

## Caution/Notice

### Caution

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### Notice

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**Storage and Operation Conditions**

The insulating coating of capacitors does not form a perfect seal; therefore, do not use or store capacitors in a corrosive atmosphere, especially where chloride gas, sulfide gas, acid, alkali, salt or the like are present. Also avoid exposure to moisture. Before cleaning, bonding or molding this product, verify that these processes do not affect product quality by testing the performance of a cleaned, bonded or molded product in the intended equipment. Store the capacitors where the temperature and relative humidity do not exceed 5 to 40 degrees centigrade and 20 to 70%. Use capacitors within 6 months after delivery.

**Rating**

**1. Operating Voltage**

When DC-rated capacitors are to be used in AC or ripple current circuits, be sure to maintain the  $V_{p-p}$  value of the applied voltage or the  $V_{0-p}$  which contains DC bias within the rated voltage range.

When the voltage is applied to the circuit, starting or stopping may generate irregular voltage for a transit period because of resonance or switching. Be sure to use a capacitor with a rated voltage range that includes these irregular voltages.

When DC-rated capacitors are to be used in input circuits from commercial power source (AC filter), be sure to use Safety Recognized Capacitors because various regulations on withstand voltage or impulse withstand established for all equipment should be taken into consideration.

| Voltage                | DC Voltage | DC+AC Voltage | AC Voltage | Pulse Voltage (1) | Pulse Voltage (2) |
|------------------------|------------|---------------|------------|-------------------|-------------------|
| Positional Measurement |            |               |            |                   |                   |

**2. Operating Temperature and Self-generated Heat**


Keep the surface temperature of a capacitor below the upper limit of its rated operating temperature range. Be sure to take into account the heat generated by the capacitor itself. When the capacitor is used in a high-frequency current, pulse current or similar current, it may have self-generated heat due to dielectric loss. In the case of "High Dielectric Constant Type Capacitors," applied voltage load should be such that self-generated heat is within 20 °C under the condition where the capacitor is subjected at an atmosphere temperature of 25 °C. Please contact us if self-generated heat occurs with "Temperature Compensating Type Capacitors".

When measuring, use a thermocouple of small thermal capacity -K of  $\phi 0.1\text{mm}$  under conditions where the capacitor is not affected by radiant heat from other components or wind from surroundings. Excessive heat may lead to deterioration of the capacitor's characteristics and reliability. Never attempt to perform measurement with the cooling fan running. Otherwise, accurate measurement cannot be ensured.

**3. Fail-Safe**

Be sure to provide an appropriate fail-safe function on your product to prevent a second damage that may be caused by the abnormal function or the failure of our product.

## Caution

 Continued from the preceding page.

### ■ Soldering and Mounting

#### 1. Vibration and Impact

Do not expose a capacitor or its leads to excessive shock or vibration during use.

#### 2. Soldering

When soldering this product to a PCB/PWB, do not exceed the solder heat resistance specification of the capacitor. Subjecting this product to excessive heating could melt the internal junction solder and may result in thermal shocks that can crack the ceramic element.

#### 3. Bonding, Resin Molding and Coating

In case of bonding, molding or coating this product, verify that these processes do not affect the quality of the capacitor by testing the performance of the bonded, molded or coated product in the intended equipment.

In case the amount of application, dryness/hardening conditions of adhesives and molding resins containing organic solvents (ethyl acetate, methyl ethyl ketone, toluene, etc.) are unsuitable, the outer coating resin of a capacitor may be damaged by the organic solvents and may result, worst case, in a short circuit.

The variation in thickness of adhesive or molding resin or coating may cause an outer coating resin cracking and/or ceramic element cracking of a capacitor in a temperature cycling.

#### 4. Treatment after Bonding, Resin Molding and Coating

When the outer coating is hot (over 100 degrees centigrade) after soldering, it becomes soft and fragile, so please be careful not to give it mechanical stress.

**FAILURE TO FOLLOW THE ABOVE CAUTIONS MAY RESULT, WORST CASE, IN A SHORT CIRCUIT AND CAUSE FUMING OR PARTIAL DISPERSION WHEN THE PRODUCT IS USED.**

## Notice

### ■ Rating

#### 1. Capacitance change of capacitor

In case of F/X7R/X7S/X7T/X8L/Y5V/Z5U char.

Capacitors have an aging characteristic, whereby the capacitor continually decreases its capacitance slightly if the capacitor is left on for a long time. Moreover, capacitance might change greatly depending on the surrounding temperature or an applied voltage.

### ■ Soldering and Mounting

#### 1. Cleaning (ultrasonic cleaning)

To perform ultrasonic cleaning, observe the following conditions.

Rinse bath capacity: Output of 20 watts per liter or less.

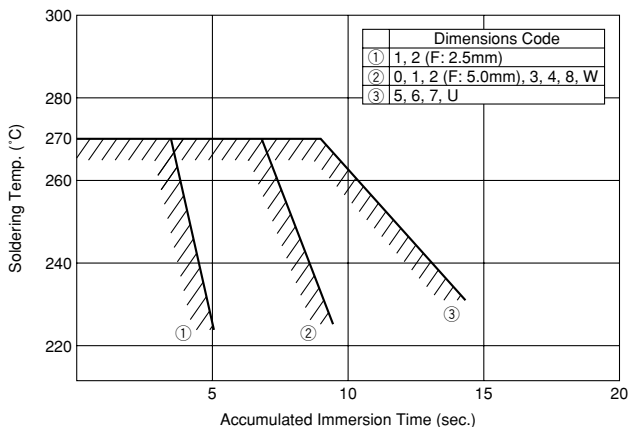
Rinsing time: 5 min. maximum.

Do not vibrate the PCB/PWB directly.

Excessive ultrasonic cleaning may lead to fatigue destruction of the lead wires.

#### 2. Soldering and Mounting


##### (1) Allowable Conditions for Soldering Temperature and Time



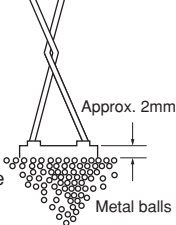
Perform soldering within tolerance range (shaded portion).


##### (2) Insertion of the Lead Wire

- When soldering, insert the lead wire into the PCB without mechanically stressing the lead wire.
- Insert the lead wire into the PCB with a distance appropriate to the lead space.

| Dimensions Code               | Rated Voltage  | DC25V   |      | DC50V  |         |         |     | DC100V |        |         | DC250V  | DC630V        | DC1kV         |               |
|-------------------------------|--|---------|------|--------|---------|---------|-----|--------|--------|---------|---------|---------------|---------------|---------------|
|                               | Temp. Char.  | X7S     | X7R  | C0G    | X7S     | X7R     | F   | Y5V    | C0G    | X7S     | X7R     | X7R, U2J      |               |               |
| 0                             |  |         | 104K |        | -       |         | 473 | 103Z   |        | -       |         | -             | -             | -             |
| 1                             |  | 224K    |      | A 102J |         | 224K    |     |        | A 102J |         | 224K    | U 102J        | -             | -             |
| 2                             |  |         |      |        |         |         |     |        |        |         |         | 103 J4U (U2J) | 472 J7U (U2J) | 102 JAU (U2J) |
|                               |  | 475 K2C | -    | -      | 475 K5C | 105 K5C | -   | -      | -      | -       | 105 K1C | 473 K4C (X7R) | 153 K7C (X7R) | 102 KAC (X7R) |
| 3, 4, W                       |  |         |      |        |         |         |     |        |        |         |         | 473 J4U (U2J) | 103 J7U (U2J) | 472 JAU (U2J) |
|                               |  | 226 K2C | -    | -      | -       | 335 K5C | -   | -      | -      | 225 K1C | -       | 224 K4C (X7R) | 104 K7C (X7R) | 333 KAC (X7R) |
| 5, U                          |  |         |      |        |         |         |     |        |        |         |         | -             | 333 J7U (U2J) | 103 JAU (U2J) |
|                               |  | -       | -    | -      | -       | -       | -   | -      | -      | -       | -       | 474 K4C (X7R) | 474 M7C (X7R) | 104 KAC (X7R) |
| Temperature Characteristics   | Marked with code (C0G char.: A, X7S/X7R char.: C, F/Y5V char.: F, U2J char.: U)<br>A part is omitted (Please refer to the marking example.)  |         |      |        |         |         |     |        |        |         |         |               |               |               |
| Nominal Capacitance           | Under 100pF: Actual value 100pF and over: Marked with 3 figures  |         |      |        |         |         |     |        |        |         |         |               |               |               |
| Capacitance Tolerance         | Marked with code<br>A part is omitted (Please refer to the marking example.)   |         |      |        |         |         |     |        |        |         |         |               |               |               |
| Rated Voltage                 | Marked with code (DC25V: 2, DC50V: 5, DC100V: 1, DC250V: 4, DC500V: 9, DC630V: 7, DC1kV: A)<br>Lower horizontal line for F char.<br>A part is omitted (Please refer to the marking example.) |         |      |        |         |         |     |        |        |         |         |               |               |               |
| Manufacturer's Identification | Marked with <br>A part is omitted (Please refer to the marking example.)                                  |         |      |        |         |         |     |        |        |         |         |               |               |               |

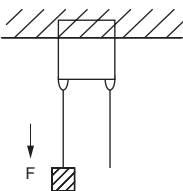
# RDE Series (Only for Commercial) Specifications and Test Methods


| No.  | Item                        | Specifications   |   | Test Method  |                 |                           |                                |                               |                |                           |                         |                           |                |                           |                               |                         |                           |              |                           |                |                           |                |                           |  |       |                           |
|--|-----------------------------|--|---|--|-----------------|---------------------------|--------------------------------|-------------------------------|----------------|---------------------------|-------------------------|---------------------------|----------------|---------------------------|-------------------------------|-------------------------|---------------------------|--------------|---------------------------|----------------|---------------------------|----------------|---------------------------|--|-------|---------------------------|
|  |                             | Temperature Compensating Type  | High Dielectric Constant Type   |  |                 |                           |                                |                               |                |                           |                         |                           |                |                           |                               |                         |                           |              |                           |                |                           |                |                           |  |       |                           |
| 1  | Operating Temperature Range | -55 to +125°C  | Char. X7R, X7S: -55 to +125°C<br>Char. F: -25 to +85°C<br>Char. Y5V: -30 to +85°C   | –  |                 |                           |                                |                               |                |                           |                         |                           |                |                           |                               |                         |                           |              |                           |                |                           |                |                           |  |       |                           |
| 2  | Appearance                  | No defects or abnormalities  |   | Visual inspection  |                 |                           |                                |                               |                |                           |                         |                           |                |                           |                               |                         |                           |              |                           |                |                           |                |                           |  |       |                           |
| 3  | Dimension and Marking       | See previous pages   |   | Visual inspection, Vernier Caliper   |                 |                           |                                |                               |                |                           |                         |                           |                |                           |                               |                         |                           |              |                           |                |                           |                |                           |  |       |                           |
| 4  | Dielectric Strength         | Between Terminals  | No defects or abnormalities   | <p>The capacitors should not be damaged when test voltages of Table are applied between the terminals for 1 to 5 sec. (Charge/Discharge current <math>\leq</math> 50mA)</p> <table border="1"> <thead> <tr> <th></th> <th>Rated Voltage</th> <th>Test Voltage</th> </tr> </thead> <tbody> <tr> <td rowspan="3">Temperature Compensating Type</td> <td>DC50V, DC100V</td> <td>300% of the rated voltage</td> </tr> <tr> <td>DC250V</td> <td>200% of the rated voltage</td> </tr> <tr> <td>DC630V</td> <td>150% of the rated voltage</td> </tr> <tr> <td rowspan="4">High Dielectric Constant Type</td> <td>DC1kV</td> <td>130% of the rated voltage</td> </tr> <tr> <td>DC25V, DC50V</td> <td>250% of the rated voltage</td> </tr> <tr> <td>DC100V, DC250V</td> <td>200% of the rated voltage</td> </tr> <tr> <td>DC500V, DC630V</td> <td>150% of the rated voltage</td> </tr> <tr> <td></td> <td>DC1kV</td> <td>120% of the rated voltage</td> </tr> </tbody> </table> |                 | Rated Voltage             | Test Voltage                   | Temperature Compensating Type | DC50V, DC100V  | 300% of the rated voltage | DC250V                  | 200% of the rated voltage | DC630V         | 150% of the rated voltage | High Dielectric Constant Type | DC1kV                   | 130% of the rated voltage | DC25V, DC50V | 250% of the rated voltage | DC100V, DC250V | 200% of the rated voltage | DC500V, DC630V | 150% of the rated voltage |  | DC1kV | 120% of the rated voltage |
|  |                             |  | Rated Voltage   |  | Test Voltage    |                           |                                |                               |                |                           |                         |                           |                |                           |                               |                         |                           |              |                           |                |                           |                |                           |  |       |                           |
| Temperature Compensating Type  | DC50V, DC100V               | 300% of the rated voltage  |   |  |                 |                           |                                |                               |                |                           |                         |                           |                |                           |                               |                         |                           |              |                           |                |                           |                |                           |  |       |                           |
|  | DC250V                      | 200% of the rated voltage  |   |  |                 |                           |                                |                               |                |                           |                         |                           |                |                           |                               |                         |                           |              |                           |                |                           |                |                           |  |       |                           |
|  | DC630V                      | 150% of the rated voltage  |   |  |                 |                           |                                |                               |                |                           |                         |                           |                |                           |                               |                         |                           |              |                           |                |                           |                |                           |  |       |                           |
| High Dielectric Constant Type  | DC1kV                       | 130% of the rated voltage  |   |  |                 |                           |                                |                               |                |                           |                         |                           |                |                           |                               |                         |                           |              |                           |                |                           |                |                           |  |       |                           |
|  | DC25V, DC50V                | 250% of the rated voltage  |   |  |                 |                           |                                |                               |                |                           |                         |                           |                |                           |                               |                         |                           |              |                           |                |                           |                |                           |  |       |                           |
|  | DC100V, DC250V              | 200% of the rated voltage  |   |  |                 |                           |                                |                               |                |                           |                         |                           |                |                           |                               |                         |                           |              |                           |                |                           |                |                           |  |       |                           |
|  | DC500V, DC630V              | 150% of the rated voltage  |   |  |                 |                           |                                |                               |                |                           |                         |                           |                |                           |                               |                         |                           |              |                           |                |                           |                |                           |  |       |                           |
|  | DC1kV                       | 120% of the rated voltage  |   |  |                 |                           |                                |                               |                |                           |                         |                           |                |                           |                               |                         |                           |              |                           |                |                           |                |                           |  |       |                           |
| Body Insulation  | No defects or abnormalities | <p>The capacitor is placed in a container with metal balls of 1mm diameter so that each terminal, short-circuited, is kept approximately 2mm from the balls as shown in the figure, for 1 to 5 sec. between capacitor terminals and metal balls. (Charge/Discharge current <math>\leq</math> 50mA)</p>  <table border="1"> <thead> <tr> <th>Rated Voltage</th> <th>Test Voltage</th> </tr> </thead> <tbody> <tr> <td>DC25V, DC50V</td> <td>250% of the rated voltage</td> </tr> <tr> <td>DC100V, DC250V, DC500V, DC630V</td> <td>200% of the rated voltage</td> </tr> <tr> <td>DC1kV</td> <td>DC1300V</td> </tr> </tbody> </table> | Rated Voltage   | Test Voltage   | DC25V, DC50V    | 250% of the rated voltage | DC100V, DC250V, DC500V, DC630V | 200% of the rated voltage     | DC1kV          | DC1300V                   |                         |                           |                |                           |                               |                         |                           |              |                           |                |                           |                |                           |  |       |                           |
| Rated Voltage  | Test Voltage                |  |   |  |                 |                           |                                |                               |                |                           |                         |                           |                |                           |                               |                         |                           |              |                           |                |                           |                |                           |  |       |                           |
| DC25V, DC50V   | 250% of the rated voltage   |  |   |  |                 |                           |                                |                               |                |                           |                         |                           |                |                           |                               |                         |                           |              |                           |                |                           |                |                           |  |       |                           |
| DC100V, DC250V, DC500V, DC630V   | 200% of the rated voltage   |  |   |  |                 |                           |                                |                               |                |                           |                         |                           |                |                           |                               |                         |                           |              |                           |                |                           |                |                           |  |       |                           |
| DC1kV  | DC1300V                     |  |   |  |                 |                           |                                |                               |                |                           |                         |                           |                |                           |                               |                         |                           |              |                           |                |                           |                |                           |  |       |                           |
| 5  | Insulation Resistance       | Between Terminals  | <p>Rated Voltage: DC25V, DC50V, DC100V<br/>10,000M<math>\Omega</math> min. or 500M<math>\Omega</math> <math>\cdot</math> <math>\mu</math>F min. whichever is smaller<br/>Rated Voltage: DC250V, DC500V, DC630V, DC1kV<br/>10,000M<math>\Omega</math> min. or 100M<math>\Omega</math> <math>\cdot</math> <math>\mu</math>F min. whichever is smaller</p> | <p>The insulation resistance should be measured with a DC voltage not exceeding the rated voltage (DC500<math>\pm</math>50V in case of rated voltage: DC500V, DC630V, DC1kV) at normal temperature and humidity and within 2 min. of charging. (Charge/Discharge current <math>\leq</math> 50mA)</p>   |                 |                           |                                |                               |                |                           |                         |                           |                |                           |                               |                         |                           |              |                           |                |                           |                |                           |  |       |                           |
| 6  | Capacitance                 | Within the specified tolerance   |   | The capacitance, Q/D.F. should be measured at 25°C at the frequency and voltage shown in the table.  |                 |                           |                                |                               |                |                           |                         |                           |                |                           |                               |                         |                           |              |                           |                |                           |                |                           |  |       |                           |
| 7  | Q/Dissipation Factor (D.F.) | <p>30pF min.: Q<math>\geq</math>1,000<br/>30pF max.: Q<math>\geq</math>400+20C<br/>C: Nominal capacitance (pF)</p>   | <p>Char. X7R: 0.025 max.<br/>Char. F, Y5V: 0.05 max.<br/>Char. X7S: 0.125 max.</p>  | <p>Temperature Compensating Type</p> <table border="1"> <thead> <tr> <th>Capacitance</th> <th>C<math>\leq</math>1000pF</th> <th>C&gt;1000pF</th> </tr> </thead> <tbody> <tr> <td>Item</td> <td></td> <td></td> </tr> <tr> <td>Frequency</td> <td>1<math>\pm</math>0.1MHz</td> <td>1<math>\pm</math>0.1kHz</td> </tr> <tr> <td>Voltage</td> <td>AC0.5 to 5V (r.m.s.)</td> <td>AC1<math>\pm</math>0.2V (r.m.s.)</td> </tr> </tbody> </table>   | Capacitance     | C $\leq$ 1000pF           | C>1000pF                       | Item                          |                |                           | Frequency               | 1 $\pm$ 0.1MHz            | 1 $\pm$ 0.1kHz | Voltage                   | AC0.5 to 5V (r.m.s.)          | AC1 $\pm$ 0.2V (r.m.s.) |                           |              |                           |                |                           |                |                           |  |       |                           |
|  |                             |  |   | Capacitance  | C $\leq$ 1000pF | C>1000pF                  |                                |                               |                |                           |                         |                           |                |                           |                               |                         |                           |              |                           |                |                           |                |                           |  |       |                           |
| Item   |                             |  |   |  |                 |                           |                                |                               |                |                           |                         |                           |                |                           |                               |                         |                           |              |                           |                |                           |                |                           |  |       |                           |
| Frequency  | 1 $\pm$ 0.1MHz              | 1 $\pm$ 0.1kHz   |   |  |                 |                           |                                |                               |                |                           |                         |                           |                |                           |                               |                         |                           |              |                           |                |                           |                |                           |  |       |                           |
| Voltage  | AC0.5 to 5V (r.m.s.)        | AC1 $\pm$ 0.2V (r.m.s.)  |   |  |                 |                           |                                |                               |                |                           |                         |                           |                |                           |                               |                         |                           |              |                           |                |                           |                |                           |  |       |                           |
| <p>High Dielectric Constant Type</p> <table border="1"> <thead> <tr> <th>Capacitance</th> <th>C<math>\leq</math>10<math>\mu</math>F</th> <th>C&gt;10<math>\mu</math>F</th> </tr> </thead> <tbody> <tr> <td>Item</td> <td></td> <td></td> </tr> <tr> <td>Frequency</td> <td>1<math>\pm</math>0.1kHz</td> <td>120<math>\pm</math>24Hz</td> </tr> <tr> <td>Voltage</td> <td>AC1<math>\pm</math>0.2V (r.m.s.)</td> <td>AC0.5<math>\pm</math>0.1V (r.m.s.)</td> </tr> </tbody> </table> | Capacitance                 | C $\leq$ 10 $\mu$ F  | C>10 $\mu$ F  | Item   |                 |                           | Frequency                      | 1 $\pm$ 0.1kHz                | 120 $\pm$ 24Hz | Voltage                   | AC1 $\pm$ 0.2V (r.m.s.) | AC0.5 $\pm$ 0.1V (r.m.s.) |                |                           |                               |                         |                           |              |                           |                |                           |                |                           |  |       |                           |
| Capacitance  | C $\leq$ 10 $\mu$ F         | C>10 $\mu$ F   |   |  |                 |                           |                                |                               |                |                           |                         |                           |                |                           |                               |                         |                           |              |                           |                |                           |                |                           |  |       |                           |
| Item   |                             |  |   |  |                 |                           |                                |                               |                |                           |                         |                           |                |                           |                               |                         |                           |              |                           |                |                           |                |                           |  |       |                           |
| Frequency  | 1 $\pm$ 0.1kHz              | 120 $\pm$ 24Hz   |   |  |                 |                           |                                |                               |                |                           |                         |                           |                |                           |                               |                         |                           |              |                           |                |                           |                |                           |  |       |                           |
| Voltage  | AC1 $\pm$ 0.2V (r.m.s.)     | AC0.5 $\pm$ 0.1V (r.m.s.)  |   |  |                 |                           |                                |                               |                |                           |                         |                           |                |                           |                               |                         |                           |              |                           |                |                           |                |                           |  |       |                           |

Continued on the following page. 

# RDE Series (Only for Commercial) Specifications and Test Methods

Continued from the preceding page.

| No.                     | Item  |   | Specifications  |   | Test Method   |      |                  |   |      |   |       |   |      |   |       |   |      |
|-------------------------|---|---|---|---|---|------|------------------|---|------|---|-------|---|------|---|-------|---|------|
|                         |   |   | Temperature Compensating Type   | High Dielectric Constant Type   |   |      |                  |   |      |   |       |   |      |   |       |   |      |
| 8                       | Capacitance Temperature Characteristics                 | Capacitance Change                      | Within the specified tolerance (Table A on last column)   | Within the specified tolerance (Table B on last column)                   | <p>The capacitance change should be measured after 5 min. at each specified temperature stage.</p> <p>(1) Temperature Compensating Type<br/>The temperature coefficient is determined using the capacitance measured in step 3 as a reference. When cycling the temperature sequentially from step 1 through 5 (-55 to +125°C) the capacitance should be within the specified tolerance for the temperature coefficient and capacitance change as shown in Table A. The capacitance drift is calculated by dividing the differences between the maximum and minimum measured values in step 1, 3 and 5 by the cap. value in step 3.</p> <table border="1"> <thead> <tr> <th>Step</th> <th>Temperature (°C)</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>25±2</td> </tr> <tr> <td>2</td> <td>-55±3</td> </tr> <tr> <td>3</td> <td>25±2</td> </tr> <tr> <td>4</td> <td>125±3</td> </tr> <tr> <td>5</td> <td>25±2</td> </tr> </tbody> </table> <p>(2) High Dielectric Constant Type<br/>The ranges of capacitance change compared with the 25°C (Char. F: 20°C) value over the temperature ranges as shown in Table B should be within the specified ranges.</p> <ul style="list-style-type: none"> <li>Pretreatment (for high dielectric constant type)<br/>Perform a heat treatment at 150+0/-10°C for 1 hr., and then let sit at room temperature for 24±2 hrs.</li> </ul> | Step | Temperature (°C) | 1 | 25±2 | 2 | -55±3 | 3 | 25±2 | 4 | 125±3 | 5 | 25±2 |
|                         |   | Step                                    | Temperature (°C)  |   |   |      |                  |   |      |   |       |   |      |   |       |   |      |
|                         |   | 1                                       | 25±2  |   |   |      |                  |   |      |   |       |   |      |   |       |   |      |
| 2                       | -55±3   |   |   |   |   |      |                  |   |      |   |       |   |      |   |       |   |      |
| 3                       | 25±2  |   |   |   |   |      |                  |   |      |   |       |   |      |   |       |   |      |
| 4                       | 125±3   |   |   |   |   |      |                  |   |      |   |       |   |      |   |       |   |      |
| 5                       | 25±2  |   |   |   |   |      |                  |   |      |   |       |   |      |   |       |   |      |
| Temperature Coefficient | Within the specified tolerance (Table A on last column) |   |   |   |   |      |                  |   |      |   |       |   |      |   |       |   |      |
| Capacitance Drift       | Within ±0.2% or ±0.05pF, whichever is larger            |   |   |   |   |      |                  |   |      |   |       |   |      |   |       |   |      |
| 9                       | Terminal Strength                                       | Tensile Strength                        | Termination not to be broken or loosened  |   | <p>As in the figure, fix the capacitor body, apply the force gradually to each lead in the radial direction of the capacitor until reaching 10N and then keep the force applied for 10±1 sec.</p>    |      |                  |   |      |   |       |   |      |   |       |   |      |
|                         |   | Bending Strength                        | Termination not to be broken or loosened  |   |   |      |                  |   |      |   |       |   |      |   |       |   |      |
| 10                      | Vibration Resistance                                    | Appearance                              | No defects or abnormalities   |   | <p>The capacitor is soldered securely to a supporting terminal and a 10 to 55Hz vibration of 1.5mm peak-peak amplitude is applied for 6 hrs. total, 2 hrs. in each mutually perpendicular direction. Allow 1 min. to cycle the frequency from 10Hz to 55Hz and the converse.</p>  |      |                  |   |      |   |       |   |      |   |       |   |      |
|                         |   | Capacitance                             | Within the specified tolerance  |   |   |      |                  |   |      |   |       |   |      |   |       |   |      |
|                         |   | Q/D.F.                                  | 30pF min.: $Q \geq 1,000$<br>30pF max.: $Q \geq 400+20C$<br>C: Nominal capacitance (pF)                             | Char. X7R: 0.025 max.<br>Char. F, Y5V: 0.05 max.<br>Char. X7S: 0.125 max. |   |      |                  |   |      |   |       |   |      |   |       |   |      |
| 11                      | Solderability of Leads                                  |   | Lead wire should be soldered with uniform coating on the axial direction over 3/4 of the circumferential direction. |   | <p>The terminal of a capacitor is dipped into a 25% ethanol (JIS-K-8101) solution of rosin (JIS-K-5902) and then into molten solder for 2±0.5 sec. In both cases the depth of dipping is up to about 1.5mm to 2mm from the terminal body.</p> <p>Temp. of solder: 245±5°C Lead Free Solder (Sn-3.0Ag-0.5Cu) 235±5°C H60A or H63A Eutectic Solder</p>  |      |                  |   |      |   |       |   |      |   |       |   |      |
| 12                      | Resistance to Soldering Heat                            | Appearance                              | No defects or abnormalities   |   | <p>The lead wire is immersed in the melted solder 1.5mm to 2mm from the main body at 350±10°C for 3.5±0.5 sec.</p> <p>The specified items are measured after 24±2 hrs.</p> <ul style="list-style-type: none"> <li>Pretreatment (for high dielectric constant type)<br/>Perform a heat treatment at 150+0/-10°C for 1 hr., and then let sit at room temperature for 24±2 hrs.</li> </ul>   |      |                  |   |      |   |       |   |      |   |       |   |      |
|                         |   | Capacitance Change                      | Within ±2.5% or ±0.25pF (whichever is larger)   | Char. X7R, X7S: Within ±10%<br>Char. F, Y5V: Within ±20%                  |   |      |                  |   |      |   |       |   |      |   |       |   |      |
|                         |   | Dielectric Strength (Between Terminals) | No defects  |   |   |      |                  |   |      |   |       |   |      |   |       |   |      |

Continued on the following page. 

# RDE Series (Only for Commercial) Specifications and Test Methods

Continued from the preceding page.

| No.                                     | Item  | Specifications   |   | Test Method   |  |      |                  |              |                               |                         |                           |               |                           |                               |                              |                           |                |                           |            |                           |
|---|---|--|---|---|--|------|------------------|--------------|-------------------------------|-------------------------|---------------------------|---------------|---------------------------|-------------------------------|------------------------------|---------------------------|----------------|---------------------------|------------|---------------------------|
|   |   | Temperature Compensating Type  | High Dielectric Constant Type   |   |  |      |                  |              |                               |                         |                           |               |                           |                               |                              |                           |                |                           |            |                           |
| 13                                      | Temperature Cycle   | Appearance   | No defects or abnormalities   |   | <p>The capacitor should be subjected to 5 temperature cycles.<br/>Remove and set for 24±2 hrs. at room temperature, then measure.</p> <table border="1"> <thead> <tr> <th>Step</th> <th>Temperature (°C)</th> <th>Time (min)</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>Min. Operating Temp. ±3</td> <td>30±3</td> </tr> <tr> <td>2</td> <td>Room Temp.</td> <td>3 max.</td> </tr> <tr> <td>3</td> <td>Max. Operating Temp. ±3</td> <td>30±3</td> </tr> <tr> <td>4</td> <td>Room Temp.</td> <td>3 max.</td> </tr> </tbody> </table> <p>• Pretreatment (for high dielectric constant type)<br/>Perform a heat treatment at 150+0/-10°C for 1 hr., and then let sit at room temperature for 24±2 hrs.</p>   | Step | Temperature (°C) | Time (min)   | 1                             | Min. Operating Temp. ±3 | 30±3                      | 2             | Room Temp.                | 3 max.                        | 3                            | Max. Operating Temp. ±3   | 30±3           | 4                         | Room Temp. | 3 max.                    |
|   |   | Step   | Temperature (°C)  | Time (min)  |  |      |                  |              |                               |                         |                           |               |                           |                               |                              |                           |                |                           |            |                           |
|   |   | 1  | Min. Operating Temp. ±3   | 30±3  |  |      |                  |              |                               |                         |                           |               |                           |                               |                              |                           |                |                           |            |                           |
|   |   | 2  | Room Temp.  | 3 max.  |  |      |                  |              |                               |                         |                           |               |                           |                               |                              |                           |                |                           |            |                           |
|   |   | 3  | Max. Operating Temp. ±3   | 30±3  |  |      |                  |              |                               |                         |                           |               |                           |                               |                              |                           |                |                           |            |                           |
| 4                                       | Room Temp.  | 3 max.   |   |   |  |      |                  |              |                               |                         |                           |               |                           |                               |                              |                           |                |                           |            |                           |
| Capacitance Change                      | Within ±5% or ±0.5pF (whichever is larger)  | Char. X7R, X7S: Within ±12.5%<br>Char. F, Y5V: Within ±30%   |   |   |  |      |                  |              |                               |                         |                           |               |                           |                               |                              |                           |                |                           |            |                           |
| Q/D.F.                                  | 30pF min.: Q≥350<br>10pF to 30pF: Q≥275+5C/2<br>10pF max.: Q≥200+10C<br>C: Nominal capacitance (pF)   | Char. X7R: 0.05 max.<br>Char. F, Y5V: 0.075 max.<br>Char. X7S: 0.2 max.  |   |   |  |      |                  |              |                               |                         |                           |               |                           |                               |                              |                           |                |                           |            |                           |
| Insulation Resistance                   | Rated Voltage: DC25V, DC50V, DC100V<br>1,000MΩ, 50MΩ • μF min. (whichever is smaller)<br>Rated Voltage: DC250V, DC500V, DC630V, DC1kV<br>1,000MΩ, 10MΩ • μF min. (whichever is smaller) |  |   |   |  |      |                  |              |                               |                         |                           |               |                           |                               |                              |                           |                |                           |            |                           |
| Dielectric Strength (Between Terminals) | No defects or abnormalities   |  |   |   |  |      |                  |              |                               |                         |                           |               |                           |                               |                              |                           |                |                           |            |                           |
| 14                                      | Humidity (Steady State)   | Appearance   | No defects or abnormalities   |   | <p>Set the capacitor at 40±2°C and relative humidity of 90 to 95% for 500±2<sub>0</sub> hrs.<br/>Remove and set for 24±2 hrs. at room temperature, then measure.</p> <p>• Pretreatment (for high dielectric constant type)<br/>Perform a heat treatment at 150+0/-10°C for 1 hr., and then let sit at room temperature for 24±2 hrs.</p>   |      |                  |              |                               |                         |                           |               |                           |                               |                              |                           |                |                           |            |                           |
|   |   | Capacitance Change   | Within ±5% or ±0.5pF (whichever is larger)  | Char. X7R, X7S: Within ±15%<br>Char. F, Y5V: Within ±30%                |  |      |                  |              |                               |                         |                           |               |                           |                               |                              |                           |                |                           |            |                           |
|   |   | Q/D.F.   | 30pF min.: Q≥350<br>10pF to 30pF: Q≥275+5C/2<br>10pF max.: Q≥200+10C<br>C: Nominal capacitance (pF)   | Char. X7R: 0.05 max.<br>Char. F, Y5V: 0.075 max.<br>Char. X7S: 0.2 max. |  |      |                  |              |                               |                         |                           |               |                           |                               |                              |                           |                |                           |            |                           |
|   |   | Insulation Resistance  | Rated Voltage: DC25V, DC50V, DC100V<br>1,000MΩ, 50MΩ • μF min. (whichever is smaller)<br>Rated Voltage: DC250V, DC500V, DC630V, DC1kV<br>1,000MΩ, 10MΩ • μF min. (whichever is smaller)   |   |  |      |                  |              |                               |                         |                           |               |                           |                               |                              |                           |                |                           |            |                           |
| 15                                      | Humidity Load   | Appearance   | No defects or abnormalities   |   | <p>Apply the rated voltage for 500±2<sub>0</sub> hrs. at 40±2°C and in 90 to 95% humidity.<br/>Remove and set for 24±2 hrs. at room temperature, then measure.<br/>(Charge/Discharge current ≤50mA)</p> <p>• Pretreatment (for high dielectric constant type)<br/>Perform a heat treatment at 150+0/-10°C for 1 hr., and then let sit at room temperature for 24±2 hrs.</p>  |      |                  |              |                               |                         |                           |               |                           |                               |                              |                           |                |                           |            |                           |
|   |   | Capacitance Change   | Within ±7.5% or ±0.75pF (whichever is larger)   | Char. X7R, X7S: Within ±15%<br>Char. F, Y5V: Within ±30%                |  |      |                  |              |                               |                         |                           |               |                           |                               |                              |                           |                |                           |            |                           |
|   |   | Q/D.F.   | 30pF min.: Q≥200<br>30pF max.: Q≥100+10C/3<br>C: Nominal capacitance (pF)   | Char. X7R: 0.05 max.<br>Char. F, Y5V: 0.075 max.<br>Char. X7S: 0.2 max. |  |      |                  |              |                               |                         |                           |               |                           |                               |                              |                           |                |                           |            |                           |
|   |   | Insulation Resistance  | Rated Voltage: DC25V, DC50V, DC100V<br>500MΩ or 25MΩ • μF min. (whichever is smaller)<br>Rated Voltage: DC250V, DC500V, DC630V, DC1kV<br>1,000MΩ or 10MΩ • μF min. (whichever is smaller) |   |  |      |                  |              |                               |                         |                           |               |                           |                               |                              |                           |                |                           |            |                           |
| 16                                      | High Temperature Load   | Appearance   | No defects or abnormalities   |   | <p>Apply voltage in Table for 1000±4<sub>0</sub> hrs. at the maximum operating temperature±3°C.<br/>Remove and set for 24±2 hrs. at room temperature, then measure. (Charge/Discharge current ≤50mA)</p> <table border="1"> <thead> <tr> <th></th> <th>Rated Voltage</th> <th>Test Voltage</th> </tr> </thead> <tbody> <tr> <td rowspan="2">Temperature Compensating Type</td> <td>DC50V, DC100V, DC250V</td> <td>150% of the rated voltage</td> </tr> <tr> <td>DC630V, DC1kV</td> <td>120% of the rated voltage</td> </tr> <tr> <td rowspan="3">High Dielectric Constant Type</td> <td>DC25V, DC50V, DC100V, DC250V</td> <td>150% of the rated voltage</td> </tr> <tr> <td>DC500V, DC630V</td> <td>120% of the rated voltage</td> </tr> <tr> <td>DC1kV</td> <td>110% of the rated voltage</td> </tr> </tbody> </table> <p>• Pretreatment (for high dielectric constant type)<br/>Apply test voltage for 1 hr., at test temperature.<br/>Remove and set for 24±2 hrs. at room temperature.</p> |      | Rated Voltage    | Test Voltage | Temperature Compensating Type | DC50V, DC100V, DC250V   | 150% of the rated voltage | DC630V, DC1kV | 120% of the rated voltage | High Dielectric Constant Type | DC25V, DC50V, DC100V, DC250V | 150% of the rated voltage | DC500V, DC630V | 120% of the rated voltage | DC1kV      | 110% of the rated voltage |
|   |   |  | Rated Voltage   | Test Voltage  |  |      |                  |              |                               |                         |                           |               |                           |                               |                              |                           |                |                           |            |                           |
|   |   | Temperature Compensating Type  | DC50V, DC100V, DC250V   | 150% of the rated voltage   |  |      |                  |              |                               |                         |                           |               |                           |                               |                              |                           |                |                           |            |                           |
|   |   |  | DC630V, DC1kV   | 120% of the rated voltage   |  |      |                  |              |                               |                         |                           |               |                           |                               |                              |                           |                |                           |            |                           |
| High Dielectric Constant Type           | DC25V, DC50V, DC100V, DC250V  | 150% of the rated voltage  |   |   |  |      |                  |              |                               |                         |                           |               |                           |                               |                              |                           |                |                           |            |                           |
|   | DC500V, DC630V  | 120% of the rated voltage  |   |   |  |      |                  |              |                               |                         |                           |               |                           |                               |                              |                           |                |                           |            |                           |
|   | DC1kV   | 110% of the rated voltage  |   |   |  |      |                  |              |                               |                         |                           |               |                           |                               |                              |                           |                |                           |            |                           |
| Capacitance Change                      | Within ±3% or ±0.3pF (whichever is larger)  | Char. X7R, X7S: Within ±15% (Rated Voltage: DC630V or less)<br>Within ±20% (Rated Voltage: DC1kV)<br>Char. F, Y5V: Within ±30% |   |   |  |      |                  |              |                               |                         |                           |               |                           |                               |                              |                           |                |                           |            |                           |
| Q/D.F.                                  | 30pF min.: Q≥350<br>10pF to 30pF: Q≥275+5C/2<br>10pF max.: Q≥200+10C<br>C: Nominal capacitance (pF)   | Char. X7R: 0.05 max.<br>Char. F, Y5V: 0.075 max.<br>Char. X7S: 0.2 max.  |   |   |  |      |                  |              |                               |                         |                           |               |                           |                               |                              |                           |                |                           |            |                           |
| Insulation Resistance                   | Rated Voltage: DC25V, DC50V, DC100V<br>1,000MΩ, 50MΩ • μF min. (whichever is smaller)<br>Rated Voltage: DC250V, DC500V, DC630V, DC1kV<br>1,000MΩ, 10MΩ • μF min. (whichever is smaller) |  |   |   |  |      |                  |              |                               |                         |                           |               |                           |                               |                              |                           |                |                           |            |                           |
| 17                                      | Solvent Resistance  | Appearance   | No defects or abnormalities   |   | <p>The capacitor should be fully immersed, unagitated, in reagent at 20 to 25°C for 30±5 sec. and then removed gently. Marking on the surface of the capacitor should immediately be visually examined.<br/>Reagent:<br/>• Isopropyl alcohol</p>   |      |                  |              |                               |                         |                           |               |                           |                               |                              |                           |                |                           |            |                           |
|   |   | Marking  | Legible   |   |  |      |                  |              |                               |                         |                           |               |                           |                               |                              |                           |                |                           |            |                           |

Table A

| Char. | Nominal Values (ppm/°C) *1 | Capacitance Change from 25°C (%) |       |       |       |       |       |
|-------|----------------------------|----------------------------------|-------|-------|-------|-------|-------|
|       |                            | -55°C                            |       | -30°C |       | -10°C |       |
|       |                            | Max.                             | Min.  | Max.  | Min.  | Max.  | Min.  |
| C0G   | 0±30                       | 0.58                             | -0.24 | 0.40  | -0.17 | 0.25  | -0.11 |
| U2J   | -750±120                   | 8.78                             | 5.04  | 6.04  | 3.47  | 3.84  | 2.21  |

\*1: Nominal values denote the temperature coefficient within a range of 25 to 125°C

Table B

| Char. | Temp. Range   | Reference Temp. | Cap. Change Rate |
|-------|---------------|-----------------|------------------|
| X7R   | -55 to +125°C | 25°C            | Within ±15%      |
| X7S   |               |                 | Within ±22%      |
| Y5V   | -30 to + 85°C | 20°C            | Within ±33%      |
| F     | -25 to + 85°C |                 | Within ±38%      |



## ■ Packaging

Two types of packaging for monolithic ceramic capacitors are available.

### 1. Bulk Packaging

Minimum Quantity

| Dimensions Code | Dimensions (L×W)   | Minimum Quantity (pcs./Bag)* |
|-----------------|--|------------------------------|
| 0               | 3.6×3.5mm or 4.0×3.5mm or 5.0×3.5mm (Depends on Part Number) | 500                          |
| 1               | 4.0×3.5mm or 4.5×3.5mm or 5.0×3.5mm (Depends on Part Number) |                              |
| 2               | 5.0×3.5mm or 5.5×4.0mm or 5.7×4.5mm (Depends on Part Number) |                              |
| 3               | 5.0×4.5mm or 5.5×5.0mm or 6.0×5.5mm (Depends on Part Number) |                              |
| 4               | 7.5×5.5mm  |                              |
| 5               | 7.5×7.5mm or 7.5×8.0mm (Depends on Part Number)              |                              |
| 6               | 10.0×10.0mm  |                              |
| 8               | 7.5×5.5mm  |                              |
| 7               | 12.5×12.5mm  | 100                          |
| U               | 7.7×12.5mm or 7.7×13.0mm (Depends on Part Number)            | 200                          |
| W               | 5.5×7.5mm or 6.0×8.0mm (Depends on Part Number)              | 500                          |

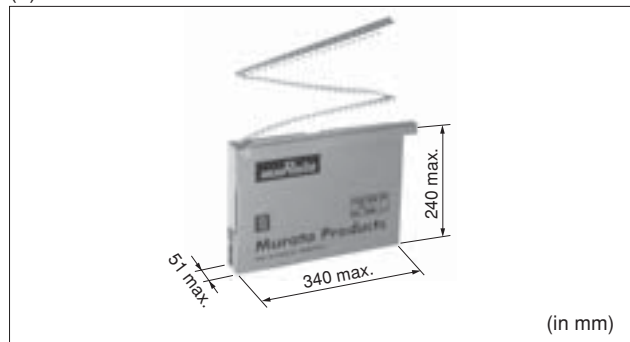
Please order with an integral multiple of the minimum quantity above.

\* Minimum Quantity may change depends on part number.

Please check our website 'Product details'.

### 2. Tape Carrier Packaging

(1) Dimensions of Ammo Pack



(2) Minimum Quantity

| Dimensions Code | Dimensions (L×W)   | Minimum Quantity (pcs./Ammo Pack)* |
|-----------------|--|------------------------------------|
| 0               | 3.6×3.5mm or 4.0×3.5mm or 5.0×3.5mm (Depends on Part Number) | 2000                               |
| 1               | 4.0×3.5mm or 4.5×3.5mm or 5.0×3.5mm (Depends on Part Number) |                                    |
| 2               | 5.0×3.5mm or 5.5×4.0mm or 5.7×4.5mm (Depends on Part Number) |                                    |
| 3               | 5.0×4.5mm or 5.5×5.0mm or 6.0×5.5mm (Depends on Part Number) |                                    |
| 4               | 7.5×5.5mm  | 2000                               |
| 5               | 7.5×7.5mm or 7.5×8.0mm (Depends on Part Number)              |                                    |
| 6               | 10.0×10.0mm  | 1500                               |
| 8               | 7.5×5.5mm  |                                    |
| U               | 7.7×12.5mm or 7.7×13.0mm (Depends on Part Number)            | 1000                               |
| W               | 5.5×7.5mm or 6.0×8.0mm (Depends on Part Number)              | 1500                               |

Please order with an integral multiple of the minimum quantity above.

\* Minimum Quantity may change depends on part number.

Please check our website 'Product details'.

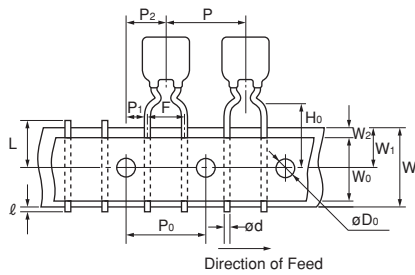
"Minimum Quantity" means the numbers of units of each delivery or order. The quantity should be an integral multiple of the "minimum quantity".  
(Please note that the actual delivery quantity in a package may change sometimes.)

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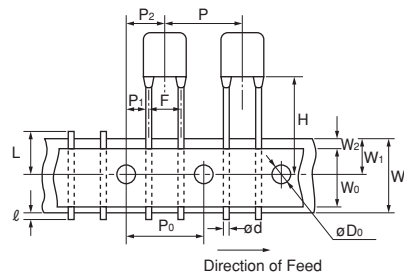
**Taping Dimensions**

**Inside Crimp Taping**



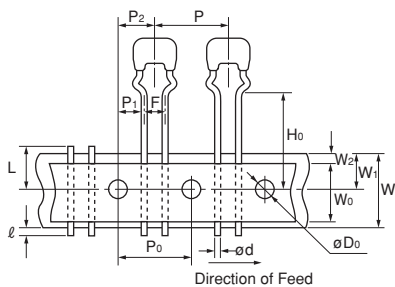
| Dimensions and Lead Style Code |
|--------------------------------|
| 0M1                            |
| 1M1                            |
| 2M1                            |
| 2M2                            |
| 3M1                            |
| 3M2                            |
| 4M1                            |
| 4M2                            |
| 8M1                            |
| 8M2                            |
| WM1                            |

**Straight Taping**



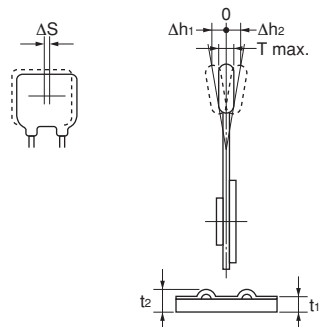
| Dimensions and Lead Style Code |
|--------------------------------|
| 1DB                            |
| 2DB                            |
| 3DB                            |
| 5E1                            |
| 5E2                            |
| 6E1                            |
| 6E2                            |
| UE1                            |

**Outside Crimp Taping**



| Dimensions and Lead Style Code |
|--------------------------------|
| 0S1                            |
| 1S1                            |
| 2S1                            |
| 2S2                            |
| 3S1                            |
| 3S2                            |

| Item   | Code                               | Dimensions (mm)                                    |
|--|------------------------------------|--|
| Pitch of Component                               | P                                  | 12.7±1.0   |
| Pitch of Sprocket Hole                           | P <sub>0</sub>                     | 12.7±0.2   |
| Lead Spacing                                     | F                                  | 2.5 <sup>+0.4</sup> <sub>-0.2</sub> (DB) (S1) (S2) |
|  |                                    | 5.0 <sup>+0.6</sup> <sub>-0.2</sub>                |
| Length from Hole Center to Component Center      | P <sub>2</sub>                     | 6.35±1.3   |
| Length from Hole Center to Lead                  | P <sub>1</sub>                     | 3.85±0.7   |
|  |                                    | 5.1±0.7 (DB) (S1) (S2)                             |
|  |                                    | 254±1.5 Total length of components pitch X 20      |
| Body Dimension                                   | Depends on Part Number             |  |
| Deviation Along Tape, Left or Right Defect       | ΔS                                 | ±2.0   |
| Carrier Tape Width                               | W                                  | 18.0±0.5   |
| Position of Sprocket Hole                        | W <sub>1</sub>                     | 9.0 <sup>+0</sup> <sub>-0.5</sub>                  |
| Lead Distance between Reference and Bottom Plane | H <sub>0</sub>                     | 16.0±0.5 (M1) (S1)                                 |
|  |                                    | 20.0±0.5 (M2) (S2)                                 |
| For Straight Lead Type                           | H                                  | 20±0.5 (E2), 17.5±0.5 (E1), 16±0.5 (DB)            |
| Diameter of Sprocket Hole                        | D <sub>0</sub>                     | 4.0±0.1  |
| Lead Diameter                                    | d                                  | 0.5±0.05   |
| Total Tape Thickness                             | t <sub>1</sub>                     | 0.6±0.3  |
| Total Thickness of Tape and Lead Wire            | t <sub>2</sub>                     | 1.5 max.   |
| Body Thickness                                   | T                                  | Depends on Part Number                             |
| Deviation Across Tape                            | Δh <sub>1</sub><br>Δh <sub>2</sub> | 2.0 max. Dimensions Code: W, U                     |
|  |                                    | 1.5 max. RHD Series                                |
|  |                                    | 1.0 max. except as above                           |
| Portion to Cut in Case of Defect                 | L                                  | 11.0 <sup>+0</sup> <sub>-1.0</sub>                 |
| Protrusion Length                                | ℓ                                  | 0.5 max.   |
| Hold Down Tape Width                             | W <sub>0</sub>                     | 9.5 min.   |
| Hold Down Tape Position                          | W <sub>2</sub>                     | 1.5±1.5  |
| Coating Extension                                | Depends on Dimensions              |  |



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