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Market needs and Product Characteristics

**RG series**

**Highly reliable, highly stable**
- Highly reliable resistors are needed in application for automotive electronics, FA instruments, and industrial test and measurement equipment due to their exposure to harsh environments. In the proximity of automotive engines with their high temperature, high humidity, dusts, vibration and hazardous chemicals, resistors with long lasting reliability and with exceptional tolerance against heat, humidity and sulfur are especially necessary.
- In consumer electronics, reliable components are required because long-term warranty is considered as an added value.
  - Various reliability tests: high reliability with ±0.1% or less drift after 10000 hours.
  - Operating temperature: -55 to 155°C; extremely heat resistant
  - Resistant to humidity: new passivation can block moisture even in very humid environment
  - Resistance to sulfur: no silver in the terminals and passivation with strong chemical resistance.
  - Resistance to pulse voltage/current: resistant to ESD and surge current.

**Low cost**
- The performance and reliability characteristics match foil resistors but are priced more reasonably.

**High precision, high performance**
- High functionality of the latest equipment requires resistors with the tightest tolerance especially in voltage divider or amplifier gain in analogue circuits.
  - Realized very tight resistance tolerance: ±0.02%.
- In order not to be affected by fluctuating environmental conditions, resistors with minimal Temperature Coefficient of Resistance (TCR) are required.
  - Realized very small TCR: ±5ppm/°C.
- In the amplification of very weak signals, resistors with the lowest current noise of its own is required. In order not to affect the dynamic range.
  - Realized low current noise: -20dB
- In high frequency circuits, resistors without any resonance at certain frequencies and with stability throughout wide frequency ranges are needed.
  - Realized stable frequency performance.

**RM series**

**Network**
- Multi-element network of "RG" series resistor elements with all the exceptional reliability, stability, precision, and performance of the RG series.

**RGH series**

**High Power**
- We have developed high power chip resistors with RG series performance and reliability characteristics.

![Image of high power chip resistors comparison]

**The trend to be smaller and shorter in electronics makes it mandatory to increase the rated power of the component.**
- Offering 1/8 Watt for 1005 size chip (conventionally 1/8W was offered with 1608chip. Occupying space is only 40% of 1608)
- Offering 1/4 Watt for 2012 size chip (conventionally 1/4W was offered with 3216chip. Occupying space is only 48% of 3216)
Specifications

Construction

RG series

Mechanical

|| Name | Material Name |
|---|---|
| 1 | Substrate | Alumina ceramic |
| 2 | Protection coat I | Resin Coating |
| 3 | Protection coat II | Inorganic coating |
| 4 | External Electrode | Tin plating (Sn 100%) |
| 5 | Inner Electrode I | Nickel plating |
| 6 | Inner Electrode II | Thin film |

<table>
<thead>
<tr>
<th>Type</th>
<th>Power</th>
<th>Tolerance % (code)</th>
<th>Resistance Range (Ω)</th>
<th>TCR ppm/°C (code)</th>
<th>Max Operating Voltage</th>
<th>Resistance Value</th>
<th>Operating Temp. Range</th>
<th>Package</th>
</tr>
</thead>
<tbody>
<tr>
<td>RG1005</td>
<td>0.1/16W</td>
<td>±0.5%</td>
<td>10 - 46.4</td>
<td>±100 (R)</td>
<td>25V</td>
<td>10 (N)</td>
<td>E-24, E-96</td>
<td>1,000pcs/real (T1,P,W), 5,000pcs/real (T5,B), 10,000pcs/real (T10,B,C,D)</td>
</tr>
<tr>
<td>RG1608</td>
<td>0.1/10W</td>
<td>±0.5%</td>
<td>100 - 2,940k</td>
<td>±100 (R)</td>
<td>75V</td>
<td>25 (P)</td>
<td>E-24, E-96</td>
<td>1,000pcs/real (T1,P,W,B), 5,000pcs/real (T5,B,C,D)</td>
</tr>
<tr>
<td>RG2012</td>
<td>0.5/8W</td>
<td>±0.5%</td>
<td>100 - 2,940k</td>
<td>±100 (Q)</td>
<td>150V</td>
<td>10 (N)</td>
<td>E-24, E-96</td>
<td>1,000pcs/real (T1,P,W,B), 5,000pcs/real (T5,B,C,D)</td>
</tr>
</tbody>
</table>

- Please contact us for Resistance tolerance ±0.01%.
- Please contact us for RG3326 series with power of 1/2W

Part Number

RG 1608 N - 102 - B - T5

- Package (T1,T5,T10)
- Resistance Tolerance
- Resistance
- (E-24: in a three-digit number, E-96: in a four-digit number 4 digits for all RG3326)

Dimensions

Part Code

<table>
<thead>
<tr>
<th>Type</th>
<th>Power</th>
<th>Resistance (Ω)</th>
<th>Tracking Tol.</th>
</tr>
</thead>
<tbody>
<tr>
<td>RGH</td>
<td>0.05</td>
<td>±5%</td>
<td>1.6</td>
</tr>
<tr>
<td>RGM</td>
<td>0.05</td>
<td>±5%</td>
<td>1.6</td>
</tr>
</tbody>
</table>

- Please contact for Alternate code
- Different resi
Reliability test: 10,000Hr < 0.1%

Specifications

**RGH series**

### Mechanical

<table>
<thead>
<tr>
<th>Type</th>
<th>RGH1005-2B</th>
<th>RGH2012-2E</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power</td>
<td>1/6W</td>
<td>1/4W</td>
</tr>
<tr>
<td>Tolerance % (code)</td>
<td>0.1% (B), 0.5% (D)</td>
<td>0.1% (B), 0.5% (D)</td>
</tr>
<tr>
<td>Resistance Range (Ω)</td>
<td>47 ~ 100kΩ</td>
<td>47 ~ 470kΩ</td>
</tr>
<tr>
<td>TCR ppm/°C (code)</td>
<td>±25ppm/°C (C)</td>
<td>±25ppm/°C (C)</td>
</tr>
<tr>
<td>Max Operating Voltage</td>
<td>75V</td>
<td>125V</td>
</tr>
<tr>
<td>Resistance Value</td>
<td>E-24, E-96</td>
<td>E-24, E-96</td>
</tr>
<tr>
<td>Sensing Temp. Range</td>
<td>-55 ~ 150°C</td>
<td>-55 ~ 150°C</td>
</tr>
</tbody>
</table>

**Part Number**

<table>
<thead>
<tr>
<th>Type</th>
<th>RGH 1005-2B - P - 102 - B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resistance Tolerance</td>
<td>(E-24 in a three digit, E-96 in a four digit)</td>
</tr>
<tr>
<td>Power (W)</td>
<td>2 for 1/8W, 2E for 1/4W</td>
</tr>
<tr>
<td>Dimension</td>
<td></td>
</tr>
<tr>
<td>Part Code</td>
<td></td>
</tr>
</tbody>
</table>

* RGH1608 with 1/6W power consumption are available to meet your needs.

**RM series**

### Mechanical

<table>
<thead>
<tr>
<th>Type</th>
<th>RM 2012</th>
<th>RM 3216</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power</td>
<td>0.05W/element</td>
<td>0.125W/element</td>
</tr>
<tr>
<td>Resistance Range (Ω)</td>
<td>100 ~ 10kΩ</td>
<td>1000 ~ 330kΩ</td>
</tr>
<tr>
<td>Absolute Tolerance % (code)</td>
<td>±0.1% (B), ±0.5% (D) (100 Ω ≤ R ≤ 2kΩ)</td>
<td>±0.1% (B), ±0.5% (D) (2kΩ ≤ R ≤ 10kΩ)</td>
</tr>
<tr>
<td>Tracking Tolerance % (code)</td>
<td>±0.02% (P)</td>
<td>±0.05% (W) (1000 Ω ≤ R ≤ 10kΩ)</td>
</tr>
<tr>
<td>Absolute TCR ppm/°C (code)</td>
<td>±25ppm (100 ≤ R ≤ 330kΩ)</td>
<td>±25ppm (100 ≤ R ≤ 330kΩ)</td>
</tr>
<tr>
<td>Tracking TCR ppm/°C (code)</td>
<td>±10ppm/°C (100 ≤ R ≤ 330kΩ)</td>
<td>±10ppm/°C (100 ≤ R ≤ 330kΩ)</td>
</tr>
</tbody>
</table>

* Please contact us for TCR ±5ppm/°C for 330kΩ or more in RM2012, RM3216
* Standard combination of resistance values
  - Identical resistance values: R1 = R2 = 1kΩ, 10kΩ, 100kΩ
  - Different resistance values: R1 = 1kΩ, R2 = 2kΩ, 3kΩ, 4kΩ, 5kΩ, 6kΩ, 7kΩ, 10kΩ, 20kΩ, 50kΩ, 100kΩ
* Please contact us for other variety than these sizes and customized specifications.

**Part Number**

<table>
<thead>
<tr>
<th>Type</th>
<th>RM 2012 A - <strong><strong>/</strong></strong> - P W X L 10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resistance Circuit</td>
<td>Package (10.50)</td>
</tr>
<tr>
<td>Dimensions</td>
<td>Tracking Resistance Tolerance</td>
</tr>
<tr>
<td>Part Code</td>
<td>Tracking Temperature Coefficient of Resistance</td>
</tr>
<tr>
<td></td>
<td>Temperature Coefficient of Resistance</td>
</tr>
</tbody>
</table>

* Please contact us for other variety than these sizes and customized specifications.
Reliability Test Data

Excellent reliability and stability

- Realized excellent reliability and stability comparable to foil resistors using stable resistive film with minimal long-term drift and exceptional environmental passivation.
- Thin film resistors are traditionally highly stable but the new RG, RM, RGH series promise even longer product life: less than ±0.1% drift after 116 years of usage under normal condition (temperature and humidity).

Humidity resistance 10000 hour 85°C 85% test data on RG/RM

**RG series**

- Moisture and life test (THB 85°C 85%)
- Temperature Humidity Bias (85°C 85%)
- Moisture Load Life (60°C 95%)

**RM series**

- Moisture and life test (THB 85°C 85%)
- Temperature Humidity Bias (85°C 85%)
- Moisture Load Life (60°C 95%)

**Test conditions:**
- Ta: 85°C, Ha: 85%RH
- Power: 50mW
- Duration: 90 min. on / 30 min off
- n=50
Temperature resistance

**RG series**

- **Temperature cycle test**

  ![Graph showing temperature cycle test results for RG series.](image)

- **High temperature exposure test (155℃)**

  ![Graph showing high temperature exposure test results for RG series.](image)

- **Load life test (85℃)**

  ![Graph showing load life test results for RG series.](image)

**RM series**

- **Temperature Humidity Bias (85℃ 85%)**

  ![Graph showing temperature humidity bias test results for RM series.](image)

- **Temperature Humidity Bias (85℃ 85%)**

  ![Graph showing temperature humidity bias test results for RM series.](image)

- **High Temperature Storage (155℃)**

  ![Graph showing high temperature storage test results for RM series.](image)

- **High Temperature Storage (155℃)**

  ![Graph showing high temperature storage test results for RM series.](image)
Sulfur resistance

Strong resistance to sulfur with no sulfur sensitive silver content and non-reactive passivation (separate Data)

Durability against pulse

Through stable thin film forming processes (resistance element and protection film), resistor has excellent durability against pulse.

Test Model

【Machine Model】

High voltage power source

Discharge Condenser

Test Sample

【Human Model】

High voltage power source

Discharge Condenser

Test Sample

●Little resistance change and stable status in low voltage loaded

Comparison test of ESD between RG series and Thick film resistor (Machine Model)

Sample: Thick Film, 10kΩ chip resistor / RG, RG10EB

Resistance Change Ratio (%)

Discharge Condenser: 20kΩ
Discharge resistor: None
Repobition: 5 times

TCR
Excellent resistance stability (little secular distortion)

Through stable thin film forming processes and unique annealing treatment (aging), resistance change is minimized durable resistor against environment in long term usage. Resistance change is little even in high temperature and high humidity environment for long term.

■ Thin Film (Susumu) vs Thick Film (Competitor)

● High Temperature Storage Test 155°C

Test Condition: Temperature 155°C No load
Sample: 10000 chips
- RESM Thin Film 1508 A Co., B Co.
- RQ1088 10KQ

Resistance Change Ratio (%)

- A Co. Thick Film 1508 R(Rt=10KΩ)
- B Co. Thick Film 1508 R(Rt=10KΩ)
- RQ1088 10KQ

Test Time (h)

- 10
- 100
- 1000
- 10000

● Temperature Humidity Bias (THB) 85°C 85%

Test Condition: Test: 85°C Humidity 85%RH 1/3 of rated power continuous load
Sample: 100
- RESM Thin Film 1508 A Co., B Co.
- RQ1088 10KQ

Resistance Change Ratio (%)

- A Co. Thick Film 1508 R(Rt=10KΩ)
- B Co. Thick Film 1508 R(Rt=10KΩ)
- RQ1088 10KQ

Test Time (h)

- 10
- 100
- 1000
- 10000

Temperature Coefficient of Resistance (TCR)

Absolute TCR: ±2ppm/°C,
TCR ratio: ±1ppm/°C

Metals have positive TCR and non or semi-conductors have negative TCR. A thick film resistor is normally a composite of metals and non-conductive materials. It shows positive TCR when the resistance value is high due to its high content of non-conductor and negative TCR when resistance is low with its high metal content. Our thin film resistor, with its proprietary composition and deposition method, shows close to zero TCR regardless the resistance value.

TCR(10⁻⁶/°K) = \frac{(R(t) - R(0))}{R(0)} \times \frac{1}{t-t_0} \times 10^6

where:
- R: measured resistive value at TC (Ω)
- R(0): measured resistive value at t(0) (Ω)
- t: measured test temperature (°C)
- t_0: measured standard temperature (°C)
Low current noise

Theoretical background

The current noise largely depends on the materials used and becomes significant in lower frequencies. This film tends to suppress the noise (see figure below). Therefore, low current noise thin film chip resistor is needed for the application that handles very low voltage near DC range.

Current Noise Features

- Comparison with Thick Film and Thin Film -

Conversion Chart of Noise Measurement

High frequency Characteristics

In high frequency, electrons only move on the surface of the conductor (skin effect). Thin film resistors, being literally thin (a few hundred angstroms), will not be affected by the skin effect nor other disturbances such as resonance or stray inductance.

Frequency Characteristics
On Environment

Thin Film products by Susumu is environmentally friendly by nature.

- Completely lead free: Our thin film products do not contain any lead even in the areas that are not restricted by RoHS.

Typical RG/RM construction and composition

<table>
<thead>
<tr>
<th>Structure</th>
<th>weight % of each structure</th>
<th>Composition of RoHS restricted materials</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>RG1005</td>
<td>RG1608</td>
</tr>
<tr>
<td>Substrate</td>
<td>83.2</td>
<td>87</td>
</tr>
<tr>
<td>Resistor</td>
<td>0.02</td>
<td>0.02</td>
</tr>
<tr>
<td>Inner electrode</td>
<td>0.66</td>
<td>0.13</td>
</tr>
<tr>
<td>Mid electrode</td>
<td>8.33</td>
<td>5.82</td>
</tr>
<tr>
<td>Outer electrode (Sn10%)</td>
<td>5.45</td>
<td>3.81</td>
</tr>
</tbody>
</table>

- Products’ extremely long lifetime contributes to conserving resources.
  - Thin film resistors are high precision and very reliable by nature. New RG series boasts 8 times longer life compared to our conventional thin film resistors.
  - Under normal usage (normal temp. and humidity), the expected resistance drift is less than 0.1% after 116 years

Comparison to our conventional product

<table>
<thead>
<tr>
<th>Product series</th>
<th>Type</th>
<th>Judgment Criteria</th>
<th>Years</th>
</tr>
</thead>
<tbody>
<tr>
<td>RG series</td>
<td>Highly reliable thin film chip resistor</td>
<td>0.1% resistance drift</td>
<td>over 116 years</td>
</tr>
<tr>
<td>NR series</td>
<td>Thin film chip resistor</td>
<td></td>
<td>14 years</td>
</tr>
</tbody>
</table>

Test Condition: 85°C, 85%RH, 10% rated voltage bias, 90 min. on/30 min. off

- Thin film enables us to make components smaller, contributing conserving resources.

Example 2: RGH series

<table>
<thead>
<tr>
<th>Power</th>
<th>Conventional type</th>
<th>RGH</th>
<th>area %</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/8W</td>
<td>1.6 X 0.8</td>
<td>1.0 X 0.5</td>
<td>39%</td>
</tr>
<tr>
<td>1/4W</td>
<td>3.2 X 1.6</td>
<td>2.0 X 1.25</td>
<td>48%</td>
</tr>
</tbody>
</table>

Comparison to our conventional product (unit: mm)

SSM Group Companies, as a whole group, strive to create environmentally friendly components.

SSM Group ISO14001 certification status

<table>
<thead>
<tr>
<th>Company Name</th>
<th>Facilities</th>
<th>Certification date</th>
<th>Certifying body</th>
<th>Cert. #</th>
</tr>
</thead>
<tbody>
<tr>
<td>Susumu Co., Ltd.</td>
<td>Obama Factory</td>
<td>2000.12.15</td>
<td>JQA</td>
<td>EM1184</td>
</tr>
<tr>
<td></td>
<td>Headquarter, Sales offices</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yokohama Denki Seiko Co., Ltd.</td>
<td>Nagata Factory</td>
<td>2001.03.09</td>
<td>JQA</td>
<td>EM1388</td>
</tr>
<tr>
<td>Thin Film Technology Corp.</td>
<td>Marketing facility</td>
<td>2000.03.24</td>
<td>UL</td>
<td>A8561</td>
</tr>
<tr>
<td>Cyntec Co., Ltd.</td>
<td>Hisin-Chu (Taiwan)</td>
<td>2002.08.26</td>
<td>UL</td>
<td>A8561</td>
</tr>
<tr>
<td></td>
<td>Suzhou (China)</td>
<td>2003.10.22</td>
<td>UKAS</td>
<td>140858</td>
</tr>
</tbody>
</table>
Design Supportive Data

Recommended land pattern

<table>
<thead>
<tr>
<th>Series</th>
<th>a</th>
<th>b</th>
<th>c</th>
</tr>
</thead>
<tbody>
<tr>
<td>RG1008, RGH1005</td>
<td>0.5</td>
<td>1.6</td>
<td>0.6</td>
</tr>
<tr>
<td>RG1608</td>
<td>1.0</td>
<td>3.0</td>
<td>1.2</td>
</tr>
<tr>
<td>RG2012, RGH2012</td>
<td>1.2</td>
<td>4.0</td>
<td>1.65</td>
</tr>
<tr>
<td>RG3216</td>
<td>2.2</td>
<td>5.0</td>
<td>2.0</td>
</tr>
</tbody>
</table>

RM series

Power Derating

1. Rated Power
   The standard ambient temperature is 30°C. When an ambient temperature exceeds 30°C, the maximum load power is calculated by multiplying the rated power with the ratio derived from the power derating curve.

2. Rated voltage
   The rated voltage is the corresponding voltage of DC or AC (commercially used frequency) current to

   \[ E = \sqrt{R \times P} \]
   
   E: Rated voltage (V)
   P: Rated power (W)
   R: Rated resistance (Ω)

Recommended Reflow

- Part’s surface temperature
  - Pre-heating: 130—160°C, 60—90sec.
  - Reflow: Over 220°C, 30—50sec.
  - Peak temperature: 240—250°C, within 10sec.

- Solder composition: Sn-Ag-Cu solder
- Repetition: up to 2 times
  (Cooling between the two reflow is required.)
Reliability test 10,000hr < 0.1%

Tape Specification

**RG series**

**RG1006** (2mm pitch paper tape)

**RG3216 Tape dimensions (Emboss)**

<table>
<thead>
<tr>
<th>Series</th>
<th>RG3216</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>2.0±0.2</td>
</tr>
<tr>
<td>B</td>
<td>3.6±0.2</td>
</tr>
<tr>
<td>W</td>
<td>8.0±0.3</td>
</tr>
<tr>
<td>E</td>
<td>1.75±0.1</td>
</tr>
<tr>
<td>P₁</td>
<td>4.0±0.1</td>
</tr>
<tr>
<td>P₂</td>
<td>4.0±0.1</td>
</tr>
<tr>
<td>D₁</td>
<td>1.5±0.05</td>
</tr>
<tr>
<td>D₂</td>
<td>1.5±0.05</td>
</tr>
<tr>
<td>T</td>
<td>1.6 max</td>
</tr>
<tr>
<td>t</td>
<td>0.3 max</td>
</tr>
</tbody>
</table>

**RG1608, RG2012** (4mm pitch paper tape)

**RM series**

**Emboss**

<table>
<thead>
<tr>
<th>Series</th>
<th>RM2012</th>
<th>RM3216</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1.6±0.2</td>
<td>2.0±0.2</td>
</tr>
<tr>
<td>B</td>
<td>4.0±0.2</td>
<td>3.6±0.2</td>
</tr>
<tr>
<td>W</td>
<td>8.0±0.3</td>
<td>8.0±0.3</td>
</tr>
<tr>
<td>E</td>
<td>1.75±0.1</td>
<td>1.75±0.1</td>
</tr>
<tr>
<td>P₁</td>
<td>4.0±0.1</td>
<td>4.0±0.1</td>
</tr>
<tr>
<td>P₂</td>
<td>4.0±0.1</td>
<td>4.0±0.1</td>
</tr>
<tr>
<td>D₁</td>
<td>2.0±0.05</td>
<td>2.0±0.05</td>
</tr>
<tr>
<td>D₂</td>
<td>1.55±0.05</td>
<td>1.55±0.05</td>
</tr>
<tr>
<td>T</td>
<td>0.1±0.5</td>
<td>0.1±0.5</td>
</tr>
<tr>
<td>t</td>
<td>0.1±0.5</td>
<td>0.1±0.5</td>
</tr>
</tbody>
</table>

**Reel Specification**  RG, RGH, RM series

Label location
Reliability test: 10,000Hr<0.1%

**RG, RM Process**

- **Sputtering**
- **Electrode & Resistance Forming**
- **Annealing**
- **Coating (Non-Organic)**
- **Trimming**
  - In-Organic formation process
  - YAG laser energy passes through the protective layer
- **Coating**
  - Black color coating for pick & place purpose
- **Marking**
- **Side Electrode Forming**
- **Inspection**
- **Products (Tape & Reel)**

**After Resistance and Electrode Pattern Forming**

![Image of electrode pattern]

**Trimming**

At trimming, resistance film becomes adjusted to target value by influence of insulated film which is transformed by heat energy of laser. Resistance before trimming is designed as lower than target value (approx. 80% to 85%).

**Resin Coat**

Epoxy resin is screen-painted onto glass inorganic film.

**Marking**

Direction mark, part number etc. are screen printed.

**Products (Tape & Reel)**
STANDARD RESISTANCE VALUES

Please refer to the following table of the standard E-Series application for resistors.

<table>
<thead>
<tr>
<th>SERIES</th>
<th>SIGNIFICANT FIGURES</th>
</tr>
</thead>
<tbody>
<tr>
<td>E-6</td>
<td>1.00 1.50 2.20 3.30 4.70 6.80</td>
</tr>
<tr>
<td>E-12</td>
<td>1.00 1.20 1.50 1.80 2.20 2.70 3.30 3.90 4.70 5.60 6.80 8.20</td>
</tr>
<tr>
<td>E-24</td>
<td>1.00 1.10 1.20 1.30 1.50 1.60 1.80 2.00 2.20 2.40 2.70 3.00 3.30 3.60 3.90</td>
</tr>
<tr>
<td></td>
<td>4.30 4.70 5.10 5.60 6.20 6.80 7.50 8.20 9.10</td>
</tr>
<tr>
<td>E-96</td>
<td>1.00 1.02 1.05 1.07 1.10 1.13 1.15 1.18 1.21 1.24 1.27 1.30 1.33 1.37 1.40</td>
</tr>
<tr>
<td></td>
<td>1.43 1.47 1.50 1.54 1.58 1.62 1.65 1.68 1.74 1.78 1.82 1.87 1.91 1.96 2.00</td>
</tr>
<tr>
<td></td>
<td>2.05 2.10 2.15 2.21 2.26 2.32 2.37 2.43 2.49 2.55 2.61 2.67 2.74 2.80 2.87</td>
</tr>
<tr>
<td></td>
<td>2.94 3.01 3.09 3.16 3.24 3.32 3.40 3.48 3.57 3.65 3.74 3.83 3.92 4.02 4.12</td>
</tr>
<tr>
<td></td>
<td>4.22 4.32 4.42 4.53 4.64 4.75 4.87 4.99 5.11 5.23 5.36 5.49 5.62 5.76 5.90</td>
</tr>
<tr>
<td></td>
<td>6.04 6.19 6.34 6.49 6.65 6.81 6.98 7.15 7.32 7.50 7.68 7.87 8.06 8.25 8.45</td>
</tr>
<tr>
<td></td>
<td>8.66 8.87 9.09 9.31 9.53 9.76</td>
</tr>
</tbody>
</table>

Preferred value of resistance shall be composed by significant figures shown in the above table and multipliers including x10, x100, x1000, x10,000, and x100,000.

- Specifications in this catalogue are subject to change for future improvement without prior notice.
- The Susumu World Group companies, including Susumu Company Ltd., Thin Film Technology Corporation, Yokohama Densi Seiko Company, Ltd., and Cyntec Company Ltd., do not recommend the use of their products in any life support applications where failure or malfunction of the product can or may cause failure of a life support device or system, or effect in any manner its safety or effectiveness. Should the customer use a product in a life support application then, in that event, the Susumu World Group companies disclaim any and all express or implied warranties as to fitness for any particular purpose or as to merchantability.

Caution for mounting the product:

- Please be careful not to scratch the protection coating while (pre/after) mounting. Any scratches may lead to the deterioration on durability against moisture.
- When soldering by soldering iron, heating should be done on a land as short time as possible (less than 3 seconds under 350°C) to prevent damage. Also, if soldering is done at high temperature, please do soldering as short time as possible (less than 3 seconds under 350°C) to prevent damage. If activating flux, such as chlorine related one, is used, please check its characteristics before using it.
- Remaining flux may lead to deterioration of durability against moisture due to corrosion and occurrence of electrolyte. Specially, if high activating flux, such as chrome related one, is used, please check its characteristics before using it.
- Adherence and remaining of ionized impurity also may lead to deterioration of durability against moisture due to corrosion and occurrence of electrolyte. Please be careful of not to touch the components with sweaty bare hand pre/after mounting.
- High temperature and long soldering may cause the poor soldering on electrode.
- In case of placing resistors in resin after mounting, please pay special attention to the selection for it. It is recommended to check durability against heat and moisture, good shock absorption, and not-containing ionized impurity.

Environment and conditions of usage:

- Usage and conditions under special environment, it is recommended to confirm the specification and reliability of products. Below conditions are considered as special environments.
  - Places where products are immersed in such liquids as water, salt water, oil, acid, and an organic solvent. Or, there is possibility of splash of these liquids.
  - Direct sunlight, exposure at outdoor, and dusty environment.
  - A place where condensation is expected.
  - A place where the exposure to toxic gas (sea breeze, HCl, Cl2, SO2, H2S, NH3, NOx, etc.) is expected.
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  - A place where condensation is expected.
  - A place where the exposure to toxic gas (sea breeze, HCl, Cl2, SO2, H2S, NH3, NOx, etc.) is expected.

- When using the product under high temperature and high humidity, including generation of heat under consideration, please derate the maximum load in accordance with the derating curve stated on the specification.
  - When conducting in high moisture environment or the state of condensation, it may lead to the increase in resistance value or break.

- Dissipation, Pulse loading
  - Please use the product under rated power. Also please set the maximum voltage under rated voltage upon pulse loading.

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