


|  |               |      |            |
|--|---------------|------|------------|
| <br>毫欧电阻 毫欧制造 | HoCSRV 晶圆电阻系列 | 系列号  | HoCSRV     |
|  |               | 修订日期 | 2022-12-21 |
|  |               | 版本号  | Ho-A0      |

# 规格书 Specification

制造商: 深圳市毫欧电子有限公司

适用: 本规格书适用于深圳市毫欧电子有限公司高精度晶圆电阻HoCSRV系列产品选型。

## Features

- AEC-Q200 Compliance
- Thin film technology
- Excellent overall stability
- Sn termination on Ni barrier layer
- Tight tolerance down to  $\pm 0.1\%$
- Extremely low TCR down to  $\pm 5 \text{ ppm}/^\circ\text{C}$
- High power rating up to 1 Watts
- SMD enabled structure
- Lead-free and RoHS compliant



## Applications

- Automotive (non-safety parts)
- Industrial
- Telecommunication
- Medical Equipment
- Measurement/Testing Equipment

## Part Numbering

**HoCSRV0204-1/4W-1KR-0.5%-TCR50**

| Ho            | CSRV         | 0204  | 1/4W  | 1KR  | 0.5%   | TCR50   |
|---------------|--------------|---|---|--|--|---|
| manufacturers | Product Type | encapsulation                                   | Rated power   | resistance   | precision  | TCR (PPM/ $^\circ\text{C}$ )  |
| 毫欧电子          | CSRV         | 0102: 2.2x1.1<br>0204: 3.5x1.4<br>0207: 5.9x2.2 | T: 1W<br>U: 1/2W<br>V: 1/4W<br>G: 2/5W<br>P: 1/5W<br>W: 1/8W<br>L: 0.3W | 0010: 1 $\Omega$<br>0100: 10 $\Omega$<br>2201: 2200 $\Omega$<br>1001: 1K $\Omega$<br>1004: 1M $\Omega$<br>R050: 0.05 $\Omega$<br>22R1: 22.1 $\Omega$<br>R0R0: 0 $\Omega$ | B: $\pm 0.1\%$<br>C: $\pm 0.25\%$<br>D: $\pm 0.5\%$<br>F: $\pm 1\%$<br>J: $\pm 5\%$<br>or Jumper | S: $\pm 5$<br>B: $\pm 10$<br>N: $\pm 15$<br>C: $\pm 25$<br>D: $\pm 50$<br>E: $\pm 100$<br>-: Jumper |

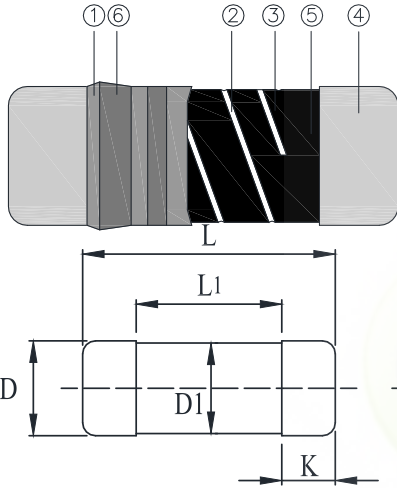


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TECHNICAL SPECIFICATIONS

| DESCRIPTION   | CSRV0102                                       |            |      | CSRV0204  |            | CSRV0207       |            |
|---|--|------------|------|---|------------|----------------|------------|
| Resistance range  | 1Ω-1MΩ; 0Ω                                     |            |      | 0.1Ω-3.4MΩ; 0Ω  |            | 0.1Ω-3.4MΩ; 0Ω |            |
| Resistance tolerance  | ±5%;±1%;±0.5%;±0.25%;±0.1%                     |            |      |   |            |                |            |
| Temperature coefficient   | ±100ppm/°C; ±50ppm/°C;<br>±25ppm/°C; ±15ppm/°C |            |      | ±100ppm/°C; ±50ppm/°C; ±25ppm/°C;<br>±15ppm/°C; ±10ppm/°C; ±5ppm/°C |            |                |            |
| Operation mode  | Standard                                       | High power |      | Standard  | High power | Standard       | High power |
| Power rating P <sub>70</sub>  | 1/8W   | 1/5W       | 0.3W | 1/4W  | 2/5W       | 1/2W           | 1W         |
| Operating voltage U <sub>max.</sub>   | 150V   | 200V       | 200V | 200V  | 200V       | 300V           | 350V       |
| Operating temperature range   | -55°C~155°C                                    |            |      |   |            |                |            |
| Max. resistance change at P70 for resistance range, ΔR/R max., after 1000 h | ≤0.5%  |            |      | ≤0.5%   |            | ≤0.5%          |            |

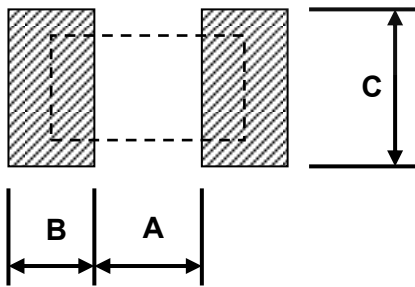
Construction & Dimension



|                      |                  |
|----------------------|------------------|
| ① Insulation Coating | ④ Electrode Cap  |
| ② Trimming Line      | ⑤ Resistor Layer |
| ③ Ceramic Rod        | ⑥ Marking        |

| Type     | L (mm)    | L <sub>1 min.</sub> (mm) | ΦD (mm)   | ΦD <sub>1</sub> (mm) | K (mm)    | Weight 1,000EA (g) |
|----------|-----------|--------------------------|-----------|----------------------|-----------|--------------------|
| CSRV0102 | 2.20±0.10 | 1.1                      | 1.10±0.10 | D +0/-0.15           | 0.45±0.05 | 7.7                |
| CSRV0204 | 3.50±0.2  | 1.7                      | 1.40±0.15 | D +0/-0.2            | 0.8±0.1   | 18.7               |
| CSRV0207 | 5.90±0.2  | 2.9                      | 2.20±0.20 | D +0/-0.2            | 1.3±0.1   | 80.9               |

Recommend Land Pattern



| Type     | A (mm) | B (mm) | C (mm) |
|----------|--------|--------|--------|
| CSRV0102 | 1.0    | 0.8    | 1.5    |
| CSRV0204 | 1.6    | 1.2    | 1.6    |
| CSRV0207 | 3.0    | 1.7    | 2.4    |

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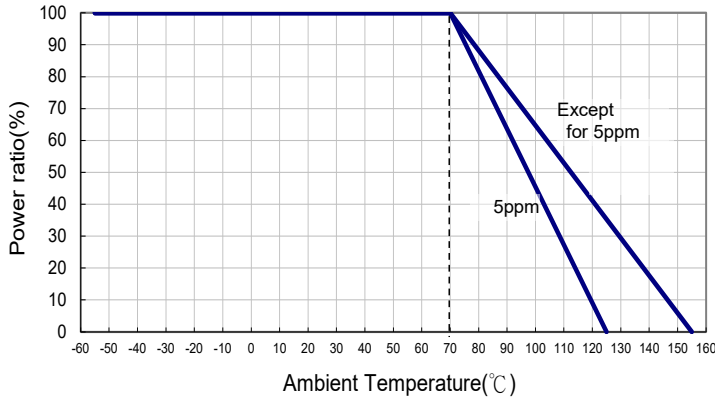


毫欧电阻 毫欧制造

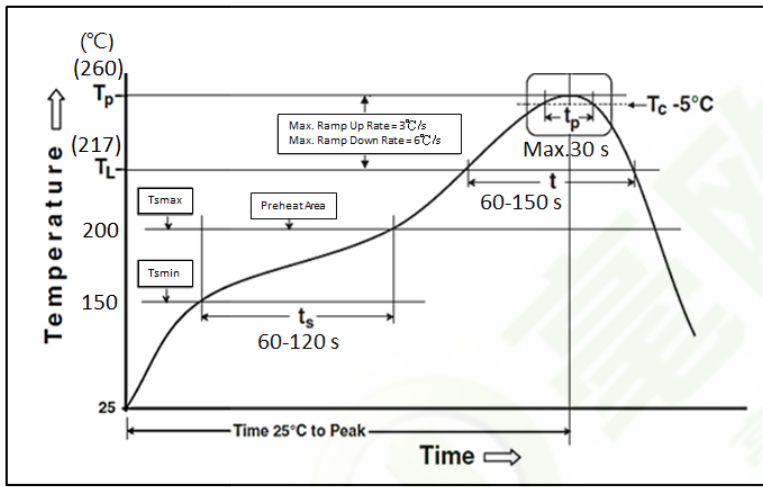
# HoCSRV 晶圆电阻系列

|      |            |
|------|------------|
| 系列号  | HoCSRV     |
| 修订日期 | 2022-12-21 |
| 版本号  | Ho-A0      |

## Derating Curve




## Soldering Condition (IPC/JEDEC J-STD-020)



## Standard Electrical Specifications

| Item<br>Type | Power Rating<br>at 70°C | Operating Temp.<br>Range | Max.<br>Operating<br>Voltage | Max.<br>Overload<br>Voltage | Resistance Range |             |             |     |     | TCR<br>(PPM/°C) |     |
|--------------|-------------------------|--------------------------|------------------------------|-----------------------------|------------------|-------------|-------------|-----|-----|-----------------|-----|
|              |                         |                          |                              |                             | ±0.1%            | ±0.25%      | ±0.5%       | ±1% | ±5% |                 |     |
| 0102         | 1/8W                    | -55 ~ +155°C             | 150V                         | 300V                        | 100Ω-56KΩ        |             |             |     |     | -               | ±15 |
|              |                         |                          |                              |                             | 100Ω-82KΩ        | 49.9Ω-200KΩ | 49.9Ω-390KΩ | -   | ±25 |                 |     |
|              |                         |                          |                              |                             | -                | 1Ω-1MΩ      |             |     |     | ±50             |     |
|              |                         |                          |                              |                             | -                | 1Ω-1MΩ      |             |     |     | ±100            |     |
| 0204         | 1/4W                    | -55 ~ +125°C             | 200V                         | 400V                        | 10Ω-332KΩ        |             | -           |     |     | ±5              |     |
|              |                         |                          |                              |                             | 49.9Ω-20KΩ       |             |             |     |     | -               | ±10 |
|              |                         | -55 ~ +155°C             | 200V                         | 400V                        | 10Ω-300KΩ        |             | -           |     |     | ±15             |     |
|              |                         |                          |                              |                             | 10Ω-1MΩ          | 10Ω-3.4MΩ   | 1Ω-3.4MΩ    |     | ±25 |                 |     |
|              |                         |                          |                              |                             | 10Ω-1MΩ          | 1Ω-3.4MΩ    | 0.2Ω-3.4MΩ  |     | ±50 |                 |     |
| -            | 0.1Ω-3.4MΩ              |                          |                              |                             | ±100             |             |             |     |     |                 |     |
| 0207         | 1/2W                    | -55 ~ +125°C             | 300V                         | 600V                        | 10Ω-332KΩ        |             | -           |     |     | ±5              |     |
|              |                         |                          |                              |                             | 49.9Ω-20KΩ       |             |             |     |     | -               | ±10 |
|              |                         | -55 ~ +155°C             | 300V                         | 600V                        | 10Ω-300KΩ        |             | -           |     |     | ±15             |     |
|              |                         |                          |                              |                             | 10Ω-1MΩ          | 10Ω-3.4MΩ   | 1Ω-3.4MΩ    |     | ±25 |                 |     |
|              |                         |                          |                              |                             | 10Ω-1MΩ          | 1Ω-3.4MΩ    | 0.2Ω-3.4MΩ  |     | ±50 |                 |     |
| -            | 0.1Ω-3.4MΩ              |                          |                              |                             | ±100             |             |             |     |     |                 |     |

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| <br>毫欧电阻 毫欧制造 | HoCSRV 晶圆电阻系列 | 系列号  | HoCSRV     |
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### High Power Rating Electrical Specifications

| Item Type | Power Rating at 70 °C | Operating Temp. Range | Max. Operating Voltage | Max. Overload Voltage | Resistance Range |             |             |            |      | TCR (PPM/°C) |     |
|-----------|-----------------------|-----------------------|------------------------|-----------------------|------------------|-------------|-------------|------------|------|--------------|-----|
|           |                       |                       |                        |                       | ±0.1%            | ±0.25%      | ±0.5%       | ±1%        | ±5%  |              |     |
| 0102      | 1/5W                  | -55 ~ +155°C          | 200V                   | 400V                  | 100Ω-56KΩ        |             |             |            |      | -            | ±15 |
|           |                       |                       |                        |                       | 100Ω-82KΩ        | 49.9Ω-200KΩ | 49.9Ω-390KΩ |            |      | -            | ±25 |
|           | -                     |                       |                        |                       | 1Ω-1MΩ           |             |             |            |      | ±50          |     |
|           | -                     |                       |                        |                       | 1Ω-1MΩ           |             |             |            | ±100 |              |     |
| 0204      | 2/5W                  | -55 ~ +125°C          | 200V                   | 400V                  | 10Ω-332KΩ        |             |             |            | -    | ±5           |     |
|           |                       | -55 ~ +155°C          | 200V                   | 400V                  | 49.9Ω-20KΩ       |             |             |            |      | -            | ±10 |
|           |                       |                       |                        |                       | 10Ω-300KΩ        |             |             |            |      | -            | ±15 |
|           |                       |                       |                        |                       | 10Ω-1MΩ          | 10Ω-3.4MΩ   | 1Ω-3.4MΩ    |            | ±25  |              |     |
|           |                       |                       |                        |                       | 10Ω-1MΩ          | 1Ω-3.4MΩ    | 0.2Ω-3.4MΩ  |            | ±50  |              |     |
|           |                       |                       |                        |                       | -                |             |             | 0.1Ω-3.4MΩ |      | ±100         |     |
| 0207      | 1W                    | -55 ~ +125°C          | 350V                   | 700V                  | 10Ω-332KΩ        |             |             |            | -    | ±5           |     |
|           |                       | -55 ~ +155°C          | 350V                   | 700V                  | 49.9Ω-20KΩ       |             |             |            |      | -            | ±10 |
|           |                       |                       |                        |                       | 10Ω-300KΩ        |             |             |            |      | -            | ±15 |
|           |                       |                       |                        |                       | 10Ω-1MΩ          | 10Ω-3.4MΩ   | 1Ω-3.4MΩ    |            | ±25  |              |     |
|           |                       |                       |                        |                       | 10Ω-1MΩ          | 1Ω-3.4MΩ    | 0.2Ω-3.4MΩ  |            | ±50  |              |     |
|           |                       |                       |                        |                       | -                |             |             | 0.1Ω-3.4MΩ |      | ±100         |     |

Operating Voltage= $\sqrt{P \cdot R}$  or Max. Operating Voltage listed above, whichever is lower.


Overload Voltage= $2.5 \cdot \sqrt{P \cdot R}$  or Max. Overload Voltage listed above, whichever is lower.

RCWV(Rated Continuous Working Voltage)= $\sqrt{P \cdot R}$  or Max. Operating Voltage whichever is lower.

### Jumper Specifications

| Item Type | Power Rating | Operating Temp. Range | Resistance | Rated Current |           |
|-----------|--------------|-----------------------|------------|---------------|-----------|
| CSRV0102  | 1/8W         | -55 ~ +155°C          | 0Ω(<15mΩ)  | 2A            |           |
|           | 1/5W         |                       |            |               |           |
|           | 0.3W         |                       |            |               |           |
| CSRV0204  | 1/4W         | -55 ~ +155°C          |            | 0Ω(<15mΩ)     | 3A        |
|           | 2/5W         |                       |            |               |           |
| CSRV0207  | 1/2W         | -55 ~ +155°C          |            |               | 0Ω(<15mΩ) |
|           | 1W           |                       |            |               |           |


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| <br>毫欧电阻 毫欧制造 | HoCSRV晶圆电阻系列 | 系列号  | HoCSRV     |
|  |              | 修订日期 | 2022-12-21 |
|  |              | 版本号  | Ho-A0      |

## ■ Environmental Characteristics

| Item   | Requirement   |        | Test Method  |
|--|---|--------|--|
|  | 5% and Below  | Jumper |  |
| Temperature Coefficient of Resistance (T.C.R.) | As Spec   |        | <b>JIS-C-5201-1 4.8</b><br><b>IEC-60115-1 4.8</b><br>At 25°C/-55°C and 25°C/+125°C, 25°C is the reference temperature<br>5ppm: At 25°C/-10°C and 25°C/+85°C, 25°C is the reference temperature                 |
| Short Time Overload                            | 10Ω-270KΩ: $\pm(0.1\%+0.01\Omega)$<br><10Ω & >270KΩ: $\pm(0.15\%+0.01\Omega)$<br>0102: $\pm(0.15\%+0.01\Omega)$<br>5ppm: $\pm(0.05\%+0.01\Omega)$ | <15mΩ  | <b>JIS-C-5201-1 4.13</b><br><b>IEC-60115-1 4.13</b><br>RCWV*2.5 or Max. Overload Voltage whichever is lower for 5 seconds  |
| Insulation Resistance                          | ≥10G  |        | <b>JIS-C-5201-1 4.6</b><br><b>IEC-60115-1 4.6</b><br>Max. Overload Voltage for 1 minute  |
| Operational Life                               | 10Ω-270KΩ: $\pm(0.25\%+0.01\Omega)$<br><10Ω & >270KΩ: $\pm(0.5\%+0.01\Omega)$<br>0102: $\pm(0.5\%+0.01\Omega)$                                    | <15mΩ  | <b>MIL-STD-202 Method 108</b><br>Condition D Steady State TA=125°C at derated power.<br>Measurement at 24±4 hours after test conclusion.<br>5ppm: 70±2°C, RCWV for 1000 hrs with 1.5 hrs "ON" and 0.5 hr "OFF" |
| Biased Humidity                                | 10Ω-270KΩ: $\pm(0.5\%+0.01\Omega)$<br><10Ω & >270KΩ: $\pm(1\%+0.01\Omega)$<br>0102: $\pm(2\%+0.01\Omega)$   | <15mΩ  | <b>MIL-STD-202 Method 103</b><br>1000 hrs 85°C/85%RH 10% of operating power.<br>(≤ 100 V)  |
| High Temperature Exposure                      | 10Ω-270KΩ: $\pm(0.25\%+0.01\Omega)$<br><10Ω & >270KΩ: $\pm(1\%+0.01\Omega)$<br>0102: $\pm(1\%+0.01\Omega)$  | <15mΩ  | <b>MIL-STD-202 Method 108</b><br>at +125°C/+155°C for 1000 hrs   |
| Board Flex                                     | 10Ω-270KΩ: $\pm(0.1\%+0.01\Omega)$<br><10Ω & >270KΩ: $\pm(0.5\%+0.01\Omega)$<br>0102: $\pm(0.5\%+0.01\Omega)$                                     | <15mΩ  | <b>AEC-Q200-005</b><br>Bending once for 60 seconds with 2mm  |
| Solderability                                  | 95% min. coverage   |        | <b>JIS-C-5201-1 4.17</b><br><b>IEC-60115-1 4.17</b><br><b>J-STD-002</b><br>245±5°C for 3 seconds   |
| Resistance to Soldering Heat                   | 10Ω-270KΩ: $\pm(0.1\%+0.01\Omega)$<br><10Ω & >270KΩ: $\pm(0.25\%+0.01\Omega)$<br>0102: $\pm(0.25\%+0.01\Omega)$<br>5ppm: $\pm(0.05\%+0.01\Omega)$ | <15mΩ  | <b>MIL-STD-202 Method 210</b><br>260±5°C for 10 seconds  |

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| <br>毫欧电阻 毫欧制造 | <b>HoCSRV晶圆电阻系列</b> | 系列号  | HoCSRV     |
|  |                     | 修订日期 | 2022-12-21 |
|  |                     | 版本号  | Ho-A0      |

| Item                   | Requirement   |               | Test Method   |
|------------------------|---|---------------|---|
|                        | 5% and Below  | Jumper        |   |
| Voltage Proof          | No breakdown or flashover   |               | <b>JIS-C-5201-1 4.7</b><br><b>IEC-60115-1 4.7</b><br>1.42 times Max. Operating Voltage for 1 minute                                 |
| Leaching               | Individual leaching area $\leq 5\%$<br>Total leaching area $\leq 10\%$  |               | <b>JIS-C-5201-1 4.18</b><br><b>IEC-60068-2-58 8.2.1</b><br>260 $\pm$ 5°C for 30 seconds   |
| Temperature Cycling    | 10 $\Omega$ -270K $\Omega$ : $\pm(0.25\%+0.01\Omega)$<br><10 $\Omega$ & >270K $\Omega$ : $\pm(0.5\%+0.01\Omega)$<br>0102: $\pm(1\%+0.01\Omega)$ | <15m $\Omega$ | <b>JESD22 Method JA-104</b><br>-55°C to +125°C, 1000 cycles   |
| Mechanical Shock       | $\pm(0.25\%+0.01\Omega)$  | <15m $\Omega$ | <b>MIL-STD-202 Method 213</b><br>Wave Form: Tolerance for half sine shock pulse.<br>Peak value is 100g's. Normal duration (D) is 6. |
| Vibration              | $\pm(0.5\%+0.01\Omega)$   | <15m $\Omega$ | <b>MIL-STD-202 Method 204</b><br>5 g's for 20 min., 12 cycles each of 3 orientations,<br>10-2000 Hz                                 |
| ESD                    | $\pm(0.5\%+0.01\Omega)$   | <15m $\Omega$ | <b>AEC-Q200-002</b><br>Human body, 0102/0204:2KV; 0207:4KV  |
| Resistance to Solvents | No visible damage on appearance and marking.  |               | <b>MIL-STD-202 Method 215</b><br>Add Aqueous wash chemical - OKEM Clean or equivalent. Do not use banned solvents.                  |
| Terminal Strength      | No broken   |               | <b>AEC-Q200-006</b><br>Force of 1.8kg for 60 seconds.   |
| Flammability           | No ignition of the tissue paper or scorching or the pinewood board  |               | <b>UL-94</b><br>V-0 or V-1 are acceptable. Electrical test not required.  |

RCWV(Rated Continuous Working Voltage)= $\sqrt{P \cdot R}$  or Max. Operating Voltage whichever is lower.

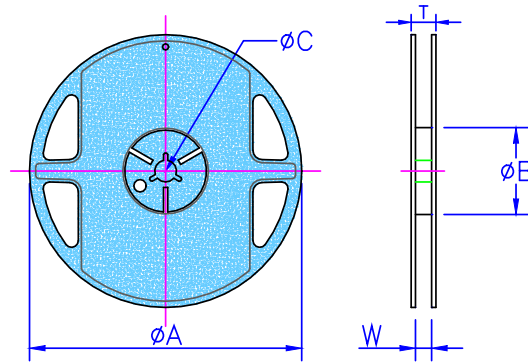
■ **Storage Temperature: 15~28°C; Humidity < 80%RH**

■ **Shelf Life: 2 years from production date.**

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深圳市毫欧电子有限公司 | 电话：0755-2 8153 546 | 传真：0755-22 6301 81 | 网址：www.moolee.com.cn

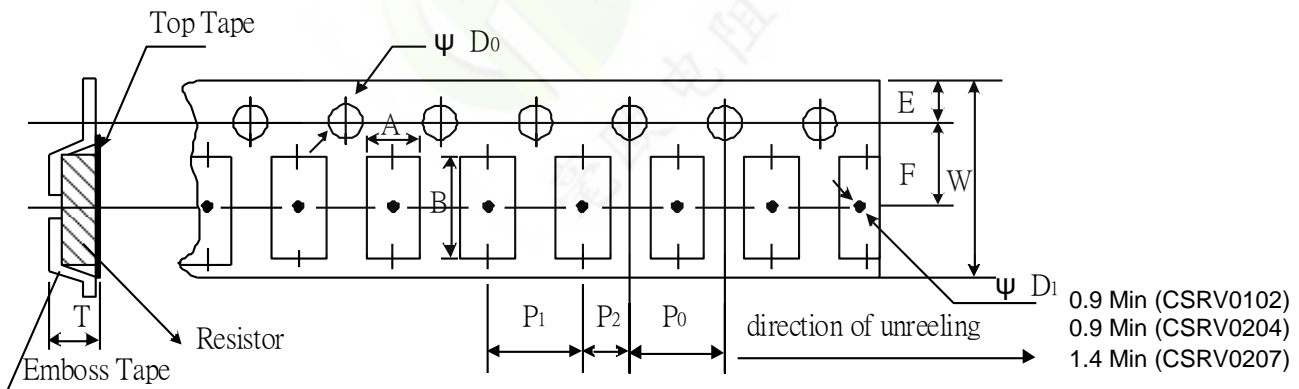
## ■ Packaging



### Packaging Quantity & Reel Specifications

| Type     | Reel Diameter | ΦA (mm)   | ΦB (mm)  | ΦC (mm)  | W (mm)   | T (mm)   | Emboss Plastic Tape (EA) |
|----------|---------------|-----------|----------|----------|----------|----------|--------------------------|
| CSRV0102 | 7 inch        | 178.5±1.5 | 60.0+1.0 | 13.0±0.2 | 9.0±0.5  | 12.5±0.5 | 3,000                    |
|          | 13 inch       | 330±1.0   | 100±0.5  | 13.0±0.2 | 9.5±0.5  | 13.5±0.5 | 10,000                   |
| CSRV0204 | 7 inch        | 178.5±1.5 | 60.0+1.0 | 13.0±0.2 | 9.0±0.5  | 12.5±0.5 | 3,000                    |
|          | 13 inch       | 330±1.0   | 100±0.5  | 13.0±0.2 | 9.5±0.5  | 13.5±0.5 | 10,000                   |
| CSRV0207 | 7 inch        | 178.5±1.5 | 60.0+1.0 | 13.0±0.5 | 13.0±0.5 | 15.5±0.5 | 2,000                    |
|          | 13 inch       | 330±1.0   | 99±0.5   | 13.5±0.5 | 13.4±1   | 17.8±1   | 6,000                    |

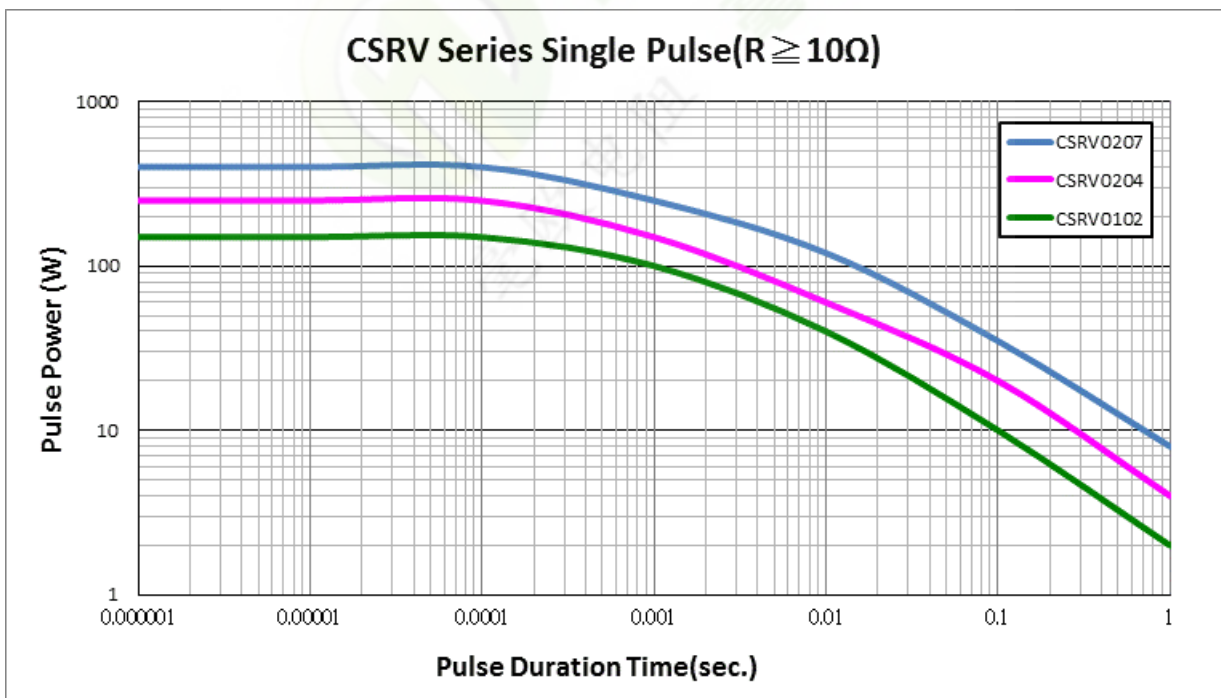
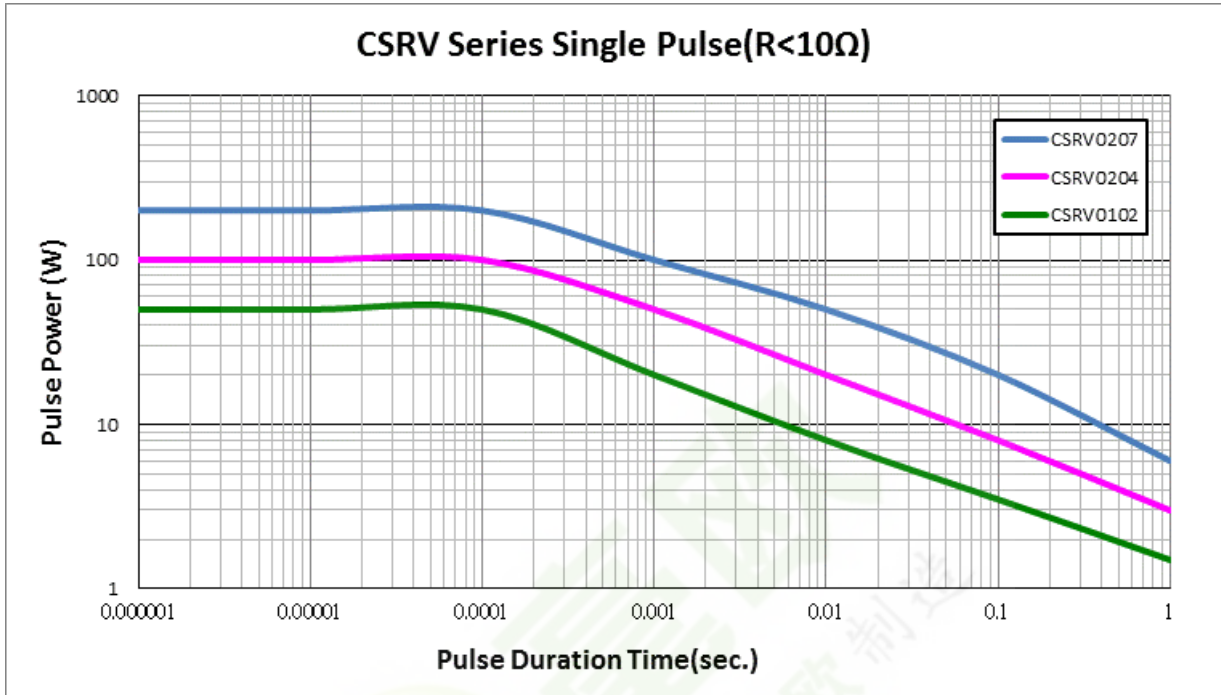
### Emboss Plastic Tape Specifications



| Type     | A (mm)    | B (mm)    | W (mm)    | E (mm)    | F (mm)    | P <sub>0</sub> (mm) | P <sub>1</sub> (mm) | P <sub>2</sub> (mm) | ΦD <sub>0</sub> (mm) | T (mm)    |
|----------|-----------|-----------|-----------|-----------|-----------|---------------------|---------------------|---------------------|----------------------|-----------|
| CSRV0102 | 1.30±0.20 | 2.40±0.20 | 8.0±0.10  | 1.75±0.10 | 3.50±0.05 | 4.00±0.10           | 4.00±0.10           | 2.00±0.05           | 1.50+0.10            | 1.50±0.10 |
| CSRV0204 | 1.55±0.20 | 3.65±0.20 | 8.0±0.10  | 1.75±0.10 | 3.50±0.05 | 4.00±0.10           | 4.00±0.10           | 2.00±0.05           | 1.50+0.10            | 1.80±0.10 |
| CSRV0207 | 2.40±0.10 | 6.15±0.10 | 12.0±0.10 | 1.75±0.10 | 5.50±0.05 | 4.00±0.10           | 4.00±0.10           | 2.00±0.05           | 1.50+0.10            | 2.70±0.10 |

### ■ Pulse withstanding capacity

The single impulse graph is the result of the impulse of rectangular shape applied. The limit of acceptance was a shift in resistance of less than 1% from the initial value. The power applied was subject to the restrictions of the maximum permissible impulse voltage graph shown.

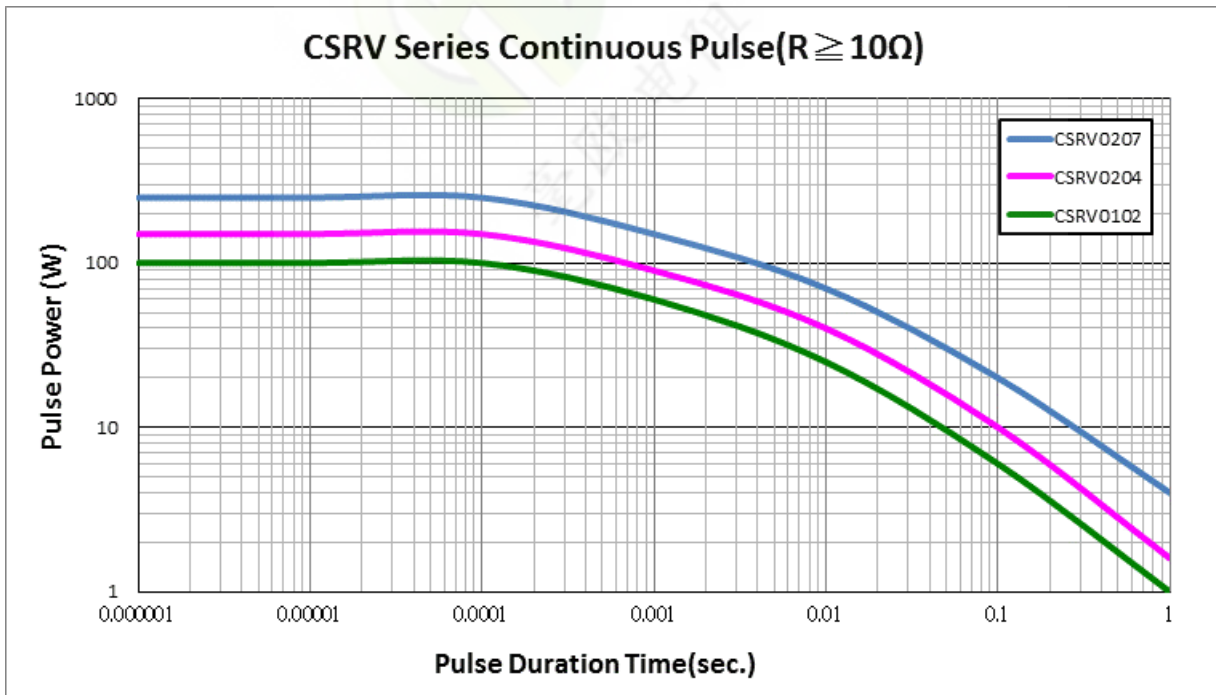
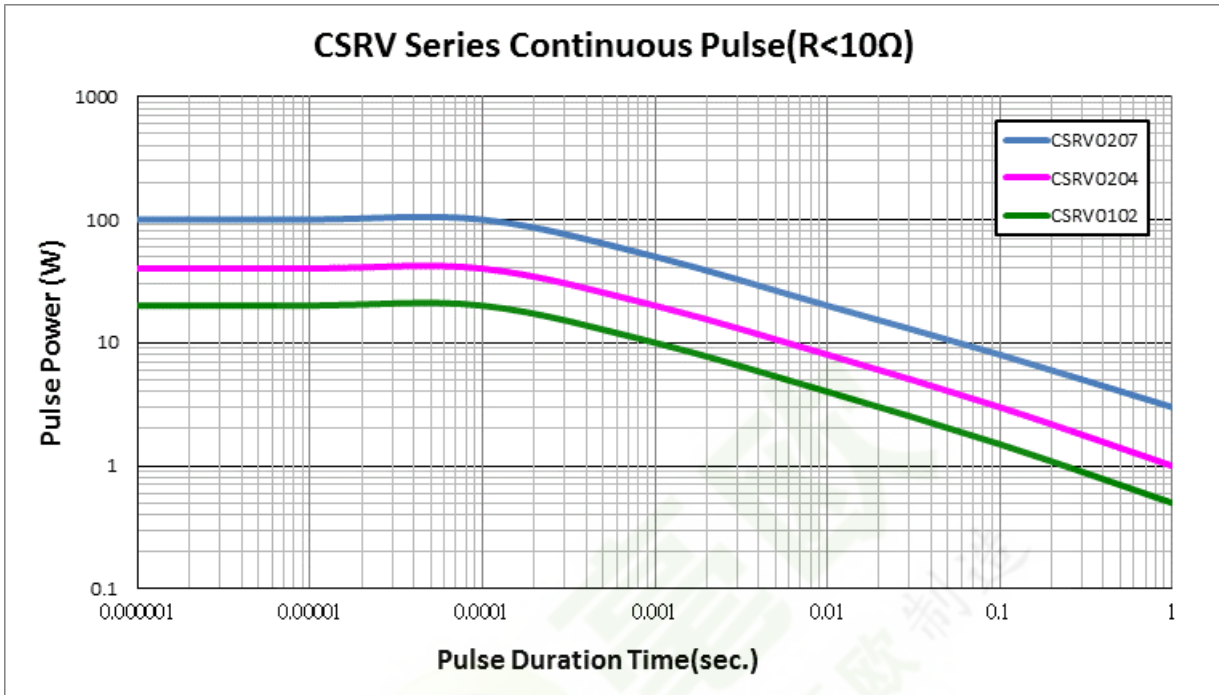




|      |            |
|------|------------|
| 系列号  | HoCSRV     |
| 修订日期 | 2022-12-21 |
| 版本号  | Ho-A0      |

## Continuous Pulse

The continuous load graph was obtained by applying repetitive rectangular pulses where the pulse period was adjusted so that the average power dissipated in the resistor was equal to its rated power at 70°C. Again the limit of acceptance was a shift in resistance of less than 1% from the initial value.



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## HoCSRV 晶圆电阻系列

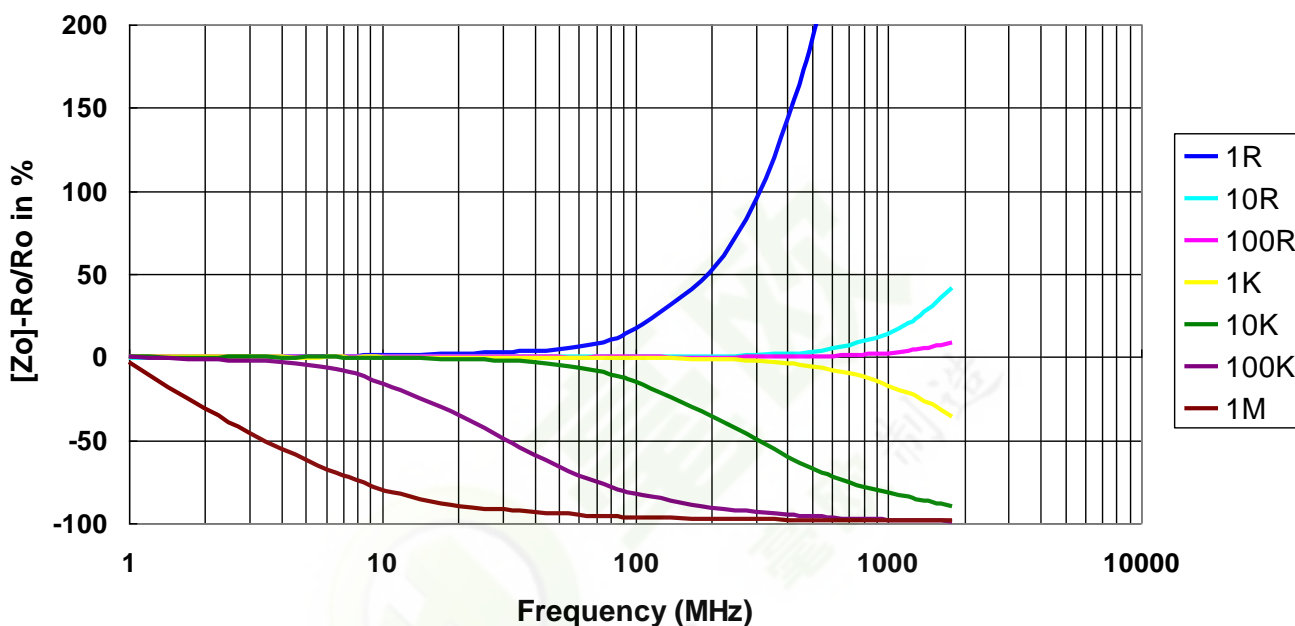
|      |            |
|------|------------|
| 系列号  | HoCSRV     |
| 修订日期 | 2022-12-21 |
| 版本号  | Ho-A0      |

### Marking & Resistance Tolerance

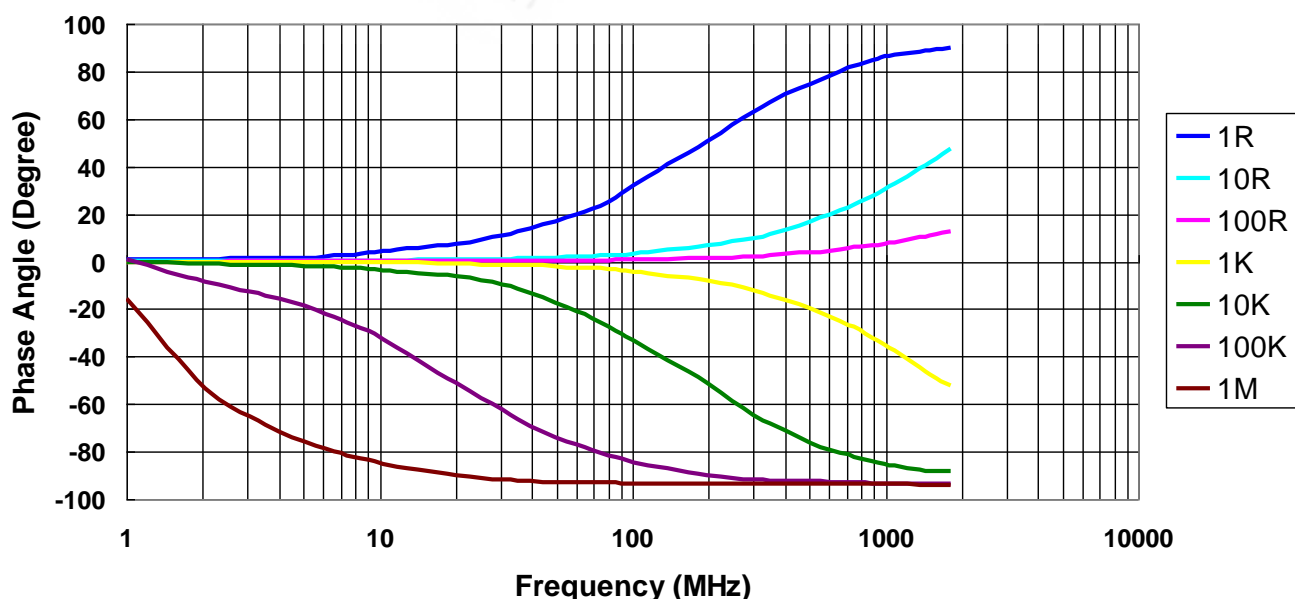
Resistors are designed to function according to ohmic laws. This is basically true of resistors for frequencies up to 100kHz. At higher frequencies, there is an additional contribution to the impedance by an ideal resistor switched in series with a coil and both switched parallel to a capacitor. The values of the capacitance and inductance are mainly determined by the dimensions of the terminations and the conductive path length.

The environment surrounding components has a large influence on the behavior of the component on the printed-circuit board.

## Frequency vs. Impedance CSRV Series (CSRV0204)



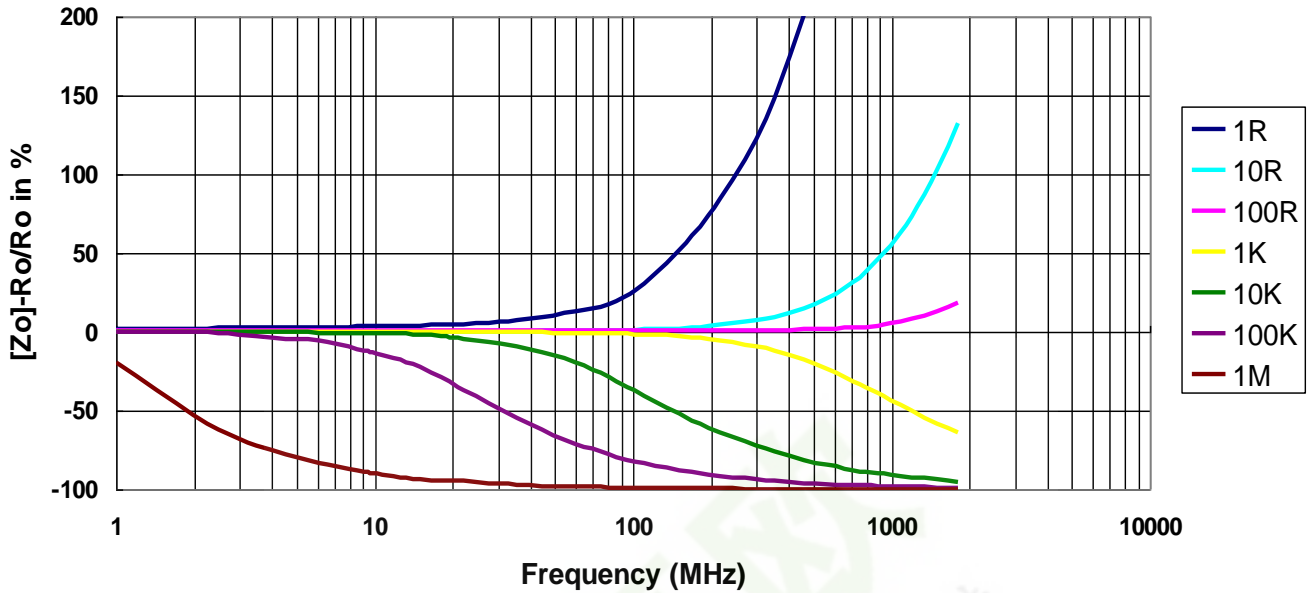
## Frequency vs. Phase Angle CSRV Series (CSRV0204)



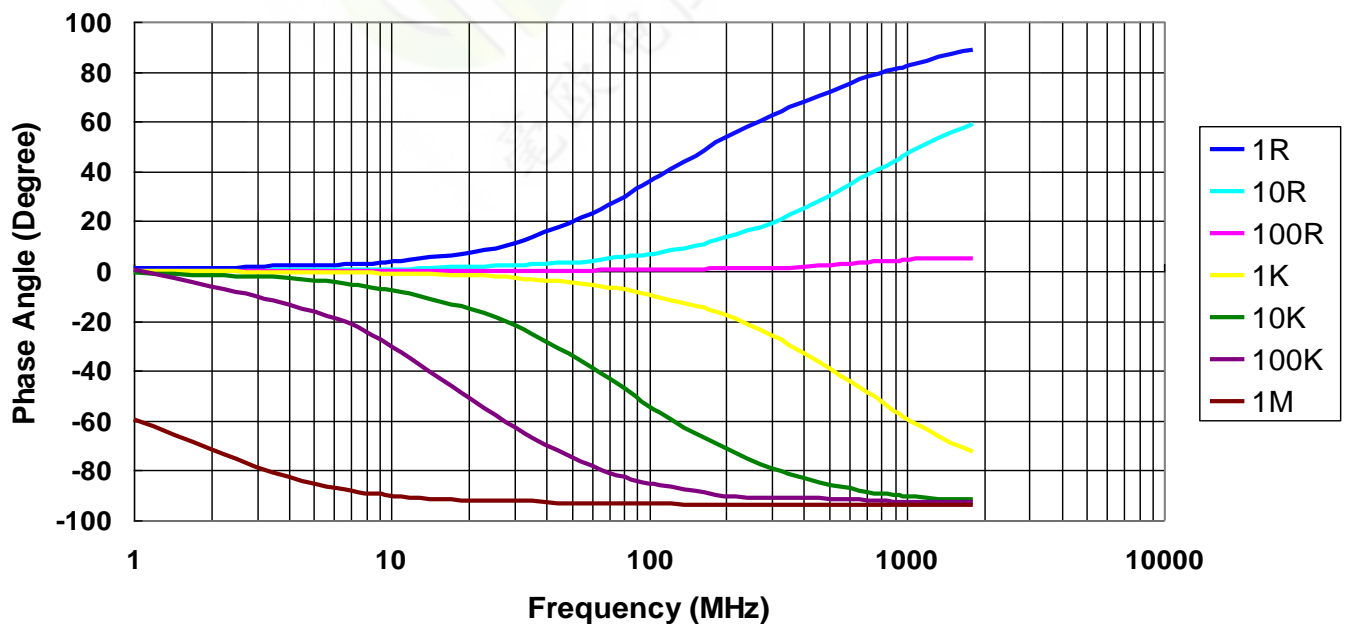
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|      |            |
|------|------------|
| 系列号  | HoCSRV     |
| 修订日期 | 2022-12-21 |
| 版本号  | Ho-A0      |

## Frequency vs. Impedance CSRV Series (CSRV0207)



## Frequency vs. Phase Angle CSRV Series (CSRV0207)



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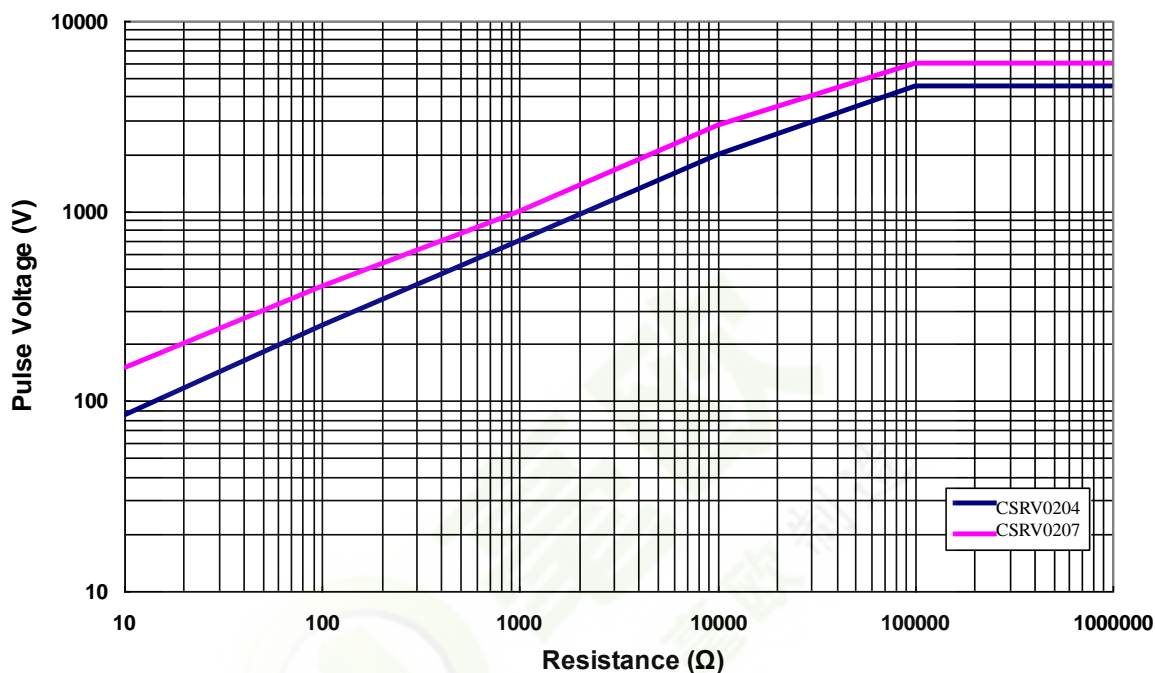
# HoCSRV 晶圆电阻系列

|      |            |
|------|------------|
| 系列号  | HoCSRV     |
| 修订日期 | 2022-12-21 |
| 版本号  | Ho-A0      |

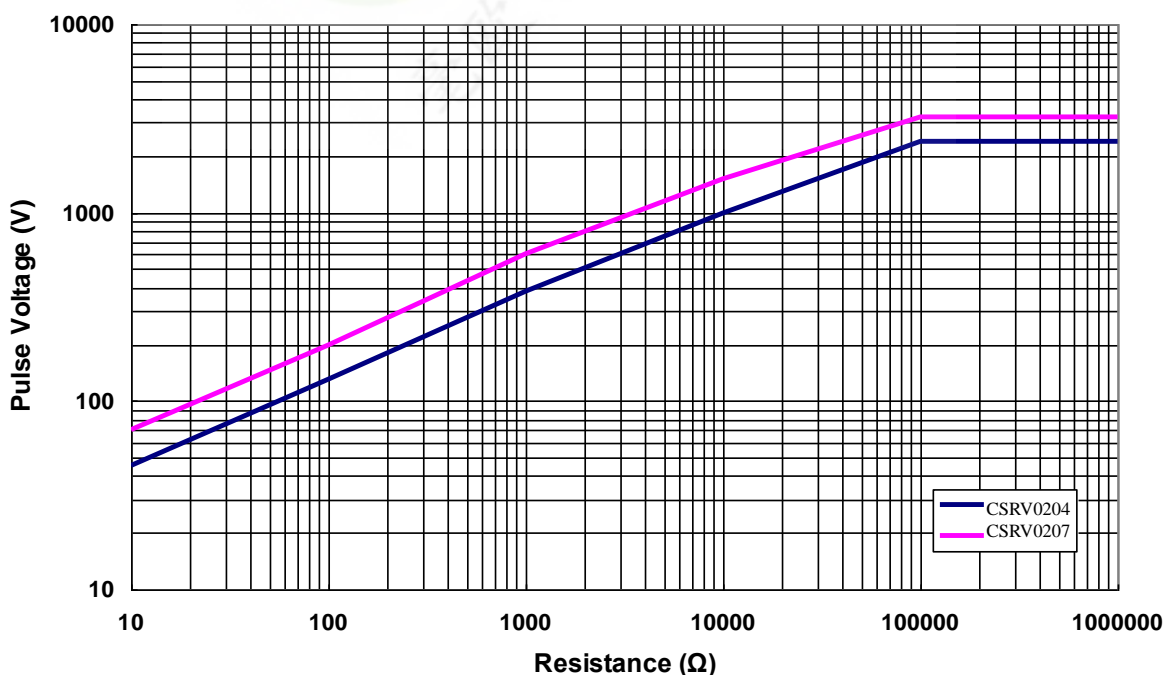
## Lightning Surge

Resistors are tested in accordance with IEC 60115-1 using both 1.2/50us and 10/700us pulse shapes. The limit of acceptance is a shift in resistance of less than 0.5% from the initial value.

### 1.2/50μs Lightning Surge

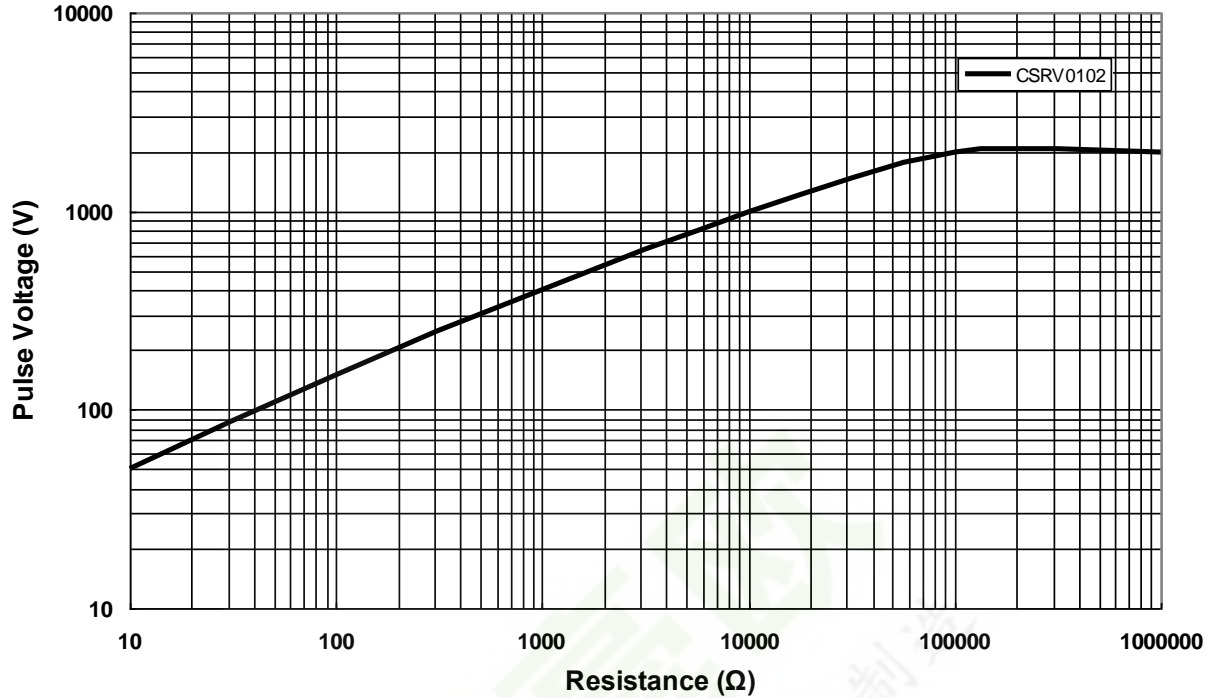


### 10/700μs Lightning Surge

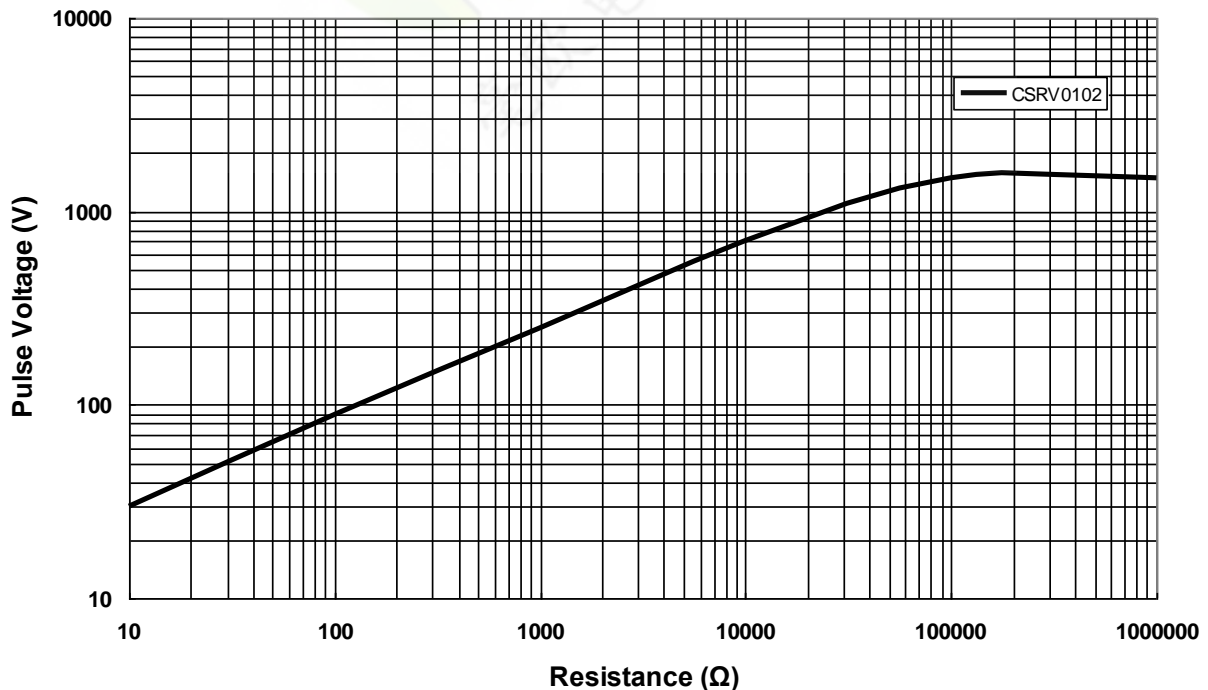


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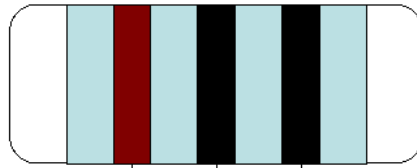
### 1.2/50 $\mu$ s Lightning Surge



### 10/700 $\mu$ s Lightning Surge

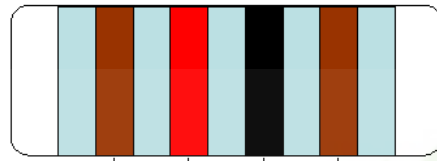


### Marking & Resistance Tolerance



1st digit      2nd digit      Multiplier

|     |      |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
|-----|------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| ±5% | E-24 | 1.0 | 1.1 | 1.2 | 1.3 | 1.5 | 1.6 | 1.8 | 2.0 | 2.2 | 2.4 | 2.7 | 3.0 | 3.3 | 3.6 | 3.9 | 4.3 | 4.7 | 5.1 | 5.6 | 6.2 | 6.8 | 7.5 | 8.2 | 9.1 |
|-----|------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|



1st digit      2nd digit      3rd digit      Multiplier

|       |       |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
|-------|-------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| ±1%   | E-96  | 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 | 1.43 | 1.47 | 1.50 | 1.54 | 1.58 | 1.62 | 1.65 | 1.69 | 1.74 |
|       |       | 1.78 | 1.82 | 1.87 | 1.91 | 1.96 | 2.00 | 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 | 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 | 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 | 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 | 8.66 | 8.87 | 9.09 | 9.31 | 9.53 | 9.76 |
| ±0.5% | E-192 | 10.0 | 10.1 | 10.2 | 10.4 | 10.5 | 10.6 | 10.7 | 10.9 | 11.0 | 11.1 | 11.3 | 11.4 | 11.5 | 11.7 | 11.8 | 12.0 | 12.1 | 12.3 | 12.4 | 12.6 | 12.7 | 12.9 | 13.0 | 13.2 |
|       |       | 13.3 | 13.5 | 13.7 | 13.8 | 14.0 | 14.2 | 14.3 | 14.5 | 14.7 | 14.9 | 15.0 | 15.2 | 15.4 | 15.6 | 15.8 | 16.0 | 16.2 | 16.4 | 16.5 | 16.7 | 16.9 | 17.2 | 17.4 | 17.6 |
|       |       | 17.8 | 18.0 | 18.2 | 18.4 | 18.7 | 18.9 | 19.1 | 19.3 | 19.6 | 19.8 | 20.0 | 20.3 | 20.5 | 20.8 | 21.0 | 21.3 | 21.5 | 21.8 | 22.1 | 22.3 | 22.6 | 22.9 | 23.2 | 23.4 |
|       |       | 23.7 | 24.0 | 24.3 | 24.6 | 24.9 | 25.2 | 25.5 | 25.8 | 26.1 | 26.4 | 26.7 | 27.1 | 27.4 | 27.7 | 28.0 | 28.4 | 28.7 | 29.1 | 29.4 | 29.8 | 30.1 | 30.5 | 30.9 | 31.2 |
|       |       | 31.6 | 32.0 | 32.4 | 32.8 | 33.2 | 33.6 | 34.0 | 34.4 | 34.8 | 35.2 | 35.7 | 36.1 | 36.5 | 37.0 | 37.4 | 37.9 | 38.3 | 38.8 | 39.2 | 39.7 | 40.2 | 40.7 | 41.2 | 41.7 |
|       |       | 42.2 | 42.7 | 43.2 | 43.7 | 44.2 | 44.8 | 45.3 | 45.9 | 46.4 | 47.0 | 47.5 | 48.1 | 48.7 | 49.3 | 49.9 | 50.5 | 51.1 | 51.7 | 52.3 | 53.0 | 53.6 | 54.2 | 54.9 | 55.6 |
|       |       | 56.2 | 56.9 | 57.6 | 58.3 | 59.0 | 59.7 | 60.4 | 61.2 | 61.9 | 62.6 | 63.4 | 64.2 | 64.9 | 65.7 | 66.5 | 67.3 | 68.1 | 69.0 | 69.8 | 70.6 | 71.5 | 72.3 | 73.2 | 74.1 |
| 75.0  | 75.9  | 76.8 | 77.7 | 78.7 | 79.6 | 80.6 | 81.6 | 82.5 | 83.5 | 84.5 | 85.6 | 86.6 | 87.6 | 88.7 | 89.8 | 90.9 | 92.0 | 93.1 | 94.2 | 95.3 | 96.5 | 97.6 | 98.8 |      |      |

| Color  | Digit | Multiplier       |
|--------|-------|------------------|
| Silver | -     | 10 <sup>-2</sup> |
| Gold   | -     | 10 <sup>-1</sup> |
| Black  | 0     | 10 <sup>0</sup>  |
| Brown  | 1     | 10 <sup>1</sup>  |
| Red    | 2     | 10 <sup>2</sup>  |
| Orange | 3     | 10 <sup>3</sup>  |
| Yellow | 4     | 10 <sup>4</sup>  |
| Green  | 5     | 10 <sup>5</sup>  |
| Blue   | 6     | 10 <sup>6</sup>  |
| Violet | 7     | 10 <sup>7</sup>  |
| Grey   | 8     | 10 <sup>8</sup>  |
| White  | 9     | 10 <sup>9</sup>  |

※ Resistance more than two significant figures (<1R) or more than three significant figures (>1R) will not provide color code.  
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