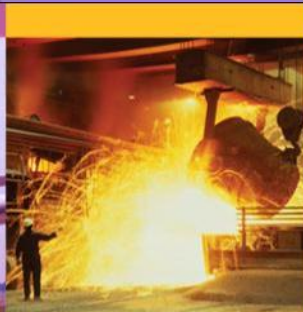


Bulk Metal[®] Foil Resistors

Product Portfolio



Stress Measurements



Process Control



Hospital Patient Bed Weighing



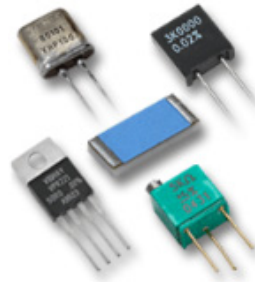
Precision Navigation Systems



Axle Overload Protection

Vishay Precision Group (VPG)

- Vishay Precision Group (VPG) is a leading designer, manufacturer, and marketer of resistance strain gages, ***ultra-precision foil resistors***, ***Resistance Foil current sensors***, load cells/transducers, instruments, weigh modules, and systems for a wide variety of applications.
- ***Bulk Metal Foil® technology*** was first introduced in 1962 and still remains the most precise resistor technology available today.



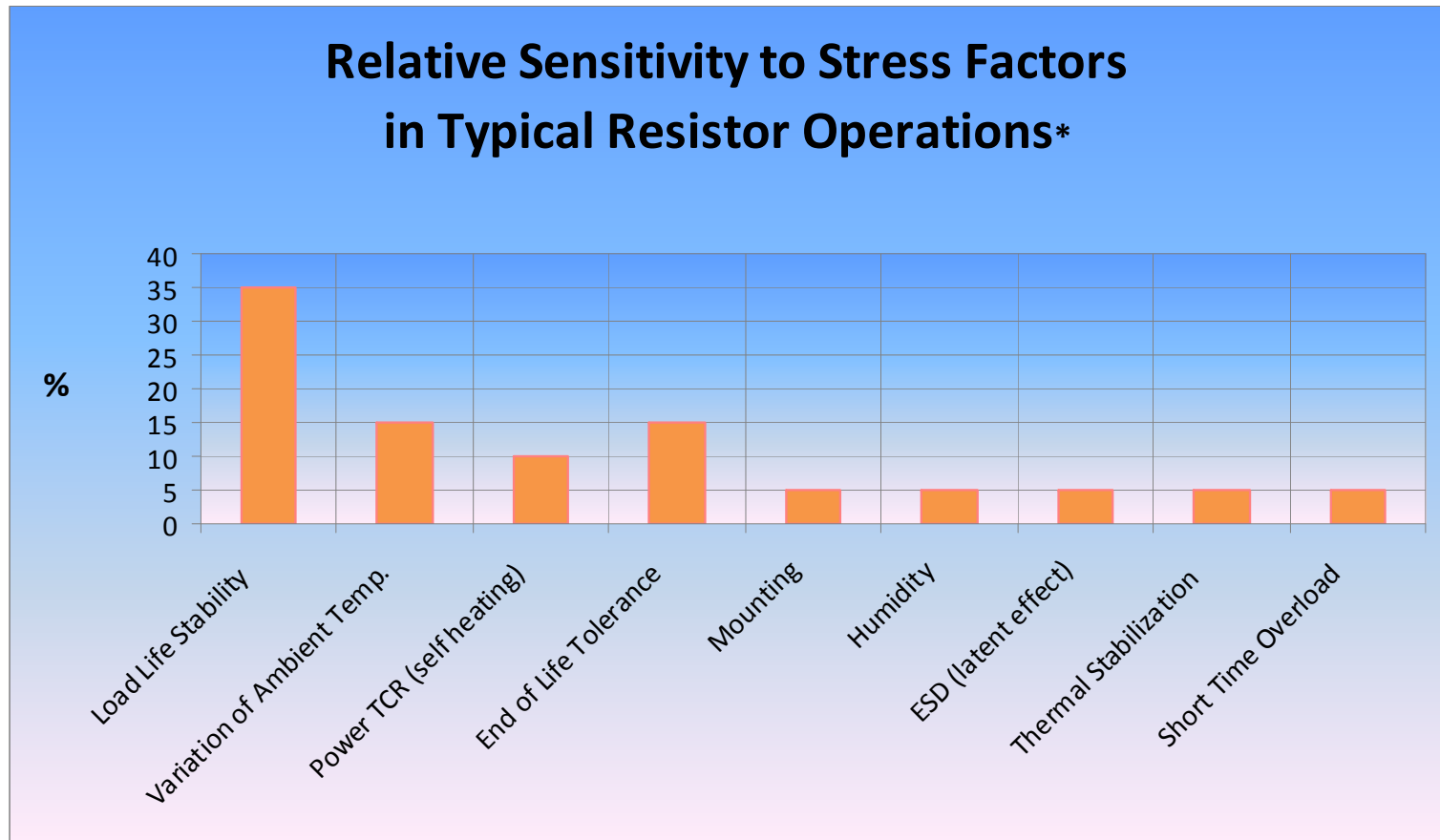
What is a Resistor ?

- Resistors are fundamental circuit components having electrical resistance and utilized in electronic circuits for the protection, operation, or control of current.
- Resistors, the most basic of passive components, are ubiquitous features of nearly every electronic system. Yet this simplest-to-describe electrical component is available in a diverse array of technologies and mechanical configurations. The application is often the determining factor in defining the resistor technology and package.
- Precision resistors are mainly used in analog circuits.

What is a Resistor ?

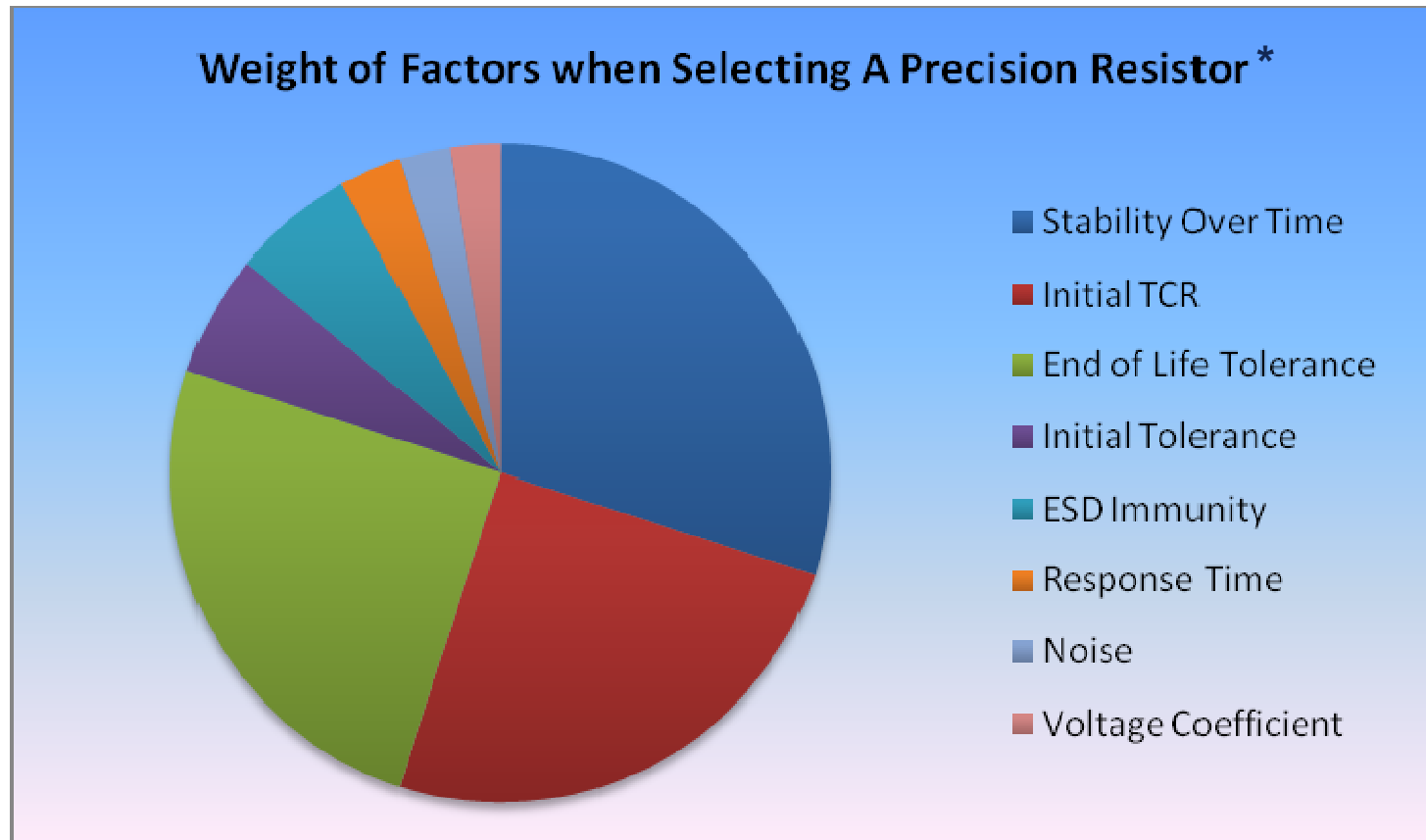
- Any analog circuit presents many unique design challenges due to location of installation (in space, below the earth's surface, mountaintop, desert, etc.) as well as severe and unpredictable environmental conditions (high and low temperatures, moisture, rain, snow, dust, salt water, etc.).
- Almost any analog circuit invokes a range of requirements for resistors of nearly all classes: wire-wound, thick film, thin film, foil, metal plate, carbon composition.
- **But what are the differences? How do I know what to choose?**

Main Reasons For Precision Resistor Malfunction



* VPG Foil Resistors estimates

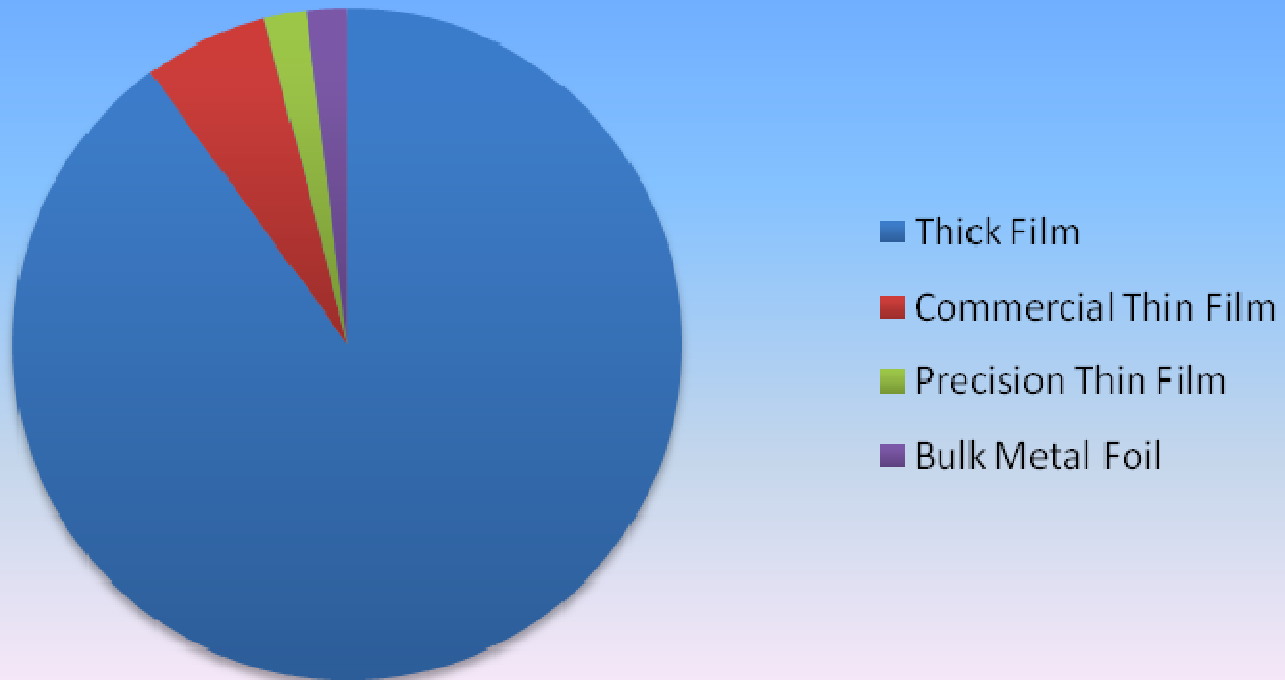
What Factors Do Design Engineers Look For?



* Vishay Foil Resistors (VPG) estimates

Cornerstone In Any Analog Circuit - Resistor

Resistors in an Analog Circuit*



* Vishay Foil Resistors (VPG) estimates

Inherent Characteristics of Foil Resistors

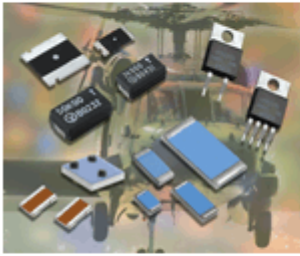
- Vishay Foil Resistors are not restricted to standard values, specific “as-required” values can be supplied at no extra cost or delivery (e.g., 100.1234Ω vs 100Ω)
- **Electrostatic discharge (ESD): at least to 25 kV**
- Rise time: 1 ns, effectively no ringing
- Thermal stabilization time <1 s
(nominal value achieved within 10 ppm of steady state value)
- Non-inductive, non-capacitive design
- Voltage Coefficient: 0.1 ppm/V
- **Current noise: $0.010 \mu V_{\text{RMS}}/\text{V}$ of applied voltage (<-40 dB)**
- **Thermal EMF: $<0.1 \mu\text{V}/\text{C}$**

Bulk Metal[®] Foil Unique Features

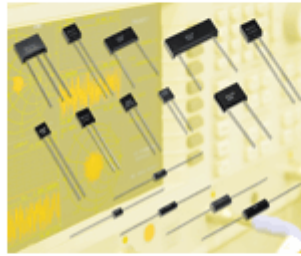
- Rated Power/ Current / Voltage
- **Temperature Coefficient of resistance absolute and tracking: from 0.1 ppm /°C**
- Resistance Tolerance absolute and match: from 0.001% (10 ppm)
- Load Life stability: from 0.002% after 2000 h at rated power
- **Power TCR (PCR): from 5 ppm at rated power with Z-Foil resistors**
- End of Life Tolerance (Total error budget): <0.05%
- Shelf Life stability : 2 ppm for at least 6 years
- No minimum order quantity

Bulk Metal® Foil – Product Line

Surface Mount (35)



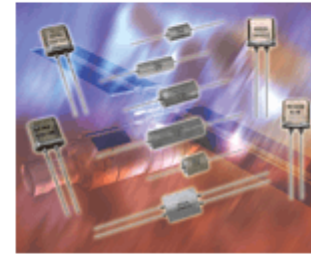
Through Hole (64)



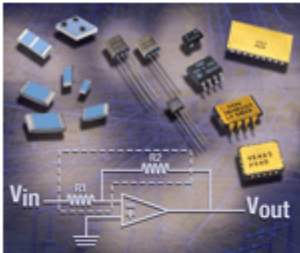
Power Current Sensor
(24)



Hermetically Sealed (9)



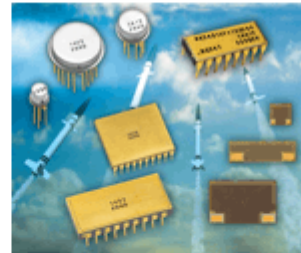
Voltage Dividers &
Networks (18)



Trimmers (5)



Hybrid Chips & PRND
(14)



Military & Space



Special Products: Tailor-made resistor products per customer specifications

Surface-Mount

VSMP Series & VSMP2018 and 0603 (Z-Foil)

wrap around terminations

- Temperature coefficient of resistance (TCR):
 ± 0.05 ppm/°C typical (0°C to 60°C)
- Tolerance: to $\pm 0.01\%$
- Resistance range: From 5 Ω
- Power TCR (PCR): 5 ppm at rated power
- Load-life stability: (70°C for 2000 h at rated power):
 $\pm 0.005\%$ (50 ppm) & $\pm 0.01\%$ (100 ppm) 10000 h
- Rated power: 100 mW to 750 mW (depending on size) at +70°C
- Matched sets are available upon request



Datasheets: <http://www.vishaypg.com/docs/63141/vsmp0603.pdf>

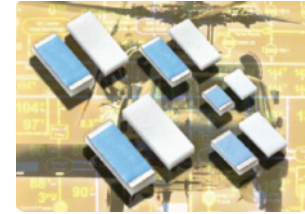
<http://www.vishaypg.com/docs/63060/vsmpseri.pdf>

<http://www.vishaypg.com/docs/63142/vsmp2018.pdf>

Press Releases: <http://www.vishaypg.com/foil-resistors/press/2009/090227foil/>

VFCP Series (Flip Chip Configuration)

- Temperature coefficient of resistance (TCR):
 ± 0.05 ppm/°C typical (0°C to 60°C)
- Tolerance: to $\pm 0.01\%$
- Resistance range: From 5 Ω
- Power TCR (PCR): 5 ppm at rated power
- Load-life stability: (70°C for 2000 h at rated power):
 $\pm 0.005\%$ (50 ppm) and $\pm 0.01\%$ (100 ppm) at 10000 h
- Rated power: 100 mW to 1000 mW (depending on size) at +70°C
- Matched sets are available upon request
- 35% PCB space saving vs. wrap-around terminations

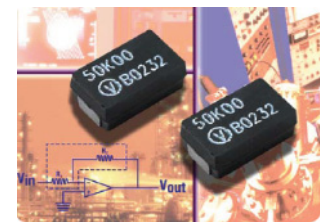


Datasheet: <http://www.vishaypg.com/docs/63106/vfcpseri.pdf>

SMRD Series High-Precision Foil Molded Surface-Mount Resistors with Flexible Terminations

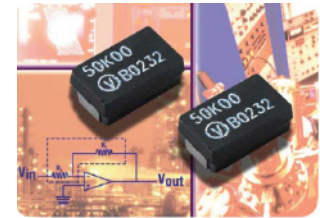
- Temperature coefficient of resistance (TCR):
 ± 2 ppm/°C typical (- 55°C to +125°C , +25°C ref)
- Tolerance: to $\pm 0.01\%$
- Rated power (at 70°C): SMR1DZ = 250 mW, SMR3DZ = 600 mW
- Load-life stability (70°C for 2000 h at rated power):
 $\pm 0.005\%$ (50 ppm)
- Flexible terminations ensure minimal stress transference from the PCB due to a difference in coefficient thermal of expansion (CTE)

Datasheet: <http://www.vishaypg.com/docs/63102/smrx.d.pdf>



SMRDZ Series Ultra-High-Precision Z-Foil Molded Surface-Mount Resistors with Flexible Terminations

- Temperature coefficient of resistance (TCR):
 ± 0.05 ppm/°C typical (0°C to +60°C)
 ± 0.2 ppm/°C typical (- 55°C to +125°C , +25°C ref)
- Tolerance: to $\pm 0.01\%$
- Rated power (at 70°C): SMR1DZ = 250 mW, SMR3DZ = 600 mW
- Load-life stability (70°C for 2000 h at rated power):
 $\pm 0.005\%$ (50 ppm)
- Flexible terminations ensure minimal stress transference from the PCB due to a difference in coefficient thermal of expansion (CTE)



Datasheet: <http://www.vishaypg.com/docs/63118/smrxdz.pdf>

Press Release: <http://www.vishaypg.com/foil-resistors/press/2007/071017foil/>

SMR3P – Flexible Terminations

- **Temperature coefficient of resistance (TCR):
 ± 0.5 ppm/°C maximum (+25°C to +125°C)**
- Resistance range: 100 Ω to 15k Ω
- Tolerance: to $\pm 0.01\%$
- Power rating: to 600 mW at 70°C
- Flexible terminations ensure minimal stress transference from the PCB due to a difference in thermal coefficient of expansions (TCE)
- Load life stability: $\pm 0.005\%$ (70°C , 2000 h at rated power)
- Power coefficient of resistance (PCR) “ ΔR due to self heating”: 5 ppm at rated power

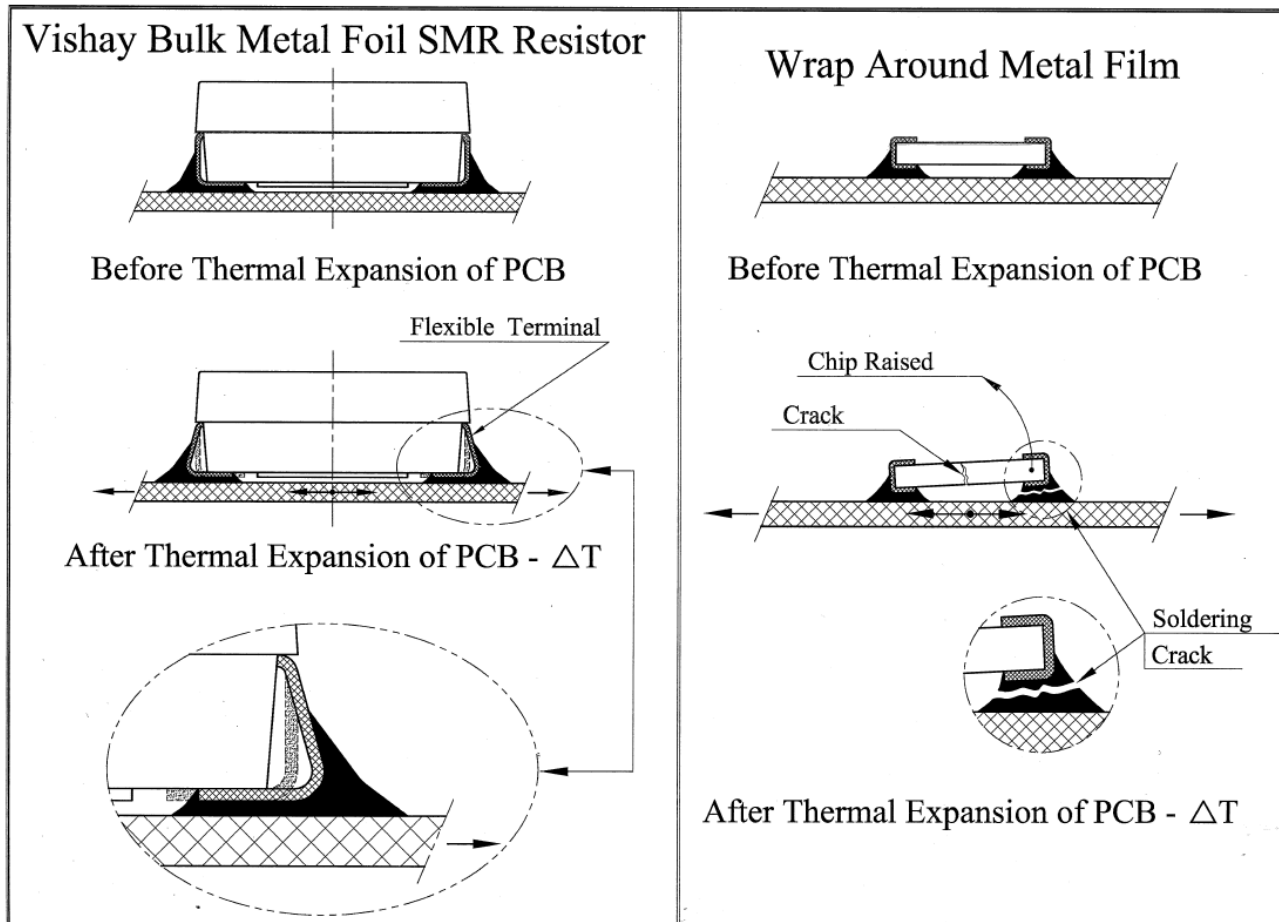


“The most stable SMD resistor in the market”

Datasheet: <http://www.vishaypg.com/docs/63185/smr3p.pdf>

Press Release: <http://www.vishaypg.com/foil-resistors/press/2010/100322photoresistors/>

Flexible Terminations Concept



DSM High-Precision Foil Surface-Mount Voltage Divider

- Temperature coefficient of resistance (TCR):
Absolute: ± 2 ppm/°C typical (0°C to +60°C)
- Tracking: 0.5 ppm/°C typical
- Resistance values: 100 Ω to 10 k Ω per resistor
- Tolerance match: to $\pm 0.01\%$
- Resistance ratio stability: $\pm 0.005\%$ (70°C for 2000 h at rated power)
- Power rating (at +70°C):
0.1 W (entire package), 0.05 W (each resistor)



Datasheet: <http://www.vishaypg.com/docs/63088/dsm.pdf>

DSMZ High-Precision Z-Foil Surface-Mount Voltage Divider

molded, flexible terminations

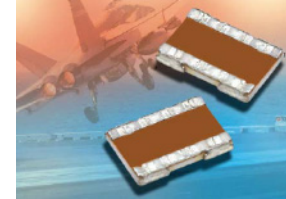
- Temperature coefficient of resistance (TCR):
Absolute: ± 0.05 ppm/ $^{\circ}\text{C}$ typical (0°C to $+60^{\circ}\text{C}$)
- Tracking: 0.1 ppm/ $^{\circ}\text{C}$ typical
- Tolerance match: to $\pm 0.01\%$
- Resistance ratio stability: $\pm 0.005\%$ (70°C for 2000 h at rated power)
- Resistance values: 100 Ω to 10 k Ω per resistor
- Power rating (at $+70^{\circ}\text{C}$):
0.1 W (entire package), 0.05 W (each resistor)



Datasheet: <http://www.vishaypg.com/docs/63121/dsmz.pdf>

VCS1625Z and VCS1625 Ultra-High Precision Current-Sensing Resistors

- VCS1625Z — Z-Based Bulk Metal[®] Foil
- VCS1625 — Bulk Metal Foil
- Temperature coefficient of resistance (TCR): (Z-Foil)
±0.05 ppm/°C typical (0°C to +60°C)
±0.2 ppm/°C typical (- 55°C to +125°C , +25°C ref)
- Tolerance: to ±0.1%
- Resistance range: 0.01 Ω to 10.0 Ω
- Load-life stability: (70°C for 2000 h, rated power): ±0.02%



Datasheets: <http://www.vishaypg.com/docs/63094/vcs1625z.pdf>
<http://www.vishaypg.com/docs/63023/vcs1625.pdf>

Press Release: <http://www.vishaypg.com/foil-resistors/press/2008/080815foil/>

VCS1610 (Kelvin Connection) Surface-Mount Current Sensing Chip Resistor

- Temperature coefficient of resistance (TCR):
 ± 2.0 ppm/°C typical (- 55°C to +125°C ,+25°C ref.)
- Resistance range: 0.1 Ω to 1 Ω (for higher or lower values please contact Application Engineering at: foil@vishaypg.com)
- Tolerance: to $\pm 0.5\%$
- Load life stability: $\pm 0.02\%$ at 70°C , 2000 h at rated power
- Power rating: 0.25 W at +70°C
- Short time overload $\leq 0.005\%$
- Weight: 0.027 mg

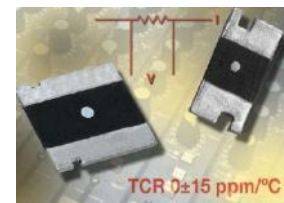


Datasheets: <http://www.vishaypg.com/docs/63137/vcs1610.pdf>

Press Release: <http://www.vishaypg.com/foil-resistors/press/2009/090826resistors/>

CSM2512/CSM3637 Precision Current-Sensing Surface-Mount Power Bulk Metal Foil Strip Resistor

- Temperature coefficient of resistance (TCR):
 ± 15 ppm/°C maximum (- 55°C to +125°C , +25°C ref)
- Tolerance: to 0.1%
- Resistance range: 1m Ω to 200 m Ω
- Load life stability, 2000 h at rated power: to $\pm 0.1\%$. (Typical current sensing resistors offer a load-life stability of $\geq 0.5\%$ through a 1000 h workload).
- Current: to 18 A, power rating: to 3 W
- Thermal EMF: 3 $\mu\text{V}/\text{C}$



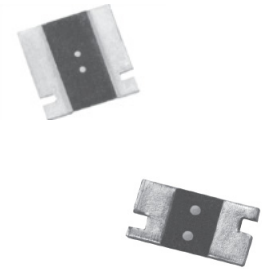
Datasheet: <http://www.vishaypg.com/docs/63089/csm.pdf>

Press Release: <http://www.vishaypg.com/foil-resistors/press/2010/100310resistorsfoil/>

CSM2512S/CSM3637S Precision Current-Sensing Surface-Mount Power Metal Strip[®] Resistor

(Improved Stability)

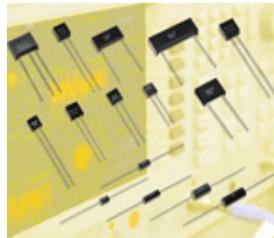
- Temperature coefficient of resistance (TCR):
 ± 15 ppm/°C maximum (- 55°C to +125°C , +25°C ref)
- Tolerance: 0.1%
- Resistance range: 10 m Ω to 100 m Ω
- **Load life stability, 2000 h at rated power: to $\pm 0.05\%$.**
(Typical current sensing resistors offer a load-life stability of $\geq 0.5\%$ through a 1000 h workload).
- Current: to 18 A, power rating: to 3 W
- Screening in accordance with EEE-INST002 available
(MIL-PRF 55342 and MIL-PRF 49465)
- Thermal EMF: 3 $\mu\text{V}/\text{C}$



Datasheet: <http://www.vishaypg.com/docs/63145/csm2512s.pdf>
<http://www.vishaypg.com/docs/63168/csm3637s.pdf>

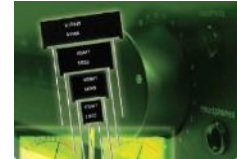
Press Release: <http://www.vishaypg.com/foil-resistors/press/2008/080627resistor/>

Through-Hole



S Series High-Precision Bulk Metal[®] Foil Resistors

- Temperature coefficient of resistance (TCR):
 ± 2 ppm/°C typical (-55°C to +125°C , +25°C ref)
- Tolerance: $\pm 0.005\%$
- Resistance range: 0.5 Ω to 1M Ω
- Load-life stability: (70°C for 2000 h at rated power): $\pm 0.005\%$
- Rated power: 0.3 W to 1 W at +125°C (depending on size)
- Non hot spot design
- Matched sets are available per request (TCR tracking: to 0.5 ppm/°C)

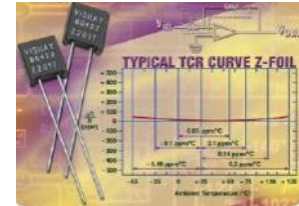


Datasheet: <http://www.vishaypg.com/docs/63001/63001.pdf>

Press Release: <http://www.vishaypg.com/foil-resistors/press/2008/080730foil/>

Z201 Ultra-High-Precision Z-Foil Resistor

- Temperature coefficient of resistance (TCR):
 ± 0.05 ppm/°C typical (0°C to +60°C)
- Tolerance: to $\pm 0.005\%$ (50 ppm)
- Resistance range: 10 Ω to 100 k Ω
- Power coefficient of resistance (PCR): 5 ppm at rated power
- Load-life stability: (70°C for 2000 h at rated power): $\pm 0.005\%$
- Rated power: 0.3 W at +125°C
- Short-time overload: $\pm 0.003\%$
- Matched sets are available upon request



Datasheet: <http://www.vishaypg.com/docs/63113/z201.pdf>

Press Release: <http://www.vishaypg.com/foil-resistors/press/2006/061215resistors/>

Z202 Ultra-High-Precision Z-Foil Miniature Resistor

- Temperature coefficient of resistance (TCR):
 ± 0.05 ppm/°C typical (0°C to +60°C)
- Tolerance: to $\pm 0.01\%$
- Resistance range: 5 Ω to 30 k Ω
- Power coefficient of resistance (PCR): 5 ppm at rated power
- Load-life stability: (70°C for 2000 h at rated power): $\pm 0.01\%$
- Rated power: 0.125 W at +125°C



Datasheet: <http://www.vishaypg.com/docs/63131/z202.pdf>

Press Release: <http://www.vishaypg.com/foil-resistors/press/2008/080208resistor/>

Z203 (Z1-Foil)

Improved long term stability



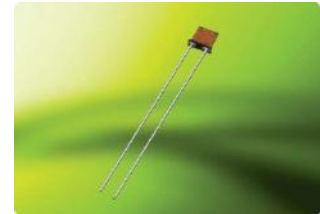
- **Temperature coefficient of resistance (TCR):**
 ± 0.5 ppm/°C maximum (+25°C to +125°C)
- Resistance range: 10 Ω to 100 k Ω
- Resistance tolerance: to $\pm 0.005\%$ (50 ppm)
- Power coefficient of resistance “ ΔR due to self heating”:
 ± 5 ppm at rated power
- Rated power: 0.6 W at 70°C , 0.3 W at 125°C
- **Load life stability: to $\pm 0.005\%$ (50 ppm) at 70°C , 10000 h at 0.3 W**
- Voltage coefficient: <0.05 ppm/V
- Drop-in upgrade for S102C/K
- Matched sets are available per request

Datasheet: <http://www.vishaypg.com/doc?63186>

Press Release: <http://www.vishaypg.com/foil-resistors/press/2010/100222resistorsfoil/>

VAR (Audio Resistor) Ultra-High-Precision Z-Foil Audio Resistor with Special Construction

- Unmolded or unencapsulated, adding an additional dimension for reducing signal distortion and increasing clarity in signal processing
- Temperature coefficient of resistance (TCR):
 ± 0.05 ppm/°C typical (0°C to +60°C)
- Resistance range: 10 Ω to 100 k Ω
- Tolerance: to $\pm 0.01\%$
- Load-life stability: (70°C for 2000 h at rated power):
 $\pm 0.01\%$ (100 ppm)
- Rated power: 0.2 W at +125°C
- Low excess noise
- High linearity or low voltage coefficient of resistance (VCR)



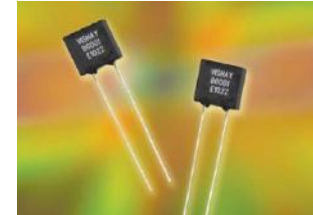
Datasheet: <http://www.vishaypg.com/docs/63140/var.pdf>

Press Release: <http://www.vishaypg.com/foil-resistors/press/2008/080507foil/>

E102Z Ultra-High-Precision Z-Foil Resistor

High ohmic values

- Temperature coefficient of resistance (TCR):
 ± 0.05 ppm/°C typical (0°C to +60°C)
- Tolerance: to $\pm 0.005\%$
- Resistance Range: 100 k Ω to 250 k Ω
- Power coefficient of resistance (PCR): 5 ppm at rated power
- Load-life stability: (70°C for 2000 h at rated power): $\pm 0.005\%$
- Rated power: 0.3 W at +125°C
- Short-time overload: $\pm 0.003\%$
- Thermal EMF: 0.05 $\mu\text{V}/^\circ\text{C}$
- Matched sets are available upon request



Datasheet: <http://www.vishaypg.com/docs/63144/e102z.pdf>

Press Release: <http://www.vishaypg.com/foil-resistors/press/2009/090130foil/>

VTA52Z through VTA56Z, VMTA55Z, VMTB60Z (Z-Foil) Tubular Axial Lead Resistors

- Temperature coefficient of resistance (TCR):
 ± 0.2 ppm/°C typical (- 55°C to +125°C , +25°C ref.)
 ± 0.05 ppm/°C typical (0°C to +60°C)
- Resistance range: 5 Ω to 300 k Ω
- Tolerance: to $\pm 0.01\%$
- Load life stability: $\pm 0.005\%$ (50 ppm) at 70°C , 2000 h at rated power
- Power rating: 0.2 W to 1.0 W at 70°C

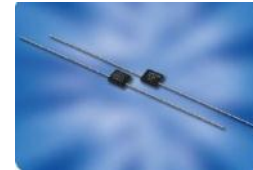


Datasheet: <http://www.vishaypg.com/docs/63163/vta5256z.pdf>

Press Release: <http://www.vishaypg.com/foil-resistors/press/2009/090918foil/>

VSA101 Ultra-High-Precision Axial Leads Z-Foil Resistor

- Temperature coefficient of resistance (TCR):
 ± 0.05 ppm/°C typical (0°C to +60°C)
- Tolerance: to $\pm 0.005\%$
- Resistance range: 5 Ω to 100 k Ω
- Power coefficient of resistance (PCR): 5 ppm at rated power
- Thermal stabilization time <1 s
(nominal value achieved within 10 ppm of steady state value)
- Load-life stability: (70°C for 2000 h at rated power): $\pm 0.005\%$
- Rated power: 0.3 W at +125°C



Datasheet: <http://www.vishaypg.com/docs/63143/vsa101.pdf>

Press Release: <http://www.vishaypg.com/foil-resistors/press/2008/080716foil/>

VSHZ, VSCZ (Z-Foil) Low Profile Conformally Coated High Precision Resistors

- Temperature coefficient of resistance (TCR): ± 0.2 ppm/°C typical (-55°C to +125°C , +25°C ref)
- Tolerance: to $\pm 0.01\%$
- Resistance range: 5 Ω to 120 k Ω
- Load life stability: to $\pm 0.01\%$ at 70°C , 2000 h at rated power
- Power rating: to 300 mW at +70°C
- Short time overload: $\leq 0.01\%$
- Maximum working voltage: 300 V



Datasheet: <http://www.vishaypg.com/docs/63149/vshzvscz.pdf>

Press Release: <http://www.vishaypg.com/foilresistors/press/2010/100416webresistors/>

VPR220Z/VPR220SZ Ultra-High-Precision Z-Foil Power Resistors

- Temperature coefficient of resistance (TCR):
 ± 0.05 ppm/°C (0°C to +60°C)
 ± 0.2 ppm/°C (- 55°C to +125°C , +25°C ref)
- Tolerance: $\pm 0.01\%$
- Resistance range: 5 Ω to 10 k Ω
- Power coefficient of resistance (PCR):
 ΔR due to self heating: 4 ppm/W typical
- Rated power: up to 8 W
- Load-life stability: to $\pm 0.005\%$ at 25°C , 2000 h at 1.5 W
- Non hot spot design
- Screening in accordance with EEE-INST002 available (MIL-PRF 39009)



Datasheets: <http://www.vishaypg.com/docs/63064/vpr220z.pdf>

<http://www.vishaypg.com/docs/63068/vpr220sz.pdf>

Press Release: <http://www.vishaypg.com/foilresistors/press/2008/080801zfoil/>

VCS101/103/401

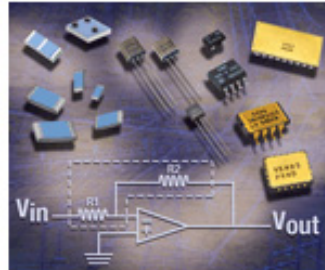
Low values, Four Terminals

- Low Ohmic Values: 0.005 Ω to 0.2 Ω
- Resistive Tolerance: to $\pm 0.1\%$
- Temperature Coefficient of Resistance (TCR):
 ± 20 ppm/ $^{\circ}\text{C}$ at 0.1 Ω , available to ± 15 ppm/ $^{\circ}\text{C}$
- Contact Applications Engineering for tighter limits
- 4 leads for Kelvin connection
- Power Rating: to 1.5 W at +25 $^{\circ}\text{C}$ (free air)
- Maximum Operating Temperature: +175 $^{\circ}\text{C}$
- Load life stability: $\pm 0.5\%$ at 25 $^{\circ}\text{C}$, 2000 h at rated power
- 4 leads for Kelvin connection



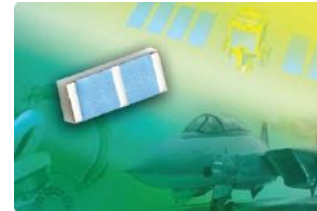
Datasheets: <http://www.vishaypg.com/docs/63016/vcs101.pdf>

Voltage Dividers and Networks



VFCD1505 Ultra-High-Precision Z-Foil Surface-Mount Flip-Chip Voltage Divider

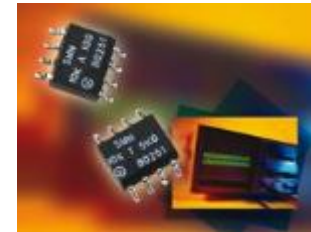
- Temperature coefficient of resistance (TCR):
Absolute: ± 0.05 ppm/ $^{\circ}\text{C}$ typical (0°C to $+60^{\circ}\text{C}$)
- Tracking: 0.1 ppm/ $^{\circ}\text{C}$ typical
- Resistance values: 1 k Ω to 10 k Ω per resistor
- Tolerance match: to $\pm 0.01\%$
- Resistance ratio stability: $\pm 0.005\%$ (70°C for 2000 h at rated power)
- Power rating (at $+70^{\circ}\text{C}$): 0.1 W (entire package),
0.05 W (each resistor)



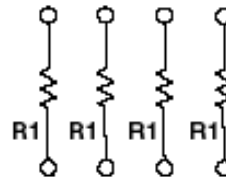
Datasheet: <http://www.vishaypg.com/docs/63109/vfcd1505.pdf>

SMN 4-Resistor Surface-Mount Network Dual-In-Line Molded Package

- Temperature coefficient of resistance (TCR):
Absolute: ± 2 ppm/ $^{\circ}\text{C}$ typical (0°C to $+60^{\circ}\text{C}$)
- TCR tracking: 0.5 ppm/ $^{\circ}\text{C}$ typical
- Resistance range: 100 Ω to 10 k Ω (per resistor)
- Resistance tolerance match: $\pm 0.01\%$
- Load-life stability: 0.005% (50 ppm), 0.1 W at 2000 h, 70°C



Up to 4 different
values
R1,R2,R3,R4

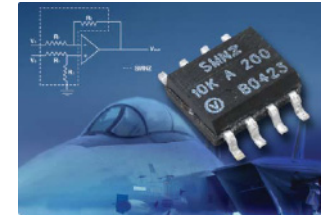


Datasheet: <http://www.vishaypg.com/docs/63081/smn.pdf>

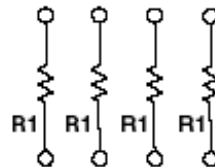
Press Release: <http://www.vishaypg.com/foil-resistors/press/2003/030707networks/>

SMNZ (Z-Foil) 4 Resistor Surface-Mount Network Dual-In-Line Molded Package

- Temperature Coefficient of Resistance (TCR): Absolute:
 ± 0.05 ppm/°C typical (0°C to +60°C)
 ± 0.2 ppm/°C typical (-55°C to +125°C, +25°C Ref.)
- Tracking: 0.1 ppm/°C typical
- Resistance tolerance match: $\pm 0.01\%$
- Resistance range: 100 Ω to 10 k Ω (per resistor)
- Power TCR (PCR) tracking: 5 ppm at rated power
- Load life stability: 0.005% (50 ppm), 0.1 W at 2000 h, 70°C



Up to 4 different
values R1,R2,R3,R4



Datasheet: <http://www.vishaypg.com/docs/63117/smnz.pdf>

Press Release: <http://www.vishaypg.com/foil-resistors/press/2007/070919foil/>

2R, 3R, 4R Series with Z-Foil Ultra-High-Precision Z-Foil Voltage Dividers and Resistor Networks

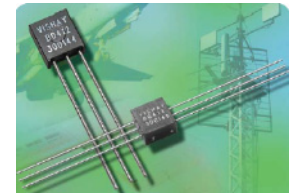
- Temperature coefficient of resistance (TCR): Absolute: ± 0.05 ppm/°C typical (0°C to +60°C)
- Tracking: 0.1 ppm/°C typical
- Tolerance: Absolute and resistance match to $\pm 0.005\%$
- Resistance range: 1 Ω to 150 k Ω (per resistor)
- Power coefficient of resistance (PCR) tracking: 5 ppm at rated power
- Load-life stability (70°C for 2000 h, rated power): $\pm 0.005\%$ (50 ppm)

Datasheet: <http://www.vishaypg.com/docs/63044/2r3r4r.pdf>



300144Z and 300145Z Ultra-High-Precision Z-Foil Single and Double Voltage Dividers

- 300144Z: 2-resistor divider; 300145Z: contains two 300144 dividers.
- Temperature coefficient of resistance:
TCR Absolute:
 ± 0.05 ppm/°C typical (0°C to +60°C)
 ± 0.2 ppm/°C typical (-55°C to +125°C , +25°C ref)
- TCR Tracking: 0.1 ppm/°C
- Tolerance: absolute and matching to $\pm 0.005\%$
- Resistance range: 100 Ω to 20 k Ω (per resistor)
- Power coefficient of resistance (PCR) tracking: 5 ppm at rated power
- Rated power: 0.2 W @ +70°C (R1 +R2)
- Ratio stability: $< \pm 0.001\%$ (10 ppm) 0.2 W at 70°C for 2000 h
- Maximum working voltage: 200 V

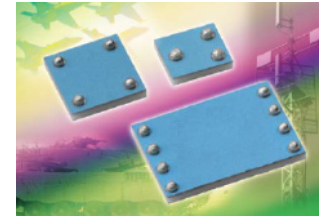


Datasheet: <http://www.vishaypg.com/docs/63115/300144z.pdf>

Press Release: <http://www.vishaypg.com/foil-resistors/press/2009/090206foil/>

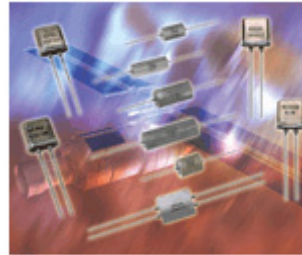
VFB1012D, VFB1515N, VFB2028N Ultra-High-Precision Z-Foil BGA Surface-Mount Resistor Divider & Network

- Temperature coefficient of resistance (TCR):
Absolute: ± 0.05 ppm/ $^{\circ}\text{C}$ typical (0°C to $+60^{\circ}\text{C}$)
 ± 0.2 ppm/ $^{\circ}\text{C}$ typical (-55°C to $+125^{\circ}\text{C}$, $+25^{\circ}\text{C}$ ref)
- TCR Tracking: 0.1 ppm/ $^{\circ}\text{C}$ typical
- Power coefficient tracking “ ΔR due to self-heating” : 5 ppm
- Load-life stability ratio: to $\pm 0.005\%$ (50 ppm) at 70°C , rated power
- Non inductive: < 0.08 μH



Datasheets: <http://www.vishaypg.com/docs/63122/vfb1012d.pdf>
<http://www.vishaypg.com/docs/63139/vfb1515n.pdf>
<http://www.vishaypg.com/docs/63157/vfb2028n.pdf>

Hermetically Sealed



Ultra-High-Precision Hermetically Sealed Z-Foil Resistors (HZ series)

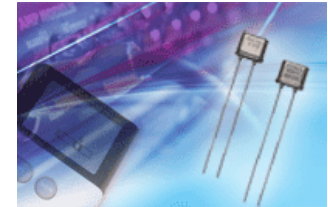
- Oil-filled and hermetically sealed
- Temperature coefficient of resistance (TCR):
 ± 0.2 ppm/°C typical (- 55°C to +125°C , +25°C ref)
- Tolerance: To $\pm 0.001\%$ (10 ppm)
- Resistance range: 5 Ω to 1.84 M Ω
- Power coefficient of resistance (PCR): 5 ppm at rated power
- Load-life stability: 20 ppm typical, 2000 h at +25°C
- Shelf life stability: ± 2 ppm for at least 6 years (unaffected by humidity)



Datasheets: <http://www.vishaypg.com/docs/63120/hzseries.pdf>

VHP203 Ultra-High-Precision, Oil Filled, Hermetically Sealed Z-Foil Resistor

- Temperature coefficient of resistance (TCR):
Absolute: ± 0.05 ppm/°C (0°C to +60°C)
- Tolerance: $\pm 0.001\%$ (10 ppm)
- Resistance range: 10 Ω to 100 k Ω
- Power coefficient of resistance (PCR): 5 ppm at rated power
- Load-life stability: $\pm 0.002\%$ maximum ΔR (60°C for 2000 h at 0.1 W)
- Shelf-life stability: 2 ppm for at least 6 years
- The hermetic sealing eliminates the ingress of moisture and oxygen, while the oil acts as a thermal conductor, thus eliminating long-term degradation of elements of unsealed resistors
- **Datasheet:** <http://www.vishaypg.com/docs/63146/vhp203.pdf>
- **Press Release:** <http://www.vishaypg.com/foil-resistors/press/2008/080627foil/>



VHZ Series - VH102Z/VHZ555

- Temperature coefficient of resistance (TCR):
 ± 0.2 ppm/°C typical (- 55°C to +125°C , +25°C ref)
- Resistance range: 5 Ω to 121 k Ω
- Tolerance: to $\pm 0.005\%$ (50 ppm)
- Load life stability to $\pm 0.002\%$ (20 ppm) at 25°C , 2000 h
at rated power
- **Load life stability, can be considerably improved through in-house stabilization**
- **Shelf life stability: 2 ppm for at least 6 years (unaffected by humidity)**



Datasheet: <http://www.vishaypg.com/docs/63063/vhzherme.pdf>

Note:

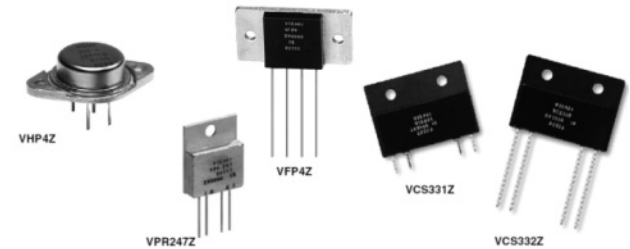
VHZ555 units are manufactured on the same production line facilities and are subjected to all the same process and lot control requirements imposed on RNC90Z version (Established Reliability Military-Qualified resistor), as well as all of the special screening, environmental conditioning and documentation stipulations outlined in MIL-PRF 55182/9

Power Current Sensors



Power Current Sense

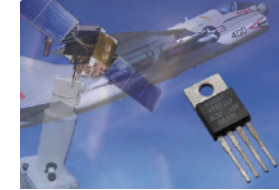
- Temperature coefficient of resistance (TCR):
 $\geq 1.0 \Omega$ to 500Ω , ± 2 ppm/ $^{\circ}\text{C}$ max., $0R25$ to $< 1.0 \Omega$, ± 3 ppm/ $^{\circ}\text{C}$ max.
(- 55°C to $+125^{\circ}\text{C}$, $+25^{\circ}\text{C}$ ref)
- Resistance range: 0.25Ω to 500Ω
- Resistance tolerance: to $\pm 0.01\%$ (100 ppm)
- Rapid ΔR Stabilization under transient loads
- Thermal Resistance: $6^{\circ}\text{C} / \text{W}$
- Load life stability:
 $\pm 0.05\%$ Max ΔR , 10 W on heat sink at $+25^{\circ}\text{C}$, 2000 h
 $\pm 0.01\%$ Max ΔR , 3 W on heat sink at $+25^{\circ}\text{C}$, 2000 h
 $\pm 0.05\%$ Max ΔR , 3 W in free air at $+25^{\circ}\text{C}$, 2000 h
- Tenfold improvement of Power Coefficient of Resistance (PCR): 4 ppm/W
- Power Rating: 10 W on heat sink at $+25^{\circ}\text{C}$, 3 W in free air at $+25^{\circ}\text{C}$



Datasheet: <http://www.vishaypg.com/docs/63086/pcsres.pdf>

VPR221SZ/VPR221Z Ultra-High-Precision Z-Foil Power Resistors

- Temperature coefficient of resistance (TCR):
 ± 0.05 ppm/°C (0°C to +60°C)
 ± 0.2 ppm/°C (-55°C to +125°C , +25°C ref)
- Tolerance: $\pm 0.01\%$
- Resistance range: 0.5 Ω to 500 Ω
- Power coefficient of resistance (PCR):
 ΔR due to self heating 4 ppm/W typical
- Rated power: up to 8 W
- Load-life stability: to $\pm 0.005\%$ at 25°C , 2000 h at 1.5 W
- Non hot spot design
- Screening in accordance with EEE-INST002 available (MIL-PRF 39009)



**4 Terminal
Mounted Heat Sink**

Datasheets: <http://www.vishaypg.com/docs/63127/vpr221sz.pdf>
<http://www.vishaypg.com/docs/63116/vpr221z.pdf>

Press Release: <http://www.vishaypg.com/foil-resistors/press/2008/080917foil/>

VFP3, VFP4 High Precision 4-Terminal Power Current Sensing Resistor

- Temperature Coefficient of Resistance (TCR):
 ± 2 ppm/°C typical (- 55°C to +125°C ,+25°C Ref.)
- Tolerance: to $\pm 0.01\%$
- Power Rating (heat-sinked): 10 W
- Load Life Stability: $\pm 0.005\%$ at 25°C , 2000 h at Rated Power
- Resistance Range: 0.05 Ω to 80 k Ω
- Electrostatic Discharge (ESD) up to 25,000 V
- Non Inductive, Non Capacitive Design
- Rise Time: 1 ns without Ringing
- Current Noise: <- 40dB

Mounted
Heat Sink



Datasheet: <http://www.vishaypg.com/docs/63014/vpf3vpf4.pdf>

VCS331, VCS332 High Precision 4-Terminal Power Current Sensing Resistor

- Temperature coefficient of resistance (TCR):
down to ± 1 ppm/°C max.
- Resistance range: 0.25 Ω to 500 Ω
- Tolerance: to $\pm 0.1\%$
- Power rating (heat-sinked): 10 W
- Load life stability: $\pm 0.01\%$ (100 ppm) at 25°C ,
- 2000 h at rated power
- Electrostatic discharge (ESD) up to 25000 V
- Non-inductive, non-capacitive design
- Rise time: 1.0ns effectively no ringing



Mounted
Heat Sink

Datasheet: <http://www.vishaypg.com/docs/63153/vcs331.pdf>

VCS301, VCS302 4-Terminal Power Current Sensing Resistor

- Temperature coefficient of resistance (TCR):
down to ± 3 ppm/°C max.
- Resistance range: 0.005 Ω to 0.25 Ω
- Tolerance: to $\pm 0.5\%$
- Power rating (on heat-sink): 10 W
- Load life stability: $\pm 0.02\%$ (200 ppm) at 25°C ,
2000 h at rated power
- Non inductive: 0.08 μ H
- Non hot spot design



Mounted
Heat Sink

Datasheet: <http://www.vishaypg.com/docs/63152/vcs301.pdf>

VCS232 Power Current Sense Resistors

- Temperature coefficient of resistance (TCR):
 ± 2 ppm/°C typical (- 55°C to +125°C , +25°C ref.)
- Resistance range: 0.2 Ω to 500 Ω
- Power rating at +25°C : 2 W (free air)
- Tolerance: to $\pm 0.02\%$
- Load life stability: to $\pm 0.01\%$, 25°C for 2000 h at rated power
- Maximum current: 3 A
- Short time overload $\leq 0.005\%$



Datasheet: <http://www.vishaypg.com/docs/63151/vcs232.pdf>

VCS232Z Ultra High Precision Z-Foil Power Current Sense Resistors

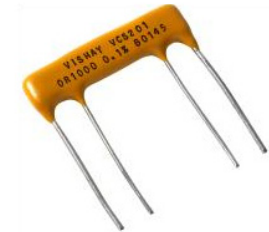
- Temperature coefficient of resistance (TCR):
 ± 0.05 ppm/°C typical (0°C to 60°C)
 ± 0.2 ppm/°C typical (- 55°C to +125°C ,+25°C ref.)
- Resistance range: 0.25 Ω to 500 Ω
- Power coefficient “ ΔR due to self heating” : 4 ppm/W typical
- Power rating at +25°C : 2 W (free air)
- Tolerance: to $\pm 0.02\%$
- Load life stability: to $\pm 0.005\%$, 25°C for 2000 h at rated power
- Maximum current: 3 A
- Short time overload $\leq 0.005\%$



Datasheet: <http://www.vishaypg.com/docs/63095/vcs232z.pdf>

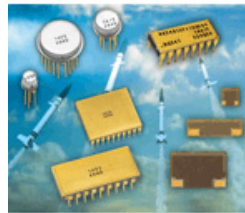
VCS201, VCS202 Ultra-High-Precision Current Sense Resistors - very low value

- Temperature coefficient of resistance (TCR):
 ± 10 ppm/°C typical (0°C to 60°C)
- Resistance range: 0.005 Ω to 0.2 Ω
- Tolerance: to $\pm 0.1\%$
- Power rating: 2 W at 25°C
- Load life stability: $\pm 0.02\%$ at 25°C , 2000 h at rated power



Datasheet: <http://www.vishaypg.com/doc?63150>

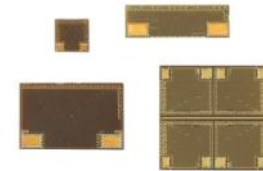
Hybrid Chips and Precision Resistor Network- Division (PRND)



Hybrid Chips

V5X5, V15X5, V15X10

- Temperature coefficient of resistance (TCR):
 ± 2 ppm/°C typical (- 55°C to +125°C , +25°C ref)
- TCR tracking : to 0.5 ppm/°C
- Resistance range: 5 Ω to 80 k Ω
- Resistance tolerance: to $\pm 0.005\%$ (50 ppm)
- Rated power: 50 mW to 150 mW at 70°C
- Load Life stability: $\pm 0.01\%$ at 70°C , 10000 h at rated power
- Short time over load: $\leq \pm 0.02\%$
- Gold plated pads for gold ball bonding interconnects during assembly
- For high-temperature and harsh environment applications please contact Foil@vishaypg.com
- Untrimmed chips can also be obtained

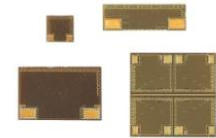


Datasheet: <http://www.vishaypg.com/docs/63024/v5x5v15x.pdf>
<http://www.vishaypg.com/docs/63189/v5x5v15x.pdf>

Hybrid Chips – Z Foil

V5X5, V15X5

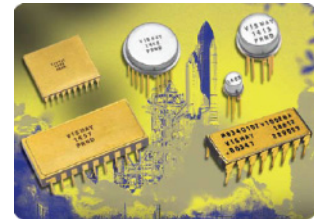
- **Temperature coefficient of resistance (TCR):**
 ± 0.05 ppm/°C typical (0°C to +60°C)
 ± 0.2 ppm/°C typical (- 55°C to +125°C , +25°C ref)
- TCR tracking : to 0.5 ppm/°C
- Resistance range: 50 Ω to 30 k Ω
- Resistance tolerance: to $\pm 0.005\%$ (50 ppm)
- Rated power: 50 mW to 150 mW at 70°C
- Load Life stability: $\pm 0.01\%$ at 70°C , 10000 h at rated power
- Short time over load: $\leq \pm 0.02\%$
- Gold plated pads for gold ball bonding interconnects during assembly
- For high-temperature and harsh environment applications please contact Foil@vishaypg.com
- Untrimmed chips can also be obtained



Datasheet: <http://www.vishaypg.com/docs/63189/v5x5v15x.pdf>

PRND (Custom Networks)

- Temperature coefficient of resistance (TCR):
Absolute: ± 2 ppm/°C typical (- 55°C to +125°C , +25°C ref)
- Tracking: 0.5 ppm/°C
- Flexible schematic designs
- Tolerance: absolute $\pm 0.005\%$; match 0.002%
- Resistance range: 5 Ω to 80 k Ω
- Load-life stability (1000 h at rated power):
 $\Delta R = 0.01\%$, $\Delta \text{Ratio} = 0.005\%$
- Hermetically-sealed packages: $< 5 \times 10^{-7}$ cc/sec
- Rated power per package up to 2.4 W
- No engineering charges, no minimum quantities
- Quick prototype delivery
- Custom designed chip arrays are available



Datasheet: <http://www.vishaypg.com/docs/63028/vsm8589.pdf>
<http://www.vishaypg.com/docs/63032/14221445.pdf>
<http://www.vishaypg.com/docs/63029/vsm4256.pdf>

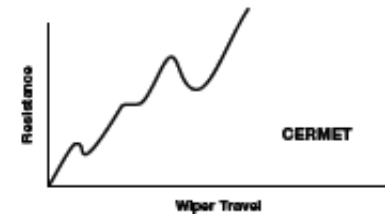
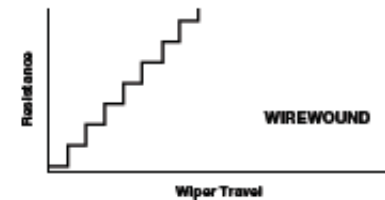
Trimmers



Trimmers

- Temperature Coefficient of Resistance, end to end: ± 5 ppm/ $^{\circ}\text{C}$. Through the wiper: ± 25 ppm/ $^{\circ}\text{C}$
- Settability: down to $\pm 0.005\%$
- Smooth and unidirectional output
- Stability in vibration environment
- Moisture seal
- Tap test: 0.05%
- All trimmers undergo noise and linearity tests during the standard production process
- “O” ring prevents ingress of fluids during any boardcleaning operation

Datasheets: <http://www.vishaypg.com/docs/63055/1202.pdf>
<http://www.vishaypg.com/docs/63054/1260.pdf>
<http://www.vishaypg.com/docs/63052/1242.pdf>
<http://www.vishaypg.com/docs/63053/1240.pdf>
<http://www.vishaypg.com/docs/63056/12801285.pdf>



Military and Space



RNC90Y/RNC90Z Military and Space Established Reliability (ER) Z-Foil Resistors

- QPL product with established reliability (MIL-PRF-55182/9)
- Load-life stability: $\pm 0.005\%$ typical ΔR for 2000 h at 125°C
- Temperature coefficient of resistance (TCR):
 ± 2 ppm/°C max (- 55°C to +175°C)
- Qualified resistance range:
 - 4.99 Ω to 121 k Ω (RNC90Y)
 - 30.1 Ω to 121 k Ω (RNC90Z)
- Resistance tolerance: to $\pm 0.005\%$



Datasheet: <http://www.vishaypg.com/docs/63007/rnc90yz.pdf>

<http://www.vishaypg.com/foil-resistors/press/2009/090128foil/>

Press Releases: <http://www.vishaypg.com/foil-resistors/press/2009/090520foil/>

RS92N, RS92NA, AN (CECC Qualified)

- CECC qualified
- Temperature coefficient of resistance (TCR):
 ± 2 ppm/°C typical (-55°C to +155°C , +20°C ref)
- Tolerance: $\pm 0.01\%$
- Resistance range: 80.6 Ω to 120 k Ω
- Load life stability: $\pm 0.005\%$ at +70°C , 2000 h at rated power



Datasheet: <http://www.vishaypg.com/docs/63138/rs92nan.pdf>

Press Release: <http://www.vishaypg.com/foil-resistors/press/2009/090506foil/>

Space Applications with Screen/Test Flow in Compliance with EEE-INST-002, (Tables 2A & 3 A, Film/Foil, Level 1) VSMP Series, Z201, VCS1625Z, SMRxDZ, CSM

- Temperature coefficient of resistance (TCR):
 ± 0.05 ppm/ $^{\circ}\text{C}$ typical (0°C to 60°C) with Z foil technology
- Tolerance: to $\pm 0.005\%$ with the Z201
- Resistance range: From $2\text{ m}\Omega$ with the CSM
- Load-life stability: (70°C for 2000 h at rated power): $\pm 0.005\%$ (50 ppm)
- Load-life stability: (70°C for 10,000 h at rated power): $\pm 0.01\%$ (100 ppm)
- Power rating: up to 3 W with the CSM
- Electrostatic discharge (ESD) up to 25,000 V

Datasheets: <http://www.vishaypg.com/docs/63169/30313x.pdf>
<http://www.vishaypg.com/docs/63165/303139.pdf>
<http://www.vishaypg.com/docs/63167/303119z.pdf>
<http://www.vishaypg.com/docs/63166/303144.pdf>
<http://www.vishaypg.com/docs/63174/303143.pdf>

Press Release: <http://www.vishaypg.com/foil-resistors/press/2009/090211foil/>



Special Products

**Resistive products crafted to
customers' unique specifications**

Special Products

- Vishay Foil resistors can be modified to specific application according to the customer requirements.
- Examples of special applications:
 - High Temperature
 - Cryogenics
 - Ultra precision
 - Long term stability
 - Matched resistors
 - Audio
 - Medical
 - Avionics
 - Military and Space

For more information please contact Application Engineering department: foil@vishaypg.com

Special Products- Enhanced Performances

- The foil resistors can be provided even with better specifications than those provided in the standard datasheets. There are specific cases where some parameters can be maximized/ Improved beyond the standard performance level to suit the customer requirements.
- Examples of such parameters are:
 - Total Error Budget (TEB) or End Of Life (EOL)
 - Long term stability
 - Resistance Value
 - Tolerance - Absolute and matched
 - TCR - Absolute and tracking

Post Manufacture Operations (PMO) for Better Load-Life Performance

- These PMO operations are uniquely applicable to resistors made of resistive Bulk Metal[®] Foil
- They take the already superior stability of Bulk Metal Foil devices one step further
- Operations described are not applicable to Thick Film, Thin Film, or Wire
- They constitute an exercising of the resin that bonds the Foil to the substrate
- The exercises that are employed are (1) temperature cycling (2) short time overload, and (3) accelerated load life

PMO

- **Temperature Cycling**

This exercise is done initially in the chip stage of all production and will eliminate any fallout in the PMO cycling. The cycling exercises the bonding resin and relaxes the Foil without reducing the bonding strength. A small reduction in resistance is tolerable during this PMO operation.

- **Short Time Overload**

The STO operation is performed on all resistors during manufacturing. Its function is to eliminate any possible weak spots, thus adding an extra measure of reliability.

PMO contd.

- **Accelerated Load Life**

- The standard load-life curve of a Foil resistor exhibits a significant portion of its change in the first 250 to 1000 hours, after which the curve begins to stabilize.
- The Accelerated Load Life exercise applies a load for a specified amount of time to eliminate this knee in the load-life curve. Upon delivery, the resistor will be on the flat part of the curve for your convenience.
- The amount of acceleration is a function of the application and should be worked out between our Applications Engineering department and your design team.

How To Order and Prototype Service

Get a quote



Standard Order



Foil Express



Door2door-Samples Service



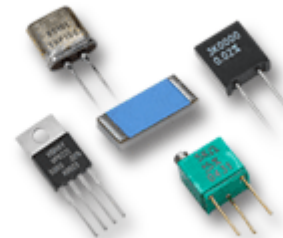
Foil 24 - Next Day Delivery



Foil Accelerated



Precision Centers



Credit Card





Foil Door2door - Service For Rapid Prototyping Samples

- When you need to evaluate 1 to 5 standard precision resistors for your prototype, you want them in a hurry. Vishay Foil resistors now guarantees a 5 working day delivery on any value from 0R002 to 1M and any tolerance to 0.005%, per individual product specifications.
- There is no need to stock a wide array of R&D precision resistors at high minimum order prices when you can buy only what you need and get them within a few days. And, because the foil resistor is the most precise resistor available, it should satisfy all your R&D requirements.
- VPG will send the resistors directly from the main facility or via one of its precision centers or “Foil resistor quick delivery sources” that are spread around the world.

Europe

FAE TERRITORY KEY:		
UK/EMEA	EMEA/AFRICA	ASIA/ISRAEL
email: emead@vishay.com tel: +44 1454 681000 mobile: +44 781 000010	email: emead@vishay.com tel: +44 1454 681000 mobile: +44 781 000010	email: emead@vishay.com tel: +44 1454 681000 mobile: +44 781 000010

Precision Centers: Contact: sub@vishay.com 8100 W. Center, Mankato, MN email: sub@vishay.com tel: +1 (505) 209 0148 mobile: +1 (970) 506 4000	Customer Service: Contact: sub@vishay.com 8100 W. Center, Mankato, MN email: sub@vishay.com tel: +1 (505) 209 0148 mobile: +1 (970) 506 4000	Sr. Sales Manager: Contact: sub@vishay.com 8100 W. Center, Mankato, MN email: sub@vishay.com tel: +1 (505) 209 0148 mobile: +1 (970) 506 4000
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South America

FAE TERRITORY KEY:
AMERICA
email: emead@vishay.com tel: +44 1454 681000 mobile: +44 781 000010



North America

FAE TERRITORY KEY:		
US/Canada	US/Canada	US/Canada
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Asia and Israel

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For further information please contact : foil@vishaypg.com

Visit us in our new website:
www.vishayfoilresistors.com