ESA SPCD 2018, THE NETHERLANDS
Vishay Precision Group (VPG) Foil Resistors

Mr. Jacob Musel, Quality Director,
VPG Foil Resistors

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Vishay Foil Resistors
VPG and VPG Foil Resistors

• VPG is a global resistive sensor technology solutions provider in mission-critical applications.

• VPG spun-off from Vishay Intertechnology in 2010.

• Approximately 2,250 VPG employees worldwide now consolidated into 8 main manufacturing facilities.

• VPG Foil Resistors division includes 3 manufacturing facilities and above 600 employees.

• Physicist Dr. Felix Zandman introduced in 1962 the Bulk Metal® Foil (BMF) technology which is still unparalleled for applications that require precision, stability and reliability.

VPG Foil Resistors

Dr. Felix Zandman
1962 - 2011
Vishay Foil Resistors - IL

- Principal plant – Vishay Foil Resistors product line located in Holon, Israel
- **ISO 9001:2015/AS9100D**
- Total employees: 452 (31-Jul-2018)
- 3 resistor models with Mil. QPL qualification
- 8 resistor families in compliance with EEE-INST-002
- 14 DLA drawings

- Above 20% of revenues from Avionics, Military and Space (AMS) market sector
**Portfolio and Roadmap VPG Foil Resistors Division**

- Extremely low TCR: 0.2 ppm/°C typical
- TCR tracking available to 0.1 ppm/°C
- Excellent load-life stability/ratio stability: ±0.002% max ΔR per MIL standard; ultra long term stability: <1 ppm/year
- Very low resistance values from 0.0005 Ω
- Any 6-digit value in the resistance range available at no additional cost with any tolerance (to 0.001%)
- High power up to 2500 W (Per special customer request)
- Rapid thermal stabilization: <1 s
- Thermal EMF: 0.05 μV/°C
- Electrostatic discharge (ESD): to at least 25 kV
- Non-inductive: < 0.08 μH
- Certification to NIST standards
- Special design to meet high temperature application requirements up to +240°C ambient temperature
Ultra-High Precision Z Foil Current Sense Resistors for Space Applications

Industry-exclusive ultra-high precision current sense resistors

- Based on Bulk Metal® Foil resistive element.
- 4 terminal Kelvin configuration for precision current sensing.
- Highly precise voltage directly proportional to measured current levels.
- Screening and testing in accordance with NASA Goddard EEE-INST-002 ((Tables 2A and 3A, Film/Foil, Level 1).

Resistor model CSM3637F (V/N 303337)

**Features**

- Resistance range: 20 mΩ to 200 mΩ (any 6 digit value)
- Resistance tolerance: to ±0.1%
- Temperature coefficient of resistance (TCR):
  - 10 ppm/°C (−55°C to +125°C, +25°C ref.)
  - For tighter TCR please contact us.
- Power rating: to 4 W at 70°C
- Load-life stability: to ±0.02% (70°C, 2000 hours at rated power)
- Short-time overload: 0.02%
- Electrostatic discharge (ESD): at least to 25kV
- Solderable terminations

Resistor model VCS1625Z (V/N 303119Z)

**Features**

- Resistance range: 0.3Ω to 10 Ω (any 6 digit value)
- Resistance tolerance: to ±0.5%
- Temperature coefficient of resistance (TCR):
  - 3 ppm/°C max. (−55°C to +125°C, +25°C ref.)
- Power rating: to 0.5 W at 70°C
- Load-life stability: to ±0.05% (70°C, 2000 hours at rated power)
- Short-time overload: 0.02%
- Electrostatic discharge (ESD): at least to 25kV
- Solderable terminations
# Surface-Mount Current Sense Performance Specifications

## Bulk Metal Foil CSM3637F Performance Specifications

<table>
<thead>
<tr>
<th>Test/Condition</th>
<th>Resistance Value</th>
<th>Typical $\Delta R$ % Limits$^{(1)}$</th>
<th>Max $\Delta R$ % Limits$^{(1)}$</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Load-life stability</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2000 h, +70°C at rated power</td>
<td>$\geq$100 mΩ</td>
<td>0.05%</td>
<td>0.5%</td>
</tr>
<tr>
<td></td>
<td>20 mΩ to &lt;100 mΩ</td>
<td>0.05%</td>
<td>0.1%</td>
</tr>
<tr>
<td><strong>Short-time overload</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 x rated power, 5 s</td>
<td>20 mΩ to 200 mΩ</td>
<td>0.02%</td>
<td>0.05%</td>
</tr>
<tr>
<td><strong>High temperature exposure</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1000 h, 170°C</td>
<td>20 mΩ to 200 mΩ</td>
<td>0.2%</td>
<td>0.3%</td>
</tr>
<tr>
<td><strong>Moisture resistance</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MIL-STD-202, method 106, 0 power, 7a and 7b not required</td>
<td>20 mΩ to 200 mΩ</td>
<td>0.005%</td>
<td>0.02%</td>
</tr>
<tr>
<td><strong>Shock</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>100 g, 6 ms, 5 pulses</td>
<td>20 mΩ to 200 mΩ</td>
<td>0.02%</td>
<td>0.05%</td>
</tr>
<tr>
<td><strong>Vibration</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10 Hz to 2000 Hz, 20G 2 axes, 6 h per axis</td>
<td>20 mΩ to 200 mΩ</td>
<td>0.02%</td>
<td>0.05%</td>
</tr>
<tr>
<td><strong>Resistance to soldering heat</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10 s to 12 s at +260°C</td>
<td>20 mΩ to 200 mΩ</td>
<td>0.03%</td>
<td>0.05%</td>
</tr>
</tbody>
</table>

**Note**

$^{(1)}$ Measurement error allowed for $\Delta R$ limits: 0.0005 Ω

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## EEE-INST-002 (Table 2A Film/Foil, Level 1) 100% Tests/Inspections$^{(1)}$

<table>
<thead>
<tr>
<th>Test/Condition</th>
<th>In tolerance</th>
</tr>
</thead>
<tbody>
<tr>
<td>RC Record</td>
<td>In tolerance</td>
</tr>
<tr>
<td>Thermal Shock</td>
<td>$25\times (\text{–65°C to +150°C})$</td>
</tr>
<tr>
<td>RC Record</td>
<td>$\Delta R = 0.1%$</td>
</tr>
<tr>
<td>High Temperature Exposure</td>
<td>$+170°C$, 100 h, no power</td>
</tr>
<tr>
<td>RC Record</td>
<td>In tolerance $\Delta R = 0.1%$</td>
</tr>
<tr>
<td>Final Inspection</td>
<td>$5%$ PDA on $\Delta R$, $10%$ PDA on out of tolerance</td>
</tr>
<tr>
<td>Visual Inspection</td>
<td>Magnification $30\times$ to $60\times$</td>
</tr>
<tr>
<td>Mechanical Inspection</td>
<td>Dimensions, workmanship, 3 units sample size</td>
</tr>
</tbody>
</table>

**Note**

$^{(1)}$ Vishay Foil Resistors will perform a pre-cap visual inspection 100% in the production flow prior to overcoating