | Cap. Range | ALL | ALL | Cap.≥10G | 50V & 100V | 1210 | Cap.≥105 | 1812 | 1825 | 2220 | 2225 | Size | Dielectric | Rated Voltage | Capacitance | 2220 | X7R | ≥100V | Cap.≥15μF | Size | Dielectric | Rated Voltage | Capacitance | 1210 | X7R | ≥100V | Cap.≥3.3μF | * No remarkable damage.<br>* Cap. change :<br>COG Within ±3.0% or ±0.3pF, whichever is larger.<br>X7R Within ±12.5%.<br>* Q/D.F. :<br>COG : Q≥350.<br>X7R : D.F.≤200% of initial requirement.<br>* I.R. : ≥1GΩ or RxC≥50Ω-F, whichever is smaller. |
| Dielectric    | Rated Vol.(V)                           | Apply Voltage  |   |               |               |         |      |                             |            |                             |      |                             |               |      |            |     |     |          |            |      |          |      |      |      |      |      |            |               |             |      |     |       |           |      |            |               |             |      |     |       |            |  |
| C0G/X7R       | ≤100                                    | 2.0 times of U <sub>R</sub>  |   |               |               |         |      |                             |            |                             |      |                             |               |      |            |     |     |          |            |      |          |      |      |      |      |      |            |               |             |      |     |       |           |      |            |               |             |      |     |       |            |  |
|               | 200≤V≤ 500                              | 1.5 times of U <sub>R</sub>  |   |               |               |         |      |                             |            |                             |      |                             |               |      |            |     |     |          |            |      |          |      |      |      |      |      |            |               |             |      |     |       |           |      |            |               |             |      |     |       |            |  |
|               | ≥630                                    | 1.2 times of U <sub>R</sub>  |   |               |               |         |      |                             |            |                             |      |                             |               |      |            |     |     |          |            |      |          |      |      |      |      |      |            |               |             |      |     |       |           |      |            |               |             |      |     |       |            |  |
| Rated Vol.(V) | Size                                    | Cap. Range   |   |               |               |         |      |                             |            |                             |      |                             |               |      |            |     |     |          |            |      |          |      |      |      |      |      |            |               |             |      |     |       |           |      |            |               |             |      |     |       |            |  |
| ALL           | ALL                                     | Cap.≥10G   |   |               |               |         |      |                             |            |                             |      |                             |               |      |            |     |     |          |            |      |          |      |      |      |      |      |            |               |             |      |     |       |           |      |            |               |             |      |     |       |            |  |
| 50V & 100V    | 1210                                    | Cap.≥105   |   |               |               |         |      |                             |            |                             |      |                             |               |      |            |     |     |          |            |      |          |      |      |      |      |      |            |               |             |      |     |       |           |      |            |               |             |      |     |       |            |  |
|               | 1812                                    |  |   |               |               |         |      |                             |            |                             |      |                             |               |      |            |     |     |          |            |      |          |      |      |      |      |      |            |               |             |      |     |       |           |      |            |               |             |      |     |       |            |  |
|               | 1825                                    |  |   |               |               |         |      |                             |            |                             |      |                             |               |      |            |     |     |          |            |      |          |      |      |      |      |      |            |               |             |      |     |       |           |      |            |               |             |      |     |       |            |  |
|               | 2220                                    |  |   |               |               |         |      |                             |            |                             |      |                             |               |      |            |     |     |          |            |      |          |      |      |      |      |      |            |               |             |      |     |       |           |      |            |               |             |      |     |       |            |  |
|               | 2225                                    |  |   |               |               |         |      |                             |            |                             |      |                             |               |      |            |     |     |          |            |      |          |      |      |      |      |      |            |               |             |      |     |       |           |      |            |               |             |      |     |       |            |  |
| Size          | Dielectric                              | Rated Voltage  | Capacitance   |               |               |         |      |                             |            |                             |      |                             |               |      |            |     |     |          |            |      |          |      |      |      |      |      |            |               |             |      |     |       |           |      |            |               |             |      |     |       |            |  |
| 2220          | X7R                                     | ≥100V  | Cap.≥15μF   |               |               |         |      |                             |            |                             |      |                             |               |      |            |     |     |          |            |      |          |      |      |      |      |      |            |               |             |      |     |       |           |      |            |               |             |      |     |       |            |  |
| Size          | Dielectric                              | Rated Voltage  | Capacitance   |               |               |         |      |                             |            |                             |      |                             |               |      |            |     |     |          |            |      |          |      |      |      |      |      |            |               |             |      |     |       |           |      |            |               |             |      |     |       |            |  |
| 1210          | X7R                                     | ≥100V  | Cap.≥3.3μF  |               |               |         |      |                             |            |                             |      |                             |               |      |            |     |     |          |            |      |          |      |      |      |      |      |            |               |             |      |     |       |           |      |            |               |             |      |     |       |            |  |

8. RELIABILITY TEST CONDITIONS AND REQUIREMENTS

| No.        | Item  | Test Condition   | Requirements   |            |             |     |   |     |               |
|------------|---|--|--|------------|-------------|-----|---|-----|---------------|
| 11.        | Adhesive Strength of Termination            | <p>* Capacitors mounted on a substrate. A force of 10N applied perpendicular to the place of substrate and parallel the line joining the center of terminations for 10±1 second.</p>  <p>Capacitor, P.C. Board, Pressurizing force</p>  | <p>* No remarkable damage or removal of the terminations.</p>  |            |             |     |   |     |               |
| 14.        | Bending Test                                | <p>* The middle part of substrate shall be pressurized by means of the pressurizing rod at a rate of about 1mm per second until the deflection becomes 5mm.</p>  <p>Unit : mm</p>  | <p>* No remarkable damage.</p> <table border="1"> <thead> <tr> <th>Dielectric</th> <th>Cap. Change</th> </tr> </thead> <tbody> <tr> <td>C0G</td> <td>Within ±3.0% or ±2.0pF, whichever is larger</td> </tr> <tr> <td>X7R</td> <td>Within ±12.5%</td> </tr> </tbody> </table> <p>(This capacitance change means the change of capacitance under specified flexure of substrate from the capacitance measured before the test)</p> | Dielectric | Cap. Change | C0G | Within ±3.0% or ±2.0pF, whichever is larger | X7R | Within ±12.5% |
| Dielectric | Cap. Change                                 |  |  |            |             |     |   |     |               |
| C0G        | Within ±3.0% or ±2.0pF, whichever is larger |  |  |            |             |     |   |     |               |
| X7R        | Within ±12.5%                               |  |  |            |             |     |   |     |               |
| 15.        | Vibration Resistance                        | <p>* Vibration frequency : 10~55 Hz/min.</p> <p>* Total amplitude : 1.5mm.</p> <p>* Test time : 6 hrs. (Two hrs each in three mutually perpendicular directions)</p> <p>* Before initial measurement (Class II only) : To apply de-aging at 150°C for 1hr then set for 24±2 hrs at room temp.</p> <p>* Measurement to be made after keeping at room temp. for 24±2 hrs (Class I) or 48±4 hrs (Class II).</p> | <p>* No remarkable damage.</p> <p>* Cap. change and D.F. : To meet initial spec.</p>   |            |             |     |   |     |               |



## 9. APPLICATION NOTES

### STORAGE

To prevent the damage of solderability of terminations, the following storage conditions are recommended :  
 Indoors under 5 ~ 40°C and 20% ~ 70% RH.

No harmful gases containing sulfuric acid, ammonia, hydrogen sulfide or chlorine.

Packaging should not be opened until the capacitors are required for use. If opened, the pack should be re-sealed as soon as is practicable. Taped product should be stored out of direct sunlight, which might promote deterioration in tape or adhesion performance. The product is recommended to be used within 12 months after shipment and checked the solderability before use.

### HANDLING

Chip capacitors are dense, hard, brittle, and abrasive materials. They are liable to suffer mechanical damage, in the form of cracks or chips. Chip Capacitors should be handled with care to avoid contamination or damage. To use vacuum or plastic tweezers to pick up or plastic tweezers is recommended for manual placement. Tape and reeled packages are suitable for automatic pick and placement machine.

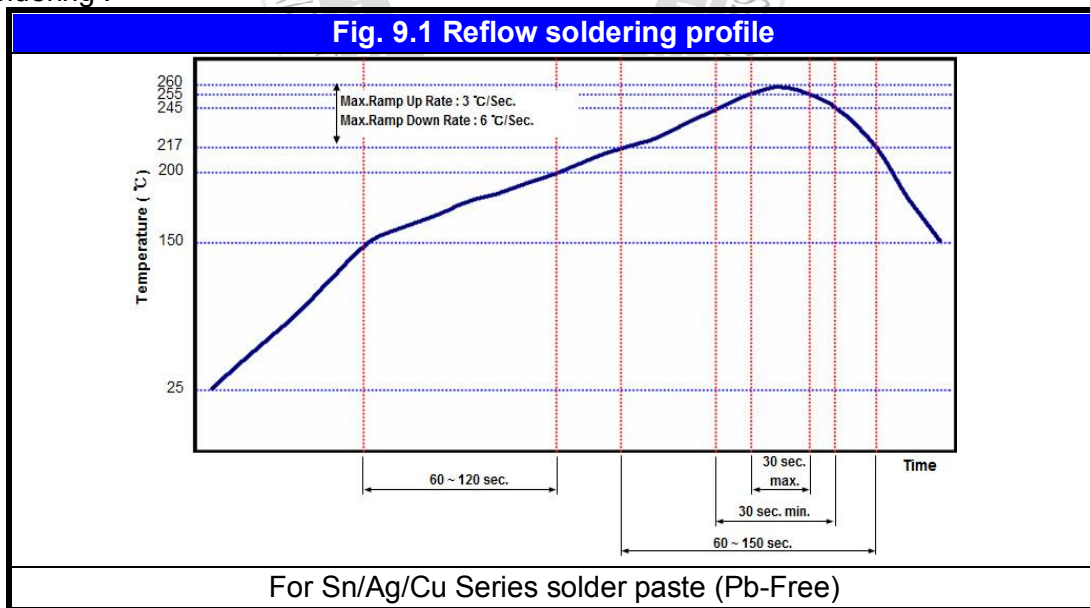
### PREHEAT

In order to minimize the risk of thermal shock during soldering, a carefully controlled preheat is required. The rate of preheat should not exceed 3°C per second.

### SOLDERING

Use middy activated rosin RA and RMA fluxes do not use activated flux. The amount of solder in each solder joint should be controlled to prevent the damage of chip capacitors caused by the stress between solder, chips, and substrate.

a.) Reflow soldering :



### COOLING

After soldering, cool the chips and the substrate gradually to room temperature. Natural cooling in air is recommended to minimize stress in the solder joint.

### CLEANING

All flux residues must be removed by using suitable electronic-grade vapor-cleaning solvents to eliminate contamination that could cause electrolytic surface corrosion. Good results can be obtained by using ultrasonic cleaning of the solvent. The choice of the proper system is depends upon many factors such as component mix, flux, and solder paste and assembly method. The ability of the cleaning system to remove flux residues and contamination from under the chips is very important.