

# SPECIFICATION

SPEC. No. D2013-C9  
DATE: 2013 Sep.

To

## Non-Controlled Copy

CUSTOMER'S PRODUCT NAME

TDK'S PRODUCT NAME

Multilayer ceramic capacitors  
Dipped radial lead type  
FK-Series  
General (Up to 50V)  
Mid voltage (100 to 630V)

### RECEIPT CONFIRMATION

DATE: \_\_\_\_\_ YEAR \_\_\_\_\_ MONTH \_\_\_\_\_ DAY \_\_\_\_\_

TDK Corporation  
Sales

Engineering

Electronic Components Sales &  
Marketing Group

TDK-EPC CORPORATION  
Ceramic Capacitors Business Group  
TDK-MCC CORPORATION  
DIELECTRIC PRODUCTS ENGINEERING DEPT.

| APPROVED | Person in charge |
|----------|------------------|
|          |                  |

| APPROVED | CHECKED | Person in charge |
|----------|---------|------------------|
|          |         |                  |

## 1. SCOPE

This specification is applicable to multilayer ceramic capacitors dipped radial lead type with a priority over the other relevant specifications.

Production places defined in this specification shall be TDK Xiamen Co., Ltd. (China).

### EXPLANATORY NOTE:

This specification warrants the quality of the lead type ceramic capacitor. The parts should be evaluated or confirmed a state of used on your product.

If the use of the parts go beyond the bounds of the specification, we can not afford to guarantee.

## 2. CODE CONSTRUCTION

(Example)

|             |            |           |            |          |             |
|-------------|------------|-----------|------------|----------|-------------|
| <u>FK28</u> | <u>X7R</u> | <u>1H</u> | <u>104</u> | <u>K</u> | <u>N006</u> |
| (1)         | (2)        | (3)       | (4)        | (5)      | (6)         |

(1)Type



| Type | Dimensions (Unit : mm) |         |         |         |              |                |
|------|------------------------|---------|---------|---------|--------------|----------------|
|      | L(max.)                | W(max.) | T(max.) | F       | l            | φ d            |
| FK18 | 4.0                    | 5.5     | 2.5     | 2.5±0.8 | 5.0          | 0.5            |
| FK14 | 4.5                    | 5.5     | 2.5     |         |              |                |
| FK16 | 5.5                    | 6.0     | 3.5     |         |              |                |
| FK11 | 5.5                    | 7.0     | 4.0     |         |              |                |
|      |                        |         |         |         | +3.0<br>-1.0 | +0.10<br>-0.03 |

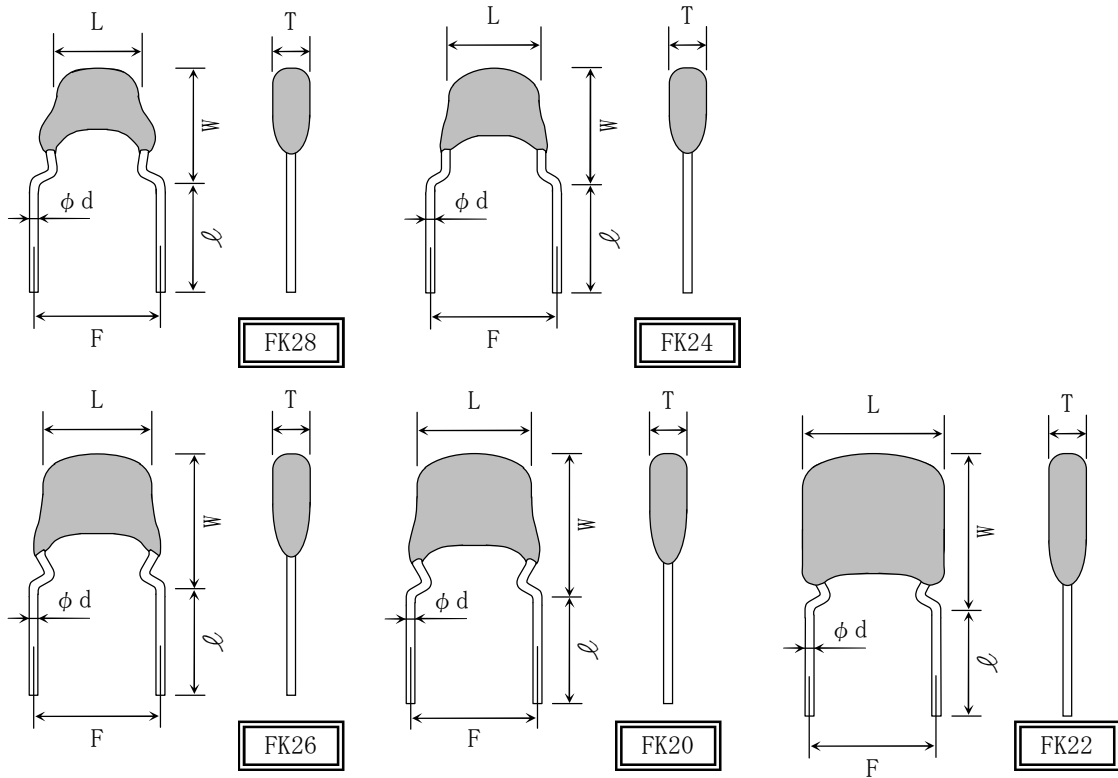
\*FK denotes forming lead.

The first digit refers to a distance between leads ( 1—2.5mm ),  
the second digit is for TDK internal code.

\*Dimension  $l$  is applied to bulk packaging.

Refer to Appendix 2 for dimension of taping packaging.

(1)Type



| Type | Dimensions (Unit : mm) |         |         |         |          |                       |
|------|------------------------|---------|---------|---------|----------|-----------------------|
|      | L(max.)                | W(max.) | T(max.) | F       | <i>l</i> | $\phi d$              |
| FK28 | 4.0                    | 5.5     | 2.5     | 5.0±1.0 | 7.0±2.0  | 0.5<br>+0.10<br>-0.03 |
| FK24 | 4.5                    | 5.5     | 2.5     |         |          |                       |
| FK26 | 5.5                    | 6.0     | 3.5     |         |          |                       |
| FK20 | 5.5                    | 7.0     | 4.0     |         |          |                       |
| FK22 | 7.5                    | 8.0     | 4.0     |         |          |                       |

\*FK denotes forming lead.

The first digit refers to a distance between leads ( 2–5.0mm ),  
the second digit is for TDK internal code.

\*Dimension *l* is applied to bulk packaging.

Refer to Appendix 3 for dimension of taping packaging.

(2)Temperature Characteristics (Details are shown in para 7 No.7,8)

(3) Rated Voltage

| Symbol | Rated Voltage |
|--------|---------------|
| 2 J    | DC 630 V      |
| 2 E    | DC 250 V      |
| 2 A    | DC 100 V      |
| 1 H    | DC 50 V       |
| 1 E    | DC 25 V       |
| 1 C    | DC 16 V       |
| 1 A    | DC 10 V       |
| 0 J    | DC 6.3 V      |

(4) Rated Capacitance

Stated in three digits and in units of pico farads (pF). The first and second digits identify the first and second significant figures of the capacitance, the third digit identifies the multiplier.

R is designated for a decimal point.

Example      2R2 → 2.2pF  
                  104 → 100,000pF

(5) Capacitance tolerance

| Symbol | Tolerance | Capacitance (C)                   |
|--------|-----------|-----------------------------------|
| C      | ±0.25 pF  | $C \leq 5\text{pF}$               |
| D      | ±0.5 pF   | $5\text{pF} < C \leq 10\text{pF}$ |
| J      | ± 5 %     | Over 10pF                         |
| K      | ±10 %     |                                   |
| M      | ±20 %     |                                   |

(6) Internal code

| Symbol | Applied voltage of Life | Packaging          |
|--------|-------------------------|--------------------|
| N020   | Rated voltage<br>×2     | Bulk<br>(FK1*type) |
| N000   |                         | Bulk<br>(FK2*type) |
| N006   |                         | Ammo Pack          |
| R020   | Rated voltage<br>×1     | Bulk<br>(FK1*type) |
| R000   |                         | Bulk<br>(FK2*type) |
| R006   |                         | Ammo Pack          |

### 3.1 Standard combination of rated capacitances and tolerances

| Class | Temperature Characteristics | Capacitance tolerance (*1) |                    | Rated capacitance                 |
|-------|-----------------------------|----------------------------|--------------------|-----------------------------------|
| 1     | COG                         | $C \leq 5$                 | C ( $\pm 0.25$ pF) | 1, 1.5, 2, 2.2, 3, 3.3, 4, 4.7, 5 |
|       |                             | $5 < C \leq 10$            | D ( $\pm 0.5$ pF)  | 6, 6.8, 7, 8, 9, 10               |
|       |                             | $10 < C \leq 10,000$       | J ( $\pm 5$ %)     | E-12 series                       |
|       |                             | $10,000 < C$               | J ( $\pm 5$ %)     | E-6 series                        |
| 2     | X5R<br>X7R<br>X7S           | $C \leq 0.1$               | K ( $\pm 10$ %)    | E-6 series                        |
|       |                             | $0.1 < C \leq 10$          | K ( $\pm 10$ %)    | E-6 series                        |
|       |                             | $10 < C$                   | M ( $\pm 20$ %)    |                                   |

\*1 C denotes Capacitance.

Unit : pF for Class1 and  $\mu$ F for Class2.

### 3.2 Capacitance Step in E series

| E series | Capacitance Step |     |     |     |     |     |     |     |     |     |     |     |
|----------|------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| E-3      | 1                |     |     | 2.2 |     |     |     | 4.7 |     |     |     |     |
| E-6      | 1                | 1.5 | 2.2 | 3.3 | 4.7 | 6.8 |     |     |     |     |     |     |
| E-12     | 1                | 1.2 | 1.5 | 1.8 | 2.2 | 2.7 | 3.3 | 3.9 | 4.7 | 5.6 | 6.8 | 8.2 |

## 4. OPERATING TEMPERATURE RANGE

| T. C.             | Min. operating Temperature | Max. operating Temperature | Reference Temperature |
|-------------------|----------------------------|----------------------------|-----------------------|
| X5R               | -55°C                      | 85°C                       | 25°C                  |
| COG<br>X7R<br>X7S | -55°C                      | 125°C                      | 25°C                  |

## 5. STORING CONDITION AND TERM

5 to 40°C at 20 to 70%RH

6 months Max.

## 6. INDUSTRIAL WASTE DISPOSAL

Dispose this product as industrial waste in accordance with the industrial Waste Law.

## 7. PERFORMANCE

table 1

| No.    | Item                         |                                          | Performance                                                                                                                                                                                                                                                                                                              | Test or inspection method                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                     |                   |           |               |               |        |                |                  |           |                    |           |                                                                                                           |                    |           |                    |
|--------|------------------------------|------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|-------------------|-----------|---------------|---------------|--------|----------------|------------------|-----------|--------------------|-----------|-----------------------------------------------------------------------------------------------------------|--------------------|-----------|--------------------|
| 1      | External Appearance          |                                          | No defects which may affect performance.                                                                                                                                                                                                                                                                                 | By visual checking.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                     |                   |           |               |               |        |                |                  |           |                    |           |                                                                                                           |                    |           |                    |
| 2      | Indication                   | Appearance                               | Meet a requirement per para 8.                                                                                                                                                                                                                                                                                           | solvent                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Solvent temp.       | Dipping time      |           |               |               |        |                |                  |           |                    |           |                                                                                                           |                    |           |                    |
|        |                              | Resistance to solvent                    | Shall be visible.                                                                                                                                                                                                                                                                                                        | Isopropyl alcohol                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | 20~25 °C            | 30±5s.            |           |               |               |        |                |                  |           |                    |           |                                                                                                           |                    |           |                    |
| 3      | Voltage Proof                | Between termination                      | No insulation breakdown or other damage.                                                                                                                                                                                                                                                                                 | <table border="1"> <thead> <tr> <th>Class</th> <th>Rated voltage</th> <th>Apply voltage</th> </tr> </thead> <tbody> <tr> <td rowspan="2">Class1</td> <td>100V and under</td> <td>Rated voltage ×3</td> </tr> <tr> <td>Over 100V</td> <td>Rated voltage ×1.5</td> </tr> <tr> <td rowspan="2">Class2</td> <td>100V and under</td> <td>Rated voltage ×2.5</td> </tr> <tr> <td>Over 100V</td> <td>Rated voltage ×1.5</td> </tr> </tbody> </table> <p>Above DC voltage shall be applied for 1~5s.<br/>Charge / discharge current shall not exceed 50mA.</p> |                     |                   | Class     | Rated voltage | Apply voltage | Class1 | 100V and under | Rated voltage ×3 | Over 100V | Rated voltage ×1.5 | Class2    | 100V and under                                                                                            | Rated voltage ×2.5 | Over 100V | Rated voltage ×1.5 |
|        |                              | Class                                    | Rated voltage                                                                                                                                                                                                                                                                                                            | Apply voltage                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                     |                   |           |               |               |        |                |                  |           |                    |           |                                                                                                           |                    |           |                    |
| Class1 | 100V and under               | Rated voltage ×3                         |                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                     |                   |           |               |               |        |                |                  |           |                    |           |                                                                                                           |                    |           |                    |
|        | Over 100V                    | Rated voltage ×1.5                       |                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                     |                   |           |               |               |        |                |                  |           |                    |           |                                                                                                           |                    |           |                    |
| Class2 | 100V and under               | Rated voltage ×2.5                       |                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                     |                   |           |               |               |        |                |                  |           |                    |           |                                                                                                           |                    |           |                    |
|        | Over 100V                    | Rated voltage ×1.5                       |                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                     |                   |           |               |               |        |                |                  |           |                    |           |                                                                                                           |                    |           |                    |
|        | Between termination coating  | No insulation breakdown or other damage. | Apply ×2.5 rated voltage.<br>(By metallic small ball method.)                                                                                                                                                                                                                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                     |                   |           |               |               |        |                |                  |           |                    |           |                                                                                                           |                    |           |                    |
| 4      | Insulation Resistance        |                                          | 10,000MΩ or 500 MΩ · μF min.<br>(As for the capacitor of rated voltage 16,10 and 6.3V DC, 10,000 MΩ or 100 MΩ · μF min.,) whichever smaller.                                                                                                                                                                             | «250V DC and under»<br>Apply rated voltage.<br>«630V DC»<br>Apply DC500V.<br>Applying time : 60sec.                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                     |                   |           |               |               |        |                |                  |           |                    |           |                                                                                                           |                    |           |                    |
| 5      | Capacitance                  |                                          | Within the specified tolerance.                                                                                                                                                                                                                                                                                          | Class 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                     |                   |           |               |               |        |                |                  |           |                    |           |                                                                                                           |                    |           |                    |
|        |                              |                                          |                                                                                                                                                                                                                                                                                                                          | Rated capacitance                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Measuring frequency | Measuring voltage |           |               |               |        |                |                  |           |                    |           |                                                                                                           |                    |           |                    |
|        |                              |                                          |                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                     | 0.5~5 Vrms.       |           |               |               |        |                |                  |           |                    |           |                                                                                                           |                    |           |                    |
|        |                              |                                          |                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                     |                   |           |               |               |        |                |                  |           |                    |           |                                                                                                           |                    |           |                    |
|        |                              |                                          |                                                                                                                                                                                                                                                                                                                          | Class 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                     |                   |           |               |               |        |                |                  |           |                    |           |                                                                                                           |                    |           |                    |
|        |                              |                                          |                                                                                                                                                                                                                                                                                                                          | Rated capacitance                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Measuring frequency | Measuring voltage |           |               |               |        |                |                  |           |                    |           |                                                                                                           |                    |           |                    |
|        |                              |                                          |                                                                                                                                                                                                                                                                                                                          | 10 μF and under                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 1kHz±10%            | 1.0±0.2 Vrms.     |           |               |               |        |                |                  |           |                    |           |                                                                                                           |                    |           |                    |
|        |                              |                                          |                                                                                                                                                                                                                                                                                                                          | Over 10 μF                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 120Hz±10%           | 0.5±0.2 Vrms.     |           |               |               |        |                |                  |           |                    |           |                                                                                                           |                    |           |                    |
| 6      | Q (Class 1)                  |                                          | As per Table 2.                                                                                                                                                                                                                                                                                                          | See No.5 in this table for measuring condition.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                     |                   |           |               |               |        |                |                  |           |                    |           |                                                                                                           |                    |           |                    |
|        | Dissipation Factor (Class 2) |                                          | <table border="1"> <thead> <tr> <th>T. C.</th> <th>D. F.</th> </tr> </thead> <tbody> <tr> <td></td> <td>0.03 max.</td> </tr> <tr> <td>X5R</td> <td>0.05 max.</td> </tr> <tr> <td>X7R</td> <td>0.075 max.</td> </tr> <tr> <td>X7S</td> <td>0.10 max.</td> </tr> <tr> <td></td> <td>0.15 max.</td> </tr> </tbody> </table> | T. C.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | D. F.               |                   | 0.03 max. | X5R           | 0.05 max.     | X7R    | 0.075 max.     | X7S              | 0.10 max. |                    | 0.15 max. | For information which product has which Dissipation Factor, please contact with our sales representative. |                    |           |                    |
| T. C.  | D. F.                        |                                          |                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                     |                   |           |               |               |        |                |                  |           |                    |           |                                                                                                           |                    |           |                    |
|        | 0.03 max.                    |                                          |                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                     |                   |           |               |               |        |                |                  |           |                    |           |                                                                                                           |                    |           |                    |
| X5R    | 0.05 max.                    |                                          |                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                     |                   |           |               |               |        |                |                  |           |                    |           |                                                                                                           |                    |           |                    |
| X7R    | 0.075 max.                   |                                          |                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                     |                   |           |               |               |        |                |                  |           |                    |           |                                                                                                           |                    |           |                    |
| X7S    | 0.10 max.                    |                                          |                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                     |                   |           |               |               |        |                |                  |           |                    |           |                                                                                                           |                    |           |                    |
|        | 0.15 max.                    |                                          |                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                     |                   |           |               |               |        |                |                  |           |                    |           |                                                                                                           |                    |           |                    |

(continued)

| No.                              | Item                                                 |                     | Performance                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Test or inspection method                                                                                                                                                                                                                                                      |                                                        |                                   |        |                                                                                                                                                            |                                                        |        |          |             |          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |      |                  |                                                                                                                                                                                        |                         |   |                              |   |                         |   |                              |
|----------------------------------|------------------------------------------------------|---------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------|-----------------------------------|--------|------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------|--------|----------|-------------|----------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------|---|------------------------------|---|-------------------------|---|------------------------------|
| 7                                | Temperature Characteristics of Capacitance (Class 1) |                     | <table border="1"> <tr> <td colspan="2">Temperature Coefficient (ppm/°C)</td> </tr> <tr> <td colspan="2">COG : <math>0 \pm 30</math></td> </tr> </table> Capacitance drift<br>Within $\pm 0.2\%$ or $\pm 0.05\text{pF}$ , whichever larger.                                                                                                                                                                                                                                               | Temperature Coefficient (ppm/°C)                                                                                                                                                                                                                                               |                                                        | COG : $0 \pm 30$                  |        | Temperature Coefficient shall be calculated based on values at 25°C and 85°C temperature.<br><br>Measuring temperature below 20°C shall be -10°C and -25°C |                                                        |        |          |             |          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |      |                  |                                                                                                                                                                                        |                         |   |                              |   |                         |   |                              |
| Temperature Coefficient (ppm/°C) |                                                      |                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                                                                                                                                                |                                                        |                                   |        |                                                                                                                                                            |                                                        |        |          |             |          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |      |                  |                                                                                                                                                                                        |                         |   |                              |   |                         |   |                              |
| COG : $0 \pm 30$                 |                                                      |                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                                                                                                                                                |                                                        |                                   |        |                                                                                                                                                            |                                                        |        |          |             |          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |      |                  |                                                                                                                                                                                        |                         |   |                              |   |                         |   |                              |
| 8                                | Temperature Characteristics of Capacitance (Class 2) |                     | <table border="1"> <tr> <td colspan="2">Capacitance Change (%)</td> </tr> <tr> <td colspan="2">No voltage applied</td> </tr> <tr> <td>X5R:</td> <td><math>\pm 15</math></td> </tr> <tr> <td>X7R:</td> <td><math>\pm 15</math></td> </tr> <tr> <td>X7S:</td> <td><math>\pm 22</math></td> </tr> </table>                                                                                                                                                                                   | Capacitance Change (%)                                                                                                                                                                                                                                                         |                                                        | No voltage applied                |        | X5R:                                                                                                                                                       | $\pm 15$                                               | X7R:   | $\pm 15$ | X7S:        | $\pm 22$ | Capacitance shall be measured by the steps shown in the following table, after thermal equilibrium is obtained for each step.<br>$\Delta C$ be calculated ref. STEP3 reading. <table border="1"> <thead> <tr> <th>Step</th> <th>Temperature (°C)</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>Reference temp. <math>\pm 2</math></td> </tr> <tr> <td>2</td> <td>Min. operating temp. <math>\pm 2</math></td> </tr> <tr> <td>3</td> <td>Reference temp. <math>\pm 2</math></td> </tr> <tr> <td>4</td> <td>Max. operating temp. <math>\pm 2</math></td> </tr> </tbody> </table> As for the capacitor of rated voltage 10V DC(1A) and 6.3V DC(0J), 0.2Vrms. shall be applied. | Step | Temperature (°C) | 1                                                                                                                                                                                      | Reference temp. $\pm 2$ | 2 | Min. operating temp. $\pm 2$ | 3 | Reference temp. $\pm 2$ | 4 | Max. operating temp. $\pm 2$ |
| Capacitance Change (%)           |                                                      |                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                                                                                                                                                |                                                        |                                   |        |                                                                                                                                                            |                                                        |        |          |             |          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |      |                  |                                                                                                                                                                                        |                         |   |                              |   |                         |   |                              |
| No voltage applied               |                                                      |                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                                                                                                                                                |                                                        |                                   |        |                                                                                                                                                            |                                                        |        |          |             |          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |      |                  |                                                                                                                                                                                        |                         |   |                              |   |                         |   |                              |
| X5R:                             | $\pm 15$                                             |                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                                                                                                                                                |                                                        |                                   |        |                                                                                                                                                            |                                                        |        |          |             |          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |      |                  |                                                                                                                                                                                        |                         |   |                              |   |                         |   |                              |
| X7R:                             | $\pm 15$                                             |                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                                                                                                                                                |                                                        |                                   |        |                                                                                                                                                            |                                                        |        |          |             |          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |      |                  |                                                                                                                                                                                        |                         |   |                              |   |                         |   |                              |
| X7S:                             | $\pm 22$                                             |                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                                                                                                                                                |                                                        |                                   |        |                                                                                                                                                            |                                                        |        |          |             |          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |      |                  |                                                                                                                                                                                        |                         |   |                              |   |                         |   |                              |
| Step                             | Temperature (°C)                                     |                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                                                                                                                                                |                                                        |                                   |        |                                                                                                                                                            |                                                        |        |          |             |          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |      |                  |                                                                                                                                                                                        |                         |   |                              |   |                         |   |                              |
| 1                                | Reference temp. $\pm 2$                              |                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                                                                                                                                                |                                                        |                                   |        |                                                                                                                                                            |                                                        |        |          |             |          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |      |                  |                                                                                                                                                                                        |                         |   |                              |   |                         |   |                              |
| 2                                | Min. operating temp. $\pm 2$                         |                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                                                                                                                                                |                                                        |                                   |        |                                                                                                                                                            |                                                        |        |          |             |          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |      |                  |                                                                                                                                                                                        |                         |   |                              |   |                         |   |                              |
| 3                                | Reference temp. $\pm 2$                              |                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                                                                                                                                                |                                                        |                                   |        |                                                                                                                                                            |                                                        |        |          |             |          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |      |                  |                                                                                                                                                                                        |                         |   |                              |   |                         |   |                              |
| 4                                | Max. operating temp. $\pm 2$                         |                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                                                                                                                                                |                                                        |                                   |        |                                                                                                                                                            |                                                        |        |          |             |          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |      |                  |                                                                                                                                                                                        |                         |   |                              |   |                         |   |                              |
| 9                                | Lead Strength                                        | Tensile Strength    | No mechanical damage such as lead breakage and loosing.                                                                                                                                                                                                                                                                                                                                                                                                                                   | With holding the parts, apply pulling force to lead drawing direction gradually.<br>Pulling strength : 5N<br>Holding time : $10 \pm 1\text{s}$ .                                                                                                                               |                                                        |                                   |        |                                                                                                                                                            |                                                        |        |          |             |          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |      |                  |                                                                                                                                                                                        |                         |   |                              |   |                         |   |                              |
|                                  |                                                      | Bending Strength    | No mechanical damage such as lead breakage and loosing.                                                                                                                                                                                                                                                                                                                                                                                                                                   | With holding the capacitors to keep the axis vertical, bend it 90 degrees with weighting and put it back to the original position.<br>This operation shall be done for 2~3s. and repeat the following times.<br>Bending forth : 5N (weight : 0.51kg)<br>Testing time : 2 times |                                                        |                                   |        |                                                                                                                                                            |                                                        |        |          |             |          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |      |                  |                                                                                                                                                                                        |                         |   |                              |   |                         |   |                              |
| 10                               | Vibration                                            | External appearance | No mechanical damage.                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Solder the capacitors on a P. C. Board shown in Appendix1 before testing.                                                                                                                                                                                                      |                                                        |                                   |        |                                                                                                                                                            |                                                        |        |          |             |          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |      |                  |                                                                                                                                                                                        |                         |   |                              |   |                         |   |                              |
|                                  |                                                      | Capacitance         | <table border="1"> <thead> <tr> <th colspan="2">Characteristics</th> <th>Change from the value before test</th> </tr> </thead> <tbody> <tr> <td>Class1</td> <td>COG</td> <td><math>\pm 2.5\%</math> or <math>\pm 0.25\text{pF}</math>, whichever larger.</td> </tr> <tr> <td rowspan="3">Class2</td> <td>X5R</td> <td><math>\pm 7.5\%</math></td> </tr> <tr> <td>X7R</td> <td><math>\pm 7.5\%</math></td> </tr> <tr> <td>X7S</td> <td><math>\pm 7.5\%</math></td> </tr> </tbody> </table> | Characteristics                                                                                                                                                                                                                                                                |                                                        | Change from the value before test | Class1 | COG                                                                                                                                                        | $\pm 2.5\%$ or $\pm 0.25\text{pF}$ , whichever larger. | Class2 | X5R      | $\pm 7.5\%$ | X7R      | $\pm 7.5\%$                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | X7S  | $\pm 7.5\%$      | Vibrate the capacitor with amplitude of 1.5mm P-P changing the frequencies from 10Hz to 55Hz and back to 10Hz in about 1min.<br>Repeat this for 2h each in 3 perpendicular directions. |                         |   |                              |   |                         |   |                              |
|                                  |                                                      |                     | Characteristics                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                                                                                                                                                | Change from the value before test                      |                                   |        |                                                                                                                                                            |                                                        |        |          |             |          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |      |                  |                                                                                                                                                                                        |                         |   |                              |   |                         |   |                              |
|                                  |                                                      |                     | Class1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | COG                                                                                                                                                                                                                                                                            | $\pm 2.5\%$ or $\pm 0.25\text{pF}$ , whichever larger. |                                   |        |                                                                                                                                                            |                                                        |        |          |             |          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |      |                  |                                                                                                                                                                                        |                         |   |                              |   |                         |   |                              |
| Class2                           | X5R                                                  | $\pm 7.5\%$         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                                                                                                                                                |                                                        |                                   |        |                                                                                                                                                            |                                                        |        |          |             |          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |      |                  |                                                                                                                                                                                        |                         |   |                              |   |                         |   |                              |
|                                  | X7R                                                  | $\pm 7.5\%$         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                                                                                                                                                |                                                        |                                   |        |                                                                                                                                                            |                                                        |        |          |             |          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |      |                  |                                                                                                                                                                                        |                         |   |                              |   |                         |   |                              |
|                                  | X7S                                                  | $\pm 7.5\%$         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                                                                                                                                                |                                                        |                                   |        |                                                                                                                                                            |                                                        |        |          |             |          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |      |                  |                                                                                                                                                                                        |                         |   |                              |   |                         |   |                              |
| Q Class1                         | Shown in Table2.                                     |                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                                                                                                                                                |                                                        |                                   |        |                                                                                                                                                            |                                                        |        |          |             |          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |      |                  |                                                                                                                                                                                        |                         |   |                              |   |                         |   |                              |
| D. F. Class2                     | Meet the initial spec.                               |                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                                                                                                                                                |                                                        |                                   |        |                                                                                                                                                            |                                                        |        |          |             |          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |      |                  |                                                                                                                                                                                        |                         |   |                              |   |                         |   |                              |

(continued)

| No.                   | Item                                               | Performance                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Test or inspection method                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                      |                                                      |                                   |        |                                                    |                                                      |            |                 |             |            |                              |            |             |                 |             |
|-----------------------|----------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------|------------------------------------------------------|-----------------------------------|--------|----------------------------------------------------|------------------------------------------------------|------------|-----------------|-------------|------------|------------------------------|------------|-------------|-----------------|-------------|
| 11                    | Solderability                                      | Leads shall be covered by new solder more than 75% of its surface.                                                                                                                                                                                                                                                                                                                                                                                                                       | <p>Completely soak both terminations in solder at <math>245 \pm 5^\circ\text{C}</math> for <math>2 \pm 0.5\text{s}</math>.</p> <p>Solder : Sn-3.0Ag-0.5Cu(Pb-free)<br/> Flux : Isopropyl alcohol(JIS K 8839)<br/> Rosin(JIS K 5902)<br/> 25% solid solution.<br/> Dipping : By 1.5~2.0mm from the root of lead.</p>                                                                                                                                                                                                                  |                                                      |                                                      |                                   |        |                                                    |                                                      |            |                 |             |            |                              |            |             |                 |             |
| 12                    | Resistance to solder heat                          | External appearance                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | <p>Completely soak both terminations in solder at <math>250 \pm 5^\circ\text{C}</math> for <math>5 \pm 1\text{s}</math>.</p> <p>Solder : Sn-3.0Ag-0.5Cu(Pb-free)<br/> Flux : Isopropyl alcohol(JIS K 8839)<br/> Rosin(JIS K 5902)<br/> 25% solid solution.<br/> Dipping : By 1.5~2.0mm from the root of lead.</p>                                                                                                                                                                                                                    |                                                      |                                                      |                                   |        |                                                    |                                                      |            |                 |             |            |                              |            |             |                 |             |
|                       |                                                    | Capacitance                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                      |                                                      |                                   |        |                                                    |                                                      |            |                 |             |            |                              |            |             |                 |             |
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|                       |                                                    | Characteristics                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Change from the value before test                    |                                                      |                                   |        |                                                    |                                                      |            |                 |             |            |                              |            |             |                 |             |
|                       |                                                    | Class1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | COG                                                  | $\pm 2.5\%$ or $\pm 0.25\text{pF}$ whichever larger. |                                   |        |                                                    |                                                      |            |                 |             |            |                              |            |             |                 |             |
|                       |                                                    | Class2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | X5R                                                  | $\pm 7.5\%$                                          |                                   |        |                                                    |                                                      |            |                 |             |            |                              |            |             |                 |             |
| X7R                   | $\pm 7.5\%$                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                      |                                                      |                                   |        |                                                    |                                                      |            |                 |             |            |                              |            |             |                 |             |
| X7S                   | $\pm 7.5\%$                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                      |                                                      |                                   |        |                                                    |                                                      |            |                 |             |            |                              |            |             |                 |             |
| Q Class1              | Shown in Table2.                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                      |                                                      |                                   |        |                                                    |                                                      |            |                 |             |            |                              |            |             |                 |             |
| D.F. Class2           | Meet the initial spec.                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                      |                                                      |                                   |        |                                                    |                                                      |            |                 |             |            |                              |            |             |                 |             |
| Insulation Resistance | Meet the initial spec.                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                      |                                                      |                                   |        |                                                    |                                                      |            |                 |             |            |                              |            |             |                 |             |
| Voltage proof         | No insulation breakdown or other damage.           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                      |                                                      |                                   |        |                                                    |                                                      |            |                 |             |            |                              |            |             |                 |             |
| 13                    | Temperature Cycle and Dipping Cycle                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | <p>Temperature Cycle</p> <table border="1"> <thead> <tr> <th>Step</th> <th>Temp. (<math>^\circ\text{C}</math>)</th> <th>Time(min.)</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>Min. operating Temp. <math>\pm 3</math></td> <td><math>30 \pm 3</math></td> </tr> <tr> <td>2</td> <td>Reference temp.</td> <td>Less than 3</td> </tr> <tr> <td>3</td> <td>Max. operating Temp. <math>\pm 3</math></td> <td><math>30 \pm 3</math></td> </tr> <tr> <td>4</td> <td>Reference temp.</td> <td>Less than 3</td> </tr> </tbody> </table> | Step                                                 | Temp. ( $^\circ\text{C}$ )                           | Time(min.)                        | 1      | Min. operating Temp. $\pm 3$                       | $30 \pm 3$                                           | 2          | Reference temp. | Less than 3 | 3          | Max. operating Temp. $\pm 3$ | $30 \pm 3$ | 4           | Reference temp. | Less than 3 |
|                       |                                                    | Step                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Temp. ( $^\circ\text{C}$ )                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Time(min.)                                           |                                                      |                                   |        |                                                    |                                                      |            |                 |             |            |                              |            |             |                 |             |
|                       |                                                    | 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Min. operating Temp. $\pm 3$                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | $30 \pm 3$                                           |                                                      |                                   |        |                                                    |                                                      |            |                 |             |            |                              |            |             |                 |             |
|                       |                                                    | 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Reference temp.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Less than 3                                          |                                                      |                                   |        |                                                    |                                                      |            |                 |             |            |                              |            |             |                 |             |
|                       |                                                    | 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Max. operating Temp. $\pm 3$                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | $30 \pm 3$                                           |                                                      |                                   |        |                                                    |                                                      |            |                 |             |            |                              |            |             |                 |             |
|                       |                                                    | 4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Reference temp.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Less than 3                                          |                                                      |                                   |        |                                                    |                                                      |            |                 |             |            |                              |            |             |                 |             |
|                       |                                                    | Capacitance                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | <table border="1"> <thead> <tr> <th colspan="2">Characteristics</th> <th>Change from the value before test</th> </tr> </thead> <tbody> <tr> <td>Class1</td> <td>COG</td> <td><math>\pm 2.5\%</math> or <math>\pm 0.25\text{pF}</math> whichever larger.</td> </tr> <tr> <td rowspan="3">*Class2</td> <td>X5R</td> <td><math>\pm 7.5\%</math></td> </tr> <tr> <td>X7R</td> <td><math>\pm 10\%</math></td> </tr> <tr> <td>X7S</td> <td><math>\pm 10\%</math></td> </tr> </tbody> </table> <p>*Applied for some parts</p>               | Characteristics                                      |                                                      | Change from the value before test | Class1 | COG                                                | $\pm 2.5\%$ or $\pm 0.25\text{pF}$ whichever larger. | *Class2    | X5R             | $\pm 7.5\%$ | X7R        | $\pm 10\%$                   | X7S        | $\pm 10\%$  |                 |             |
|                       |                                                    | Characteristics                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Change from the value before test                    |                                                      |                                   |        |                                                    |                                                      |            |                 |             |            |                              |            |             |                 |             |
|                       |                                                    | Class1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | COG                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | $\pm 2.5\%$ or $\pm 0.25\text{pF}$ whichever larger. |                                                      |                                   |        |                                                    |                                                      |            |                 |             |            |                              |            |             |                 |             |
|                       |                                                    | *Class2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | X5R                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | $\pm 7.5\%$                                          |                                                      |                                   |        |                                                    |                                                      |            |                 |             |            |                              |            |             |                 |             |
| X7R                   | $\pm 10\%$                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                      |                                                      |                                   |        |                                                    |                                                      |            |                 |             |            |                              |            |             |                 |             |
| X7S                   | $\pm 10\%$                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                      |                                                      |                                   |        |                                                    |                                                      |            |                 |             |            |                              |            |             |                 |             |
| Q Class1              | Shown in Table2.                                   | <p>Dipping Cycle</p> <table border="1"> <thead> <tr> <th>Step</th> <th>Temp. (<math>^\circ\text{C}</math>)</th> <th>Time (min.)</th> <th>Solidy liquid</th> </tr> </thead> <tbody> <tr> <td>1</td> <td><math>65 \begin{smallmatrix} +5 \\ 0 \end{smallmatrix}</math></td> <td><math>15 \pm 2</math></td> <td>Pure water</td> </tr> <tr> <td>2</td> <td><math>0 \pm 3</math></td> <td><math>15 \pm 2</math></td> <td>Saturation salt water</td> </tr> </tbody> </table>                   | Step                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Temp. ( $^\circ\text{C}$ )                           | Time (min.)                                          | Solidy liquid                     | 1      | $65 \begin{smallmatrix} +5 \\ 0 \end{smallmatrix}$ | $15 \pm 2$                                           | Pure water | 2               | $0 \pm 3$   | $15 \pm 2$ | Saturation salt water        |            |             |                 |             |
| Step                  | Temp. ( $^\circ\text{C}$ )                         | Time (min.)                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Solidy liquid                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                      |                                                      |                                   |        |                                                    |                                                      |            |                 |             |            |                              |            |             |                 |             |
| 1                     | $65 \begin{smallmatrix} +5 \\ 0 \end{smallmatrix}$ | $15 \pm 2$                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Pure water                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                      |                                                      |                                   |        |                                                    |                                                      |            |                 |             |            |                              |            |             |                 |             |
| 2                     | $0 \pm 3$                                          | $15 \pm 2$                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Saturation salt water                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                      |                                                      |                                   |        |                                                    |                                                      |            |                 |             |            |                              |            |             |                 |             |
| D.F. Class2           | Meet the initial spec.                             | <p>Solder the capacitors on a P.C.Board shown in Appendix1 before testing.</p> <p>Leave the capacitors in ambient condition for the following time before measurement.</p> <p>Class1 : <math>24 \pm 2\text{h}</math><br/> Class2 : <math>48 \pm 4\text{h}</math></p> <p>Perform Temperature cycle(5 cycle) and dipping cycle(2 cycle) consecutively.</p>                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                      |                                                      |                                   |        |                                                    |                                                      |            |                 |             |            |                              |            |             |                 |             |
| Insulation Resistance | Meet the initial spec.                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                      |                                                      |                                   |        |                                                    |                                                      |            |                 |             |            |                              |            |             |                 |             |
| Voltage proof         | No insulation breakdown or other damage.           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                      |                                                      |                                   |        |                                                    |                                                      |            |                 |             |            |                              |            |             |                 |             |
|                       |                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                      |                                                      |                                   |        |                                                    |                                                      |            |                 |             |            |                              |            |             |                 |             |



(continued)

| No.                     | Item                               | Performance                                                                                                                                                                                                                                                                                                                                                                                                      | Test or inspection method                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                   |  |                                   |        |     |                                                            |         |                   |                            |
|-------------------------|------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------|--|-----------------------------------|--------|-----|------------------------------------------------------------|---------|-------------------|----------------------------|
| 14                      | Moisture Resistance (Steady State) | External appearance                                                                                                                                                                                                                                                                                                                                                                                              | Solder the capacitors on a P.C. Board shown in Appendix1 before testing. Leave at temperature $40 \pm 2^\circ\text{C}$ , 90 to 95%RH for 500 +24, 0h. Leave the capacitors in ambient condition for the following time before measurement.<br>Class1 : $24 \pm 2\text{h}$<br>Class2 : $48 \pm 4\text{h}$                                                                                                                                                                                                                                                                                                                          |                                   |  |                                   |        |     |                                                            |         |                   |                            |
|                         |                                    | Capacitance                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                   |  |                                   |        |     |                                                            |         |                   |                            |
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|                         |                                    | Characteristics                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Change from the value before test |  |                                   |        |     |                                                            |         |                   |                            |
| Class1                  | COG                                | $\pm 5\%$ or<br>$0.5\text{pF}$<br>whichever larger.                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                   |  |                                   |        |     |                                                            |         |                   |                            |
| *Class2                 | X5R<br>X7R<br>X7S                  | $\pm 12.5\%$<br>$\pm 25\%$                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                   |  |                                   |        |     |                                                            |         |                   |                            |
| *Applied for some parts |                                    |                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                   |  |                                   |        |     |                                                            |         |                   |                            |
|                         | Q Class1                           | Shown in Table2.                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                   |  |                                   |        |     |                                                            |         |                   |                            |
|                         | D. F. Class2                       | Characteristics<br>200% of initial spec max.                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                   |  |                                   |        |     |                                                            |         |                   |                            |
|                         | Insulation Resistance              | $1,000\text{M}\Omega$ or $50\text{M}\Omega \cdot \mu\text{F}$ min.<br>(As for the capacitor of rated voltage 16, 10 and 6.3V DC, $1,000\text{M}\Omega$ or $10\text{M}\Omega \cdot \mu\text{F}$ min.,)<br>whichever smaller.                                                                                                                                                                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                   |  |                                   |        |     |                                                            |         |                   |                            |
| 15                      | Moisture Resistance                | External appearance                                                                                                                                                                                                                                                                                                                                                                                              | Solder the capacitors on a P.C. Board shown in Appendix1 before testing. Apply the rated voltage at temperature $40 \pm 2^\circ\text{C}$ and 90 to 95%RH for 500 +24, 0h. Charge/discharge current shall not exceed 50mA. Leave the capacitors in ambient condition for the following time before measurement.<br>Class1 : $24 \pm 2\text{h}$<br>Class2 : $48 \pm 4\text{h}$<br>Voltage conditioning : (Only Class2)<br>Voltage treat the capacitor under testing temperature and voltage for 1hour. Leave the capacitors in ambient condition for $48 \pm 4\text{h}$ before measurement. Use this measurement for initial value. |                                   |  |                                   |        |     |                                                            |         |                   |                            |
|                         |                                    | Capacitance                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                   |  |                                   |        |     |                                                            |         |                   |                            |
|                         |                                    | <table border="1"> <thead> <tr> <th colspan="2">Characteristics</th> <th>Change from the value before test</th> </tr> </thead> <tbody> <tr> <td>Class1</td> <td>COG</td> <td><math>\pm 7.5\%</math> or<br/><math>\pm 0.75\text{pF}</math><br/>whichever larger.</td> </tr> <tr> <td>*Class2</td> <td>X5R<br/>X7R<br/>X7S</td> <td><math>\pm 12.5\%</math><br/><math>\pm 25\%</math></td> </tr> </tbody> </table> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Characteristics                   |  | Change from the value before test | Class1 | COG | $\pm 7.5\%$ or<br>$\pm 0.75\text{pF}$<br>whichever larger. | *Class2 | X5R<br>X7R<br>X7S | $\pm 12.5\%$<br>$\pm 25\%$ |
|                         |                                    | Characteristics                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Change from the value before test |  |                                   |        |     |                                                            |         |                   |                            |
| Class1                  | COG                                | $\pm 7.5\%$ or<br>$\pm 0.75\text{pF}$<br>whichever larger.                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                   |  |                                   |        |     |                                                            |         |                   |                            |
| *Class2                 | X5R<br>X7R<br>X7S                  | $\pm 12.5\%$<br>$\pm 25\%$                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                   |  |                                   |        |     |                                                            |         |                   |                            |
| *Applied for some parts |                                    |                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                   |  |                                   |        |     |                                                            |         |                   |                            |
|                         | Q Class1                           | Shown in Table2.                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                   |  |                                   |        |     |                                                            |         |                   |                            |
|                         | D. F. Class2                       | Characteristics<br>200% of initial spec max.                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                   |  |                                   |        |     |                                                            |         |                   |                            |
|                         | Insulation Resistance              | $500\text{M}\Omega$ or $25\text{M}\Omega \cdot \mu\text{F}$ min.<br>(As for the capacitor of rated voltage 16, 10 and 6.3V DC, $500\text{M}\Omega$ or $5\text{M}\Omega \cdot \mu\text{F}$ min.,)<br>whichever smaller.                                                                                                                                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                   |  |                                   |        |     |                                                            |         |                   |                            |

(continued)

| No.                   | Item                                                                                                                                                                                              | Performance         | Test or inspection method                                                                                                                                                                                                                                                                                                                                                                                                                               |                 |                                            |                                   |        |     |                                            |         |     |            |     |            |     |  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|-----------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|--------------------------------------------|-----------------------------------|--------|-----|--------------------------------------------|---------|-----|------------|-----|------------|-----|--|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 16                    | Life                                                                                                                                                                                              | External appearance | No mechanical damage.                                                                                                                                                                                                                                                                                                                                                                                                                                   |                 |                                            |                                   |        |     |                                            |         |     |            |     |            |     |  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|                       |                                                                                                                                                                                                   | Capacitance         | <table border="1"> <thead> <tr> <th colspan="2">Characteristics</th> <th>Change from the value before test</th> </tr> </thead> <tbody> <tr> <td>Class1</td> <td>COG</td> <td><math>\pm 3\%</math> or <math>\pm 0.3\%</math> whichever larger.</td> </tr> <tr> <td rowspan="3">*Class2</td> <td>X5R</td> <td><math>\pm 15\%</math></td> </tr> <tr> <td>X7R</td> <td><math>\pm 25\%</math></td> </tr> <tr> <td>X7S</td> <td></td> </tr> </tbody> </table> | Characteristics |                                            | Change from the value before test | Class1 | COG | $\pm 3\%$ or $\pm 0.3\%$ whichever larger. | *Class2 | X5R | $\pm 15\%$ | X7R | $\pm 25\%$ | X7S |  | <p>Solder the capacitors on a P.C.Board shown in Appendix1 before testing.</p> <p>Below the voltage shall be applied at maximum operating temperature <math>\pm 2^{\circ}\text{C}</math> for 1,000 +48,0h.</p> <hr/> <p>Applied voltage</p> <hr/> <p>Rated voltage <math>\times 2</math></p> <hr/> <p>Rated voltage <math>\times 1</math></p> <hr/> <p>For information which products has which applied voltage, please contact with our sales representative.</p> <p>Charge/discharge current shall not exceed 50mA.</p> <p>Leave the capacitors in ambient condition for the following time before measurement.</p> <p>Class1 : <math>24 \pm 2\text{h}</math><br/>Class2 : <math>48 \pm 4\text{h}</math></p> <p>Voltage conditioning : (Only Class2)<br/>Voltage treat the capacitor under testing temperature and voltage for 1hour.</p> <p>Leave the capacitors in ambient condition for <math>48 \pm 4\text{h}</math> before measurement.</p> <p>Use this measurement for initial value.</p> |
|                       |                                                                                                                                                                                                   |                     | Characteristics                                                                                                                                                                                                                                                                                                                                                                                                                                         |                 | Change from the value before test          |                                   |        |     |                                            |         |     |            |     |            |     |  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|                       |                                                                                                                                                                                                   |                     | Class1                                                                                                                                                                                                                                                                                                                                                                                                                                                  | COG             | $\pm 3\%$ or $\pm 0.3\%$ whichever larger. |                                   |        |     |                                            |         |     |            |     |            |     |  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|                       |                                                                                                                                                                                                   |                     | *Class2                                                                                                                                                                                                                                                                                                                                                                                                                                                 | X5R             | $\pm 15\%$                                 |                                   |        |     |                                            |         |     |            |     |            |     |  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| X7R                   | $\pm 25\%$                                                                                                                                                                                        |                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                 |                                            |                                   |        |     |                                            |         |     |            |     |            |     |  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| X7S                   |                                                                                                                                                                                                   |                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                 |                                            |                                   |        |     |                                            |         |     |            |     |            |     |  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| Q Class1              | Shown in Table2.                                                                                                                                                                                  |                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                 |                                            |                                   |        |     |                                            |         |     |            |     |            |     |  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| D.F. Class2           | characteristics<br>200% of initial spec max.                                                                                                                                                      |                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                 |                                            |                                   |        |     |                                            |         |     |            |     |            |     |  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| Insulation Resistance | 1,000M $\Omega$ or 50M $\Omega \cdot \mu\text{F}$ min.<br>(As for the capacitor of rated voltage 16, 10 and 6.3V DC, 1,000 M $\Omega$ or 10M $\Omega \cdot \mu\text{F}$ min.,) whichever smaller. |                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                 |                                            |                                   |        |     |                                            |         |     |            |     |            |     |  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |

\* As for the initial measurement of capacitors (Class2) on number 8, 10, 12, 13, and 14, leave capacitors at  $150 - 10, 0^{\circ}\text{C}$  for 1h and measure the value after leaving capacitors for  $48 \pm 4\text{h}$  in ambient condition.

table2

| Specification  |                           | Applicable numbers of Table1 |
|----------------|---------------------------|------------------------------|
| 30pF and over  | $Q \geq 1,000$            | 6, 10, 12, 13                |
| Less than 30pF | $Q \geq 400+20 \cdot C$   |                              |
| 30pF and over  | $Q \geq 350$              | 14, 16                       |
| Less than 30pF | $Q \geq 275+5/2 \cdot C$  |                              |
| 30pF and over  | $Q \geq 200$              | 15                           |
| Less than 30pF | $Q \geq 100+10/3 \cdot C$ |                              |

(Note) : C denotes Rated Capacitance(pF)

# Appendix 1

## P. C. board



(Unit : mm)

1. Material :Glass Epoxy(As per JIS C6484 GE4)

2. Thickness : 1.6mm

Copper(Thickness:0.035mm)  
 Solder resist

## 8. INDICATION

### 8.1 Indication (Example)

| T.C.                    | Type  | FK 1 8<br>FK 2 8                                                                  | FK 1 4<br>FK 2 4                                                                  | FK 1 6<br>FK 2 6 | FK 1 1<br>FK 2 0                                                                  | FK 2 2                                                                            |                |                                                                                     |                                                                                     |
|-------------------------|-------|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|------------------|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|----------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|
|                         | COG   | (2) —                                                                             |  |                  | (1) —<br>(2) —<br>(4) —                                                           |  | —(3)           | (1) —<br>(2) —<br>(4) —                                                             |  |
| X 5 R<br>X 7 R<br>X 7 S | (2) — |  |                                                                                   | (2) —<br>(4) —   |  | —(3)                                                                              | (2) —<br>(4) — |  | —(3)<br>—(5)                                                                        |

### 8.2 Meaning of indication

| Item                      | Detail                                                 | Type                     |                           |      |
|---------------------------|--------------------------------------------------------|--------------------------|---------------------------|------|
|                           |                                                        | FK18, FK14<br>FK28, FK24 | FK16, FK11,<br>FK26, FK20 | FK22 |
| (1) T.C.                  | For COG, indicate Black mark on the head.              | —                        | ○                         | ○    |
| (2) Rated Capacitance     | Indicate in three digits.                              | ○                        | ○                         | ○    |
| (3) Capacitance tolerance | Indicates the symbol.                                  | —                        | ○                         | ○    |
| (4) Rated voltage         | For DC50V, indicate a bar under the rated capacitance. | —                        | ○                         | ○    |
| (5) Manufacturer          | Indicates " TDK ".                                     | —                        | —                         | ○    |

## 9. INSIDE STRUCTURE AND MATERIAL



| No. | NAME                               | No. | NAME                      | MATERIAL           |                    |
|-----|------------------------------------|-----|---------------------------|--------------------|--------------------|
|     |                                    |     |                           | Class 1            | Class 2            |
| ①   | Multilayer Ceramic Chip Capacitors | ①-1 | Dielectric                | CaZrO <sub>3</sub> | BaTiO <sub>3</sub> |
|     |                                    | ①-2 | Electrode                 | Ni                 |                    |
|     |                                    | ①-3 | Termination               | Cu                 |                    |
|     |                                    | ①-4 |                           | Ni                 |                    |
|     |                                    | ①-5 |                           | Sn                 |                    |
| ②   | Coating                            |     | Epoxy                     |                    |                    |
| ③   | Solder for joint                   |     | High temp. solder         |                    |                    |
| ④   | Lead wire                          |     | Solder coated copper wire |                    |                    |

## 10. PACKAGING

Packaging shall be done to protect the components from the damage during Transportation and storing, and a label which has the following information shall be attached.

- 1) Total number of components in a plastic bag: 500pcs.max.
- 2) Tape packaging is as per TDK tape packaging specification.

- 1) Inspection No. \*
- 2) TDK P/N
- 3) Customer' s P/N
- 4) Quantity

\* Composition of Inspection No.

Example  $\frac{X}{(a)} \frac{3}{(b)} \frac{A}{(c)} - \frac{00}{(d)} - \frac{000}{(e)}$

- a) Line code
- b) Last digit of year
- c) Month and A for January and B for February and so on. (Skip I)
- d) Inspection Date of the month.
- e) Serial No. of the day

## 11. Caution

| No. | Process                                                                                                      | Condition                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|-----|--------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1   | Operating Condition<br>(Storage, Transportation)                                                             | <p>1-1. Storage</p> <ol style="list-style-type: none"> <li>1) The capacitor must be stored in an ambient temperature of 5~40°C with a relative humidity of 20~70%. The products should be used within 6 months upon receipt.</li> <li>2) The capacitors must be operated and stored in an environment free of dew condensation and these gases such as Hydrogen Sulphide, Hydrogen Sulphate, Chlorine, Ammonia and sulfur.</li> <li>3) Avoid storing in sun light and wet with dew.</li> <li>4) Do not use capacitors under high humidity and high and low atmospheric pressure which may affect capacitors reliability.</li> <li>5) Capacitors should be tested for the solderability when they are stored for long time.</li> </ol> <p>1-2. Handling in transportation</p> <ol style="list-style-type: none"> <li>1) In case of the transportation of the capacitors, the performance of the capacitors may be deteriorated depending on the transportation condition. (Refer to JEITA RCR-2335B 9.2 Handling in transportation)</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 2   | Circuit design<br> Caution | <p>2-1. Operating temperature</p> <p>Operating temperature should be followed strictly within this specification, especially be careful with the maximum temperature.</p> <ol style="list-style-type: none"> <li>1) Do not use capacitor above the maximum allowable operating temperature.</li> <li>2) Surface temperature including self heating should be below maximum operating temperature.<br/>             (Due to dielectric loss, capacitor will heat itself when AC is applied. Especially at high frequencies around its SRF, the heat might be so extreme that it may damage itself or the product mounted on. Please design the circuit so that the maximum temperature of the capacitor including the self heating to be below the maximum allowable operating temperature.<br/>             Temperature rise shall be bellow 20°C.)</li> <li>3) The electrical characteristics of the capacitors will vary depending on the temperature. The capacitors should be selected and designed in taking the temperature into consideration.</li> </ol> <p>2-2. Operating voltage</p> <ol style="list-style-type: none"> <li>1) Operating voltage across the terminals should be below the rated voltage.<br/>             When AC and DC are super imposed, <math>V_{0-P}</math> must be below the rated voltage.<br/>             ——— (1) and (2)<br/>             AC or pulse with overshooting, <math>V_{p-p}</math> must be below the rated voltage.<br/>             ——— (3), (4) and (5)<br/>             When the voltage is started to apply to the circuit or it is stopped applying, the irregular voltage may be generated for a transit period because of resonance or switching. Be sure to use a capacitor within rated voltage containing these irregular voltage.</li> </ol> |

| No.                                    | Process                                                                                                     | Condition                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                     |                |                   |                |                                        |                                                                                   |                                                                                    |                                                                                     |         |                       |                       |  |  |                                        |                                                                                   |                                                                                    |  |  |
|----------------------------------------|-------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|----------------|-------------------|----------------|----------------------------------------|-----------------------------------------------------------------------------------|------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|---------|-----------------------|-----------------------|--|--|----------------------------------------|-----------------------------------------------------------------------------------|------------------------------------------------------------------------------------|--|--|
| 2                                      | Circuit design<br> Caution | <table border="1" data-bbox="459 212 1422 784"> <thead> <tr> <th data-bbox="459 212 646 246">Voltage</th> <th data-bbox="646 212 901 246">(1) DC voltage</th> <th data-bbox="901 212 1161 246">(2) DC+AC voltage</th> <th data-bbox="1161 212 1422 246">(3) AC voltage</th> </tr> </thead> <tbody> <tr> <td data-bbox="459 246 646 481">Positional Measurement (Rated voltage)</td> <td data-bbox="646 246 901 481">  </td> <td data-bbox="901 246 1161 481">  </td> <td data-bbox="1161 246 1422 481">  </td> </tr> <tr> <th data-bbox="459 515 646 548">Voltage</th> <th data-bbox="646 515 901 548">(4) Pulse voltage (A)</th> <th data-bbox="901 515 1161 548">(5) Pulse voltage (B)</th> <th colspan="2"></th> </tr> <tr> <td data-bbox="459 548 646 784">Positional Measurement (Rated voltage)</td> <td data-bbox="646 548 901 784">  </td> <td data-bbox="901 548 1161 784">  </td> <td colspan="2"></td> </tr> </tbody> </table> <p data-bbox="451 817 1445 1153">           2) Even below the rated voltage, if repetitive high frequency AC or pulse is applied, the reliability of the capacitor may be reduced.<br/>           3) The effective capacitance will vary depending on applied DC and AC voltages. The capacitors should be selected and designed in taking the voltages into consideration.<br/>           2-3. Frequency<br/>           1) When the capacitors (Class 2) are used in AC and/or pulse voltages, the capacitors may vibrate themselves and generate audible sound.         </p> | Voltage                                                                             | (1) DC voltage | (2) DC+AC voltage | (3) AC voltage | Positional Measurement (Rated voltage) |  |  |  | Voltage | (4) Pulse voltage (A) | (5) Pulse voltage (B) |  |  | Positional Measurement (Rated voltage) |  |  |  |  |
| Voltage                                | (1) DC voltage                                                                                              | (2) DC+AC voltage                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | (3) AC voltage                                                                      |                |                   |                |                                        |                                                                                   |                                                                                    |                                                                                     |         |                       |                       |  |  |                                        |                                                                                   |                                                                                    |  |  |
| Positional Measurement (Rated voltage) |                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |  |                |                   |                |                                        |                                                                                   |                                                                                    |                                                                                     |         |                       |                       |  |  |                                        |                                                                                   |                                                                                    |  |  |
| Voltage                                | (4) Pulse voltage (A)                                                                                       | (5) Pulse voltage (B)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                     |                |                   |                |                                        |                                                                                   |                                                                                    |                                                                                     |         |                       |                       |  |  |                                        |                                                                                   |                                                                                    |  |  |
| Positional Measurement (Rated voltage) |                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                     |                |                   |                |                                        |                                                                                   |                                                                                    |                                                                                     |         |                       |                       |  |  |                                        |                                                                                   |                                                                                    |  |  |
| 3                                      | Designing P.C. board                                                                                        | <p data-bbox="424 1193 1453 1288">             If capacitor leads are inserted into different pitch holes, it may induce excessive stress in the capacitor or outer resin to result in cracking, and it may degrade the quality.           </p> <p data-bbox="424 1294 975 1323">             Recommend capacitor layout is as following.           </p> <div data-bbox="491 1355 1422 1803" style="text-align: center;"> <div style="display: flex; justify-content: space-around;"> <div style="text-align: center;"> <p>Not recommended</p>  </div> <div style="text-align: center;"> <p>Recommend</p>  </div> </div> </div>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                     |                |                   |                |                                        |                                                                                   |                                                                                    |                                                                                     |         |                       |                       |  |  |                                        |                                                                                   |                                                                                    |  |  |

| No.              | Process                                                                           | Condition                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |           |                 |                |                     |                                                                                   |                                                                                     |
|------------------|-----------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|-----------------|----------------|---------------------|-----------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|
| 4                | Lead wire insertion                                                               | <p>1) If the leads clinching is too tight, the lead wire tend to be pulled excessively to cause lead wire breakage or cracking of the coating and quality degradation. Please adjust the clinching and provide sufficient preventive maintenance. Recommended capacitor layout is as following.</p> <table border="1" data-bbox="406 313 1396 660"> <thead> <tr> <th data-bbox="406 313 558 347"></th> <th data-bbox="558 313 981 347">Not recommended</th> <th data-bbox="981 313 1396 347">Recommended</th> </tr> </thead> <tbody> <tr> <td data-bbox="406 481 558 526">Clinching</td> <td data-bbox="558 347 981 660">  </td> <td data-bbox="981 347 1396 660">  </td> </tr> </tbody> </table> <p>2) If capacitor leads are inserted into different pitch holes, it may induce excessive stress in the capacitor or outer resin to result in cracking, and it may degrade the quality. When the lead pitch does not fit with the through hole on the pc board, please adjust the lead pitch so that the capacitor body would not receive excessive force.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |           | Not recommended | Recommended    | Clinching           |  |  |
|                  | Not recommended                                                                   | Recommended                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |           |                 |                |                     |                                                                                   |                                                                                     |
| Clinching        |  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |           |                 |                |                     |                                                                                   |                                                                                     |
| 5                | Soldering                                                                         | <p>5-1. Flux selection<br/>Although highly-activated flux gives better solderability, substances which increase activity may also degrade the insulation of the capacitors. To avoid such degradation, it is recommended following.</p> <ol style="list-style-type: none"> <li>1) It is recommended to use a mildly activated rosin flux (less than 0.1wt% chlorine). Do not use acidic flux is not recommended.</li> <li>2) Excessive flux must be avoided. Please provide proper amount of flux.</li> <li>3) When water-soluble flux is used, enough washing is necessary.</li> </ol> <p>5-2. Recommended soldering profile by various methods</p> <div style="display: flex; justify-content: space-around;"> <div data-bbox="375 1310 869 1736"> <p style="text-align: center;">Flow soldering</p>  </div> <div data-bbox="885 1310 1460 1713"> <p style="text-align: center;">Manual soldering<br/>(Solder iron)</p>  </div> </div> <p>5-3. Avoiding thermal shock</p> <ol style="list-style-type: none"> <li>1) Preheating condition</li> </ol> <table border="1" data-bbox="558 1825 1125 1960"> <thead> <tr> <th data-bbox="558 1825 837 1870">Soldering</th> <th data-bbox="837 1825 1125 1870">Temp. (°C)</th> </tr> </thead> <tbody> <tr> <td data-bbox="558 1870 837 1915">Wave soldering</td> <td data-bbox="837 1870 1125 1915"><math>\Delta T \leq 150</math></td> </tr> <tr> <td data-bbox="558 1915 837 1960">Manual soldering</td> <td data-bbox="837 1915 1125 1960"><math>\Delta T \leq 190</math></td> </tr> </tbody> </table> | Soldering | Temp. (°C)      | Wave soldering | $\Delta T \leq 150$ | Manual soldering                                                                  | $\Delta T \leq 190$                                                                 |
| Soldering        | Temp. (°C)                                                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |           |                 |                |                     |                                                                                   |                                                                                     |
| Wave soldering   | $\Delta T \leq 150$                                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |           |                 |                |                     |                                                                                   |                                                                                     |
| Manual soldering | $\Delta T \leq 190$                                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |           |                 |                |                     |                                                                                   |                                                                                     |



| No.        | Process     | Condition                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |             |             |            |             |          |         |                 |        |
|------------|-------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|-------------|------------|-------------|----------|---------|-----------------|--------|
| 5          | Soldering   | <p>2) Cooling condition<br/>Natural cooling using air is recommended. If the chips are dipped into a solvent for cleaning, the temperature difference(<math>\Delta T</math>) must be less than 100°C.</p> <p>5-4. Amount of solder<br/>In sufficient solder may detach the capacitor from the P.C. board.<br/>See bellow for example of solder amount.</p> <hr/> <div style="display: flex; justify-content: space-around; align-items: center;"> <div data-bbox="512 501 619 524" style="text-align: center;">Adequate</div> <div data-bbox="751 439 1015 584">  </div> </div> <hr/> <div style="display: flex; justify-content: space-around; align-items: center;"> <div data-bbox="491 640 644 696" style="text-align: center;">Insufficient<br/>solder</div> <div data-bbox="751 600 1015 745">  </div> <div data-bbox="1098 611 1410 725" style="text-align: center;">Low robustness may cause<br/>contact failure or<br/>capacitor comes off the<br/>P.C. board.</div> </div> <hr/> <p>5-5. Solder repair by solder iron<br/>Tip temperature of solder iron varies by its type, P.C. board material and solder land size. Higher the tip temperature, quick the operation is, but the heat shock may crack the capacitor. Following condition is recommended.</p> <p style="text-align: center;">( Recommended solder iron condition )</p> <table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th data-bbox="480 954 699 987">Temp. (°C)</th> <th data-bbox="699 954 917 987">Wattage (W)</th> <th data-bbox="917 954 1136 987">Shape (mm)</th> <th data-bbox="1136 954 1355 987">Time (sec.)</th> </tr> </thead> <tbody> <tr> <td data-bbox="480 999 699 1032" style="text-align: center;">350 MAX.</td> <td data-bbox="699 999 917 1032" style="text-align: center;">20 MAX.</td> <td data-bbox="917 999 1136 1032" style="text-align: center;"><math>\phi</math> 3.0 MAX.</td> <td data-bbox="1136 999 1355 1032" style="text-align: center;">3 MAX.</td> </tr> </tbody> </table> | Temp. (°C)  | Wattage (W) | Shape (mm) | Time (sec.) | 350 MAX. | 20 MAX. | $\phi$ 3.0 MAX. | 3 MAX. |
| Temp. (°C) | Wattage (W) | Shape (mm)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Time (sec.) |             |            |             |          |         |                 |        |
| 350 MAX.   | 20 MAX.     | $\phi$ 3.0 MAX.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 3 MAX.      |             |            |             |          |         |                 |        |
| 6          | Cleaning    | <p>1) If an unsuitable cleaning fluid is used, flux residue or some foreign articles may stick to capacitor surface to deteriorate especially the insulation resistance.</p> <p>2) If cleaning condition is not suitable, it may damage the capacitor.</p> <p>2)-1. Insufficient washing</p> <ol style="list-style-type: none"> <li>(1) Terminal electrodes may corrode by Halogen in the flux.</li> <li>(2) Halogen in the flux may adhere on the surface of capacitor, and lower the insulation resistance.</li> <li>(3) Water soluble flux has higher tendency to have above mentioned problems (1) and (2).</li> </ol> <p>2)-2. Excessive washing</p> <ol style="list-style-type: none"> <li>(1) Excessive washing way damage the coating material of coated capacitor and deteriorate it.</li> <li>(2) When ultrasonic cleaning is used, excessively high ultrasonic energy output can affect the adhesion between the ceramic dielectric and the terminal electrodes.<br/>To avoid this, following is the recommended condition. <p style="margin-left: 40px;">Power : 20W/ℓ max.<br/>Frequency : 40kHz max.<br/>Washing time : 5 minutes max.</p> </li> </ol> <p>2)-3. If the cleaning fluid is contaminated, density of Halogen increases, and it may bring the same result as insufficient cleaning.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |             |             |            |             |          |         |                 |        |

| No. | Process                                | Condition                                                                                                                                                                                                                                                                                                                                                                                                                    |
|-----|----------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 7   | Coating and molding of the P. C. board | <p>1) When the P. C. board is coated, please verify the quality influence on the product.</p> <p>2) Please verify carefully that there is no harmful decomposing or reaction gas emission during curing which may damage the capacitor.</p> <p>3) Please verify the curing temperature.</p>                                                                                                                                  |
| 8   | Lead wire bending                      | <p>During lead wire bending process, mechanical stress often concentrates in one part of capacitor body and it may damage the ceramic and the coating. Refer to following for bending the lead wire.</p> <div data-bbox="746 584 1142 1003" data-label="Image"> </div> <p>When bending the lead wire, hold the wire closer to the capacitor with a fixture so that the lead bending would not affect the capacitor body.</p> |
| 9   | Handling of loose capacitor            | <p>If dropped the capacitor may crack. Once dropped do not use it. Especially, the large case sized capacitor is tendency to have cracks easily, so please handle with care.</p> <div data-bbox="703 1249 1209 1720" data-label="Image"> </div>                                                                                                                                                                              |
| 10  | Capacitance aging                      | <p>The capacitors (Class 2) have aging in the capacitance. They may not be used in precision time constant circuit. In case of the time constant circuit, the evaluation should be done well.</p>                                                                                                                                                                                                                            |

| No. | Process                                                 | Condition                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|-----|---------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 11  | Estimated life and estimated failure rate of capacitors | <p>The estimated life and the estimated failure rate depend on the temperature and the voltage. This can be calculated by the equation described in JEITA RCR-2335B Annex F(Informative) Calculation of the estimated lifetime and the estimated failure rate (Temperature acceleration : 3rd powered low, Voltage acceleration : 10degC law)</p> <p>The failure rate can be decreased by reducing the temperature and the voltage but they will not be guaranteed.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| 12  | <p>Others</p> <p>⚠ Caution</p>                          | <p>The products listed on this specification sheet are intended for use in general electronic equipment (AV equipment, telecommunications equipment, home appliances, amusement equipment, computer equipment, personal equipment, office equipment, measurement equipment, industrial robots) under a normal operation and use condition.</p> <p>The products are not designed or warranted to meet the requirements of the applications listed below, whose performance and/or quality require a more stringent level of safety or reliability, or whose failure, malfunction or trouble could cause serious damage to society, person or property. Please understand that we are not responsible for any damage or liability caused by use of the products in any of the applications below or for any other use exceeding the range or conditions set forth in this specification sheet.</p> <p>Aerospace/Aviation equipment. Transportation equipment (cars, electric trains, ships, etc.) Medical equipment. Power-generation control equipment. Atomic energy-related equipment. Seabed equipment. Transportation control equipment. Public information-processing equipment. Military equipment. Electric heating apparatus, burning equipment. Disaster prevention/crime prevention equipment. Safety equipment. Other applications that are not considered general-purpose applications.</p> <p>When using this product in general-purpose applications, you are kindly requested to take into consideration securing protection circuit/equipment or providing backup circuits, etc., to ensure higher safety.</p> |

# TAPE PACKAGING SPECIFICATION

## 1. CONSTRUCTION AND DIMENSION OF TAPING

Dimensions of FK1\* type shall be according to Appendix 2.

Dimensions of FK2\* type shall be according to Appendix 3.

## 2. QUANTITY

| Type                                   | Parts quantity/box (pcs.) |
|----------------------------------------|---------------------------|
| FK18, FK28<br>FK14, FK24<br>FK16, FK26 | 2,000                     |
| FK11, FK20<br>FK22                     | 1,500                     |

## 3. PERFORMANCE SPECIFICATIONS

3-1. The missing of components shall be within consecutive 3pcs.

3-2. Empty part for min 3pcs shall be provided at the beginning and the end of taping.

3-3. Shipping label must be attached at the side of carton.

3-4. When pull the carrier tape for left side with keeping the head of capacitors to the direction of the above figure, adhesive tape shall be upper side.

3-5. Folded tape shall contain 25pcs. of components.

## Appendix 2

## Taping dimensions

(FK18, FK14, FK16, FK11)



(Unit : mm)

| Symbol     | Dimensions | Tolerance      |
|------------|------------|----------------|
| P          | 12.7       | $\pm 1.0$      |
| P0 ※1      | 12.7       | $\pm 0.3$      |
| P1         | 5.1        | $\pm 0.7$      |
| P2         | 6.35       | $\pm 1.3$      |
| W0         | 12.0       | $\pm 1.0$      |
| W1         | 9.0        | $\pm 0.5$      |
| W2 ※2      | 3.0        | 3.0 and under  |
| W3         | 18.0       | +1.0, -0.5     |
| H0         | 16.0       | $\pm 0.5$      |
| l          | 1.0        | 1.0 and under  |
| t          | 0.6        | $\pm 0.2$      |
| L0         | 11.0       | 11.0 and under |
| F          | 2.5        | +0.5, -0.2     |
| $\phi d$   | $\phi 0.5$ | +0.1, -0.03    |
| $\phi D$   | $\phi 4.0$ | $\pm 0.2$      |
| $\Delta h$ | —          | $\pm 2$        |

※1 Accumulated pitch tolerance shall be  $\pm 2\text{mm}$  for 20 pitches.

※2 Adhesive tape shall not stick out from carrier tape.

# Appendix 3

# Taping dimensions

(FK28, FK24, FK26, FK20, FK22)



(Unit : mm)

| Symbol  | Dimensions | Tolerance      |
|---------|------------|----------------|
| P       | 12.7       | ±1.0           |
| P0 ※1   | 12.7       | ±0.3           |
| P1      | 3.85       | ±0.7           |
| P2      | 6.35       | ±1.3           |
| W0      | 12.0       | ±1.0           |
| W1      | 9.0        | ±0.5           |
| W2 ※2   | 3.0        | 3.0 and under  |
| W3      | 18.0       | +1.0, -0.5     |
| H0      | 16.0       | ±0.5           |
| l       | 1.0        | 1.0 and under  |
| t       | 0.6        | ±0.2           |
| L0      | 11.0       | 11.0 and under |
| F       | 5.0        | +0.8, -0.2     |
| phi d   | phi 0.5    | +0.1, -0.03    |
| phi D   | phi 4.0    | ±0.2           |
| Delta h | —          | ±2             |

※1 Accumulated pitch tolerance shall be ±2mm for 20 pitches.

※2 Adhesive tape shall not stick out from carrier tape.