Bulk Metal® foil resistors were invented some 40 years ago by Dr. Felix Zandman. Until today, they remain the performance leader among all resistor types, categories, and brands. Their unique construction, featuring a special resistive alloy, results in a resistor element with characteristics that no other technology can match. These include the industry's lowest temperature coefficient of resistance (TCR), and power coefficient (PCR).

All of these performance characteristics are particularly desirable in medical instrumentation and equipment, where Bulk Metal foil resistors deliver proven reliability and stable performance, even when exposed to unstable levels of temperature and humidity or other harsh environmental conditions. Their long track record of success in medical applications and Vishay’s long-term commitment to the medical market have made Bulk Metal Foil the preferred resistor for medical applications including non-invasive equipment, imaging equipment and systems, and biological implants.

As a leading supplier to the worldwide medical market, Vishay has produced a steady stream of breakthroughs in component technology, including new Z-Foil resistors that provide a temperature coefficient of ±0.2 ppm/°C and a power coefficient of 5 ppm at rated power: a ten-fold improvement over standard foil resistors.

Many medical applications require custom or semi-custom component solutions. Vishay’s Application Engineering department is available to advise customers and to make recommendations regarding non-standard technical requirements and special applications.

Please contact us at Foil@vishay.com.

Key features of Vishay Bulk Metal foil resistors:

- “Zero TCR”: ±0.2 ppm/°C (MIL range) with Z-Foil technology
- TCR tracking: to 0.1 ppm/°C
- PCR (power coefficient): 5 ppm typical at rated power for Z-Foil resistors
- Load-life stability under applied power:
  - 0.005% (50 ppm) over 2,000 hours at 70 °C
- Resistance range: any value from 2 mΩ to 3.3 MΩ (for higher and lower values, please contact us)
- Tolerance: absolute and match for voltage dividers and networks: to ±0.001 %
- 4-terminal connections for low values
- Low current noise: -40 dB
- Thermal EMF: 0.05 µV/°C
- Voltage coefficient: <0.1 ppm/V
- Non-inductive: <0.08 µH
- Rise time: 1 ns without ringing
- Lead (Pb)-free and RoHS-compliant available upon request

The following device types are available as part of Vishay foil resistor product portfolio:

- Surface-mount chips, molded resistors, and networks
- Through-hole (ledged) resistors and networks
- Hermetically sealed and molded networks
- Power current-sensing resistors
- Hybrid chips
- Voltage dividers
- Military-established-reliability resistors
- Trimming potentiometers

Ultra-High-Precision Bulk Metal® Foil Resistors

For Advanced Medical Applications, Treatment Solutions, and Biotechnology
Applications:
- Medicine and health care
- Medical R&D projects
- Non-invasive equipment
- Disease detection
- Automated imaging and scanning systems for analysis

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<tr>
<td>VSM Series (Z-Foil)</td>
<td>• Nearly zero TCR: “Z-Foil” ±0.2 ppm/°C (MIL range) typical</td>
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<tr>
<td>VSM Series (Sizes: 0805, 1206, 1506, 2010, 2512)</td>
<td>• Long-term stability under applied power ±0.01 % or ±0.005 % (reduced power) over 2,000 hours at +70 °C</td>
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<tr>
<td>VSMP Series (Z-Foil)</td>
<td>• Low PCR (power coefficient) 5 ppm typical at rated power for Z-Foil resistors</td>
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<tr>
<td>VSMP Series (Sizes: 0805, 1206, 1506, 2010, 2512)</td>
<td>• Resistance range: 10 Ω to 150 kΩ</td>
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<td>• Tolerance: ±0.01 %</td>
<td>• Low current noise: -40 dB</td>
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<tr>
<td>• Low current noise: -40 dB</td>
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<td><strong>Flip Chip</strong></td>
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<td>VFCP Series (Z-Foil)</td>
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<td>VFCP Series (Sizes: 0805, 1206, 1506, 2010, 2512)</td>
<td>• Long-term stability under 0.1 Watt: ±0.005 % over 2,000 hours at +70 °C</td>
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<tr>
<td></td>
<td>• Thermal shock: 0.005% typical</td>
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<td></td>
<td>• Shelf life stability: 25 ppm</td>
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<td>• Moisture resistance: 0.01 %</td>
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<td></td>
<td>• Resistance to soldering heat ±0.01% typical</td>
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<tr>
<td><strong>Molded</strong></td>
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<tr>
<td>SMR1D</td>
<td>• Resistance range: 2 mΩ to 200 mΩ</td>
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<td>SMR3D</td>
<td>• TCR: ±15 ppm/°C</td>
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<td></td>
<td>• Tolerance: ±0.1 %</td>
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<tr>
<td></td>
<td>• Rated power: to 3 Watt</td>
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<tr>
<td></td>
<td>• 4-terminal (Kelvin) connections</td>
</tr>
<tr>
<td><strong>Power Current Sensing</strong></td>
<td>• Low TCR of ±0.2 ppm/°C (MIL range) typical</td>
</tr>
<tr>
<td>CSM2512</td>
<td>• PCR (power coefficient): 5 ppm/°C typical at rated power for Z-Foil resistors</td>
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<tr>
<td>CSM3637</td>
<td>• Load-life stability under 1 Watt: 0.005 % over 2,000 hours at +70 °C</td>
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<td></td>
<td>• Resistance range: 0.01 Ω to 2 Ω</td>
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<td></td>
<td>• Tolerance: to ±0.1 %</td>
</tr>
<tr>
<td><strong>Voltage Dividers &amp; Networks</strong></td>
<td>• Any ratio of values between 100 Ω to 20 kΩ</td>
</tr>
<tr>
<td>VFCD1505 (Z-Foil)</td>
<td>• TCR of ±0.2 ppm/°C (MIL range) typical for Z-Foil resistors</td>
</tr>
<tr>
<td>DSM</td>
<td>• TCR tracking: 0.1 ppm/°C typical</td>
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<tr>
<td>SMN</td>
<td>• Ratio tolerance: 0.01 %</td>
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<tr>
<td></td>
<td>• Integrated construction – real estate saving</td>
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<tr>
<td><strong>Hermetic Networks (PRND)</strong></td>
<td>• TCR tracking: 0.5 ppm/°C</td>
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<tr>
<td>VSM40, 42, 45, 46</td>
<td>• Shelf life stability: 2 ppm typical</td>
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<tr>
<td>VSM85-89</td>
<td>• Load-life stability over 1,000 hours: ΔR=0.01 % ΔRatio= 0.005 %</td>
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<tr>
<td></td>
<td>• Ratio tolerance: 0.005 %</td>
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<td></td>
<td>• Moisture resistance: ΔR=0.003 % ΔRatio= 0.003 % typical</td>
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<tr>
<td></td>
<td>• No set-up charges</td>
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<tr>
<td>Series/Part Number</td>
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<tr>
<td><strong>Through-Hole</strong></td>
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</tbody>
</table>
| Molded Z201 (Z-Foil) S Series S102 IPT (Improved Performance Testing) | - Nearly zero TCR of ±0.2 ppm/°C (MIL range) typical  
- PCR (power coefficient): 5 ppm typical at rated power  
- Load-life stability under power: 0.005 % after 2,000 hours at +125 °C  
0.015 % after 10,000 hours at +125 °C | - Excellent stability and reliability under broad range of environmental conditions  
- Tight tolerance to ±0.005 % |
| Molded VFP4Z, VCS332Z, VPR221Z, VPR220Z, VCS232Z* (Z-Foil) | - Resistance range: 0.25 Ω to 10 kΩ  
- Tolerance: ±0.01 %  
- TCR: ±0.2 ppm/°C (MIL range) typical  
- PCR: 4 ppm/Watt typical  
- 4-terminal connections  
- Power rating: up to 10 Watt on heat sink | - High stability and high reliability under harsh environment conditions |
| Hermetic VPR247Z, VHP4Z, VHP3Z* (Z-Foil) | - Resistance range: 0.25 Ω to 80 kΩ  
- Tolerance: ±0.01 %  
- TCR: ±2 ppm/°C (MIL range) typical  
- 4-terminal connections  
- Power rating: up to 10 Watt on heat sink | - Low ohmic values  
- High power ratings |
| **Power Current Sensing** | | |
| Molded VFP3, VFP4, VPR220 VPR221, VCS3XX, VCS2XX* | - Any ratio of values between 100 Ω to 20 kΩ  
- TCR tracking: 0.5 ppm/°C  
- Ratio tolerance: 0.005 %  
- Load life stability under 0.05 Watt over 2,000 hours at +25 °C  
ΔR=0.002 %  
ΔRatio=0.001 % typical | - Nearlly zero TCR tracking  
- Provides superior environmental protection and moisture resistance (hermetic packages) |
| Hermetic VPR247, VHP3, VHP4 | | |
| **Voltage Divider** | | |
| Molded 300144 300145 | - Any ratio of values between 100 Ω to 20 kΩ  
- Shelf life stability ratio: 2 ppm typical  
- Ratio tolerance: 0.001 %  
- TCR tracking: 0.1 ppm/°C typical  
- Load life stability ratio under 0.1 Watt over 2,000 hours at 80 °C: 0.001 % | - Mechanically robust  
- Excellent stability  
- Custom designs |
| Hermetic VHD200 VHD144 | | |
| **Sealed Networks** | | |
| 1442, 1445, 1446, 1457, 1460 | - TCR tracking: 0.5 ppm/°C  
- Ratio tolerance: 0.005 %  
- Shelf life stability: 2 ppm typical  
- Moisture resistance:  
ΔR=0.003 %  
ΔRatio=0.003 % typical | - Very tight tolerance  
- Wide ohmic value ranges  
- Available in 4 terminal connections |
| Hermetic H-Series, Oil-Filled Hermetically Sealed Ultra Precision VHAXXX VHP202 | - Resistance range: 5 Ω to 1MΩ4  
- Tolerance: ±0.001%  
- TCR: ±2 ppm/°C (MIL range) typical  
- Shelf life stability: 2 ppm typical | - Very tight tolerance  
- Wide ohmic value ranges  
- Available in 4 terminal connections |
| Hermetic Ultra-Precision Resistor with Almost Zero TCR VHP100, 101, 102, 103 | - Resistance range: 100Ω to 150KΩ  
- Tolerance: 0.005 %  
- TCR of ±0.3 ppm/°C (15 °C to 45 °C, 25°C Ref)  
±0.6 ppm/°C  
(-55 °C to +125 °C,+25°C Ref)  
- Shelf life stability: 2 ppm typical | - No humidity effect, hermetically sealed against moisture |

* Conformally coated

For technical support, contact foil@vishay.com
Example 1. End Product: Cardiac Mapping System

Real time display of heart electrical activity

Customer Schematic / Specifications:
- Ohmic value: 10K each
- Absolute tolerance: 0.005 %
- Ratio tolerance: 0.005 % between R1 to R4, and R5 to R8
- Absolute TCR (Temperature Coefficient of Resistance): 2 ppm/ºC typical
- TCR tracking: 0.5 ppm/ºC between R1 to R4, and R5 to R8

Customer Requirements:
- High ratio stability under working conditions
- Surface mount device

Foil Solution: VSM46
- Hermetically sealed high precision network – 16 terminals gull wing configuration.

The Solution:
- Offers the best combination of tracking under power temperature during time of service life. The common behaviour of all resistors mounted into the same hermetic package contributes to maintain the excellent load life and ratio stability.
- Saves mounting time and real estate on PCB instead of using discrete resistors.

Example 2. End Product: Tomography

Control of magnetic field activity

Customer Schematic / Specifications:
- Ultra precision attenuator with very high ohmic value ratio: 1:1000
- R1 < 25 Ω
  R2: 999 x R1
- Ratio definition: R1 to (R1 + R2)
- Initial attenuation accuracy: 0.003 %
- Total attenuation of ratio:
  (TCR + Shift Under Load): 0.005 % after 2000 hrs

For technical support, contact foil@vishay.com
Foil Solution: VHA512 style – 4 terminals using Z foil technology
- Hermetically sealed oil filled network – custom design

The Solution:
- High ratio stability: 0.005 % under working conditions and ambient temperature variations
- Extremely low absolute TCR of 0.2 ppm/°C
- Non-measurable shelf life drifts

Example 3. End Product: Miniature Sensors
With 3D medical imaging for a precise diagnostics and surgery

Customer Schematic / Specifications:
- Ultra precision current sensor
- Ohmic value: 0R2
- Absolute tolerance: 0.1 %
- Absolute TCR: 4 ppm/°C within +30 °C to +50 °C
- Working power: 0.05 W

Customer Requirements:
- Extremely tight TCR
- Very low PCR (Power Coefficient of Resistance)
- Low total error budget
- Tight absolute tolerance
- Surface mount device

Foil Solution: VCS2516Z
- Ultra precision surface mount current sensing chip resistor – 4 terminals

The Solution:
A small surface mount device with:
- Extremely low TCR: 0.2 ppm/°C - typical
- Very low PCR: 5 ppm at rated power
- Tight tolerance: 0.1 %

For technical support, contact foil@vishay.com
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