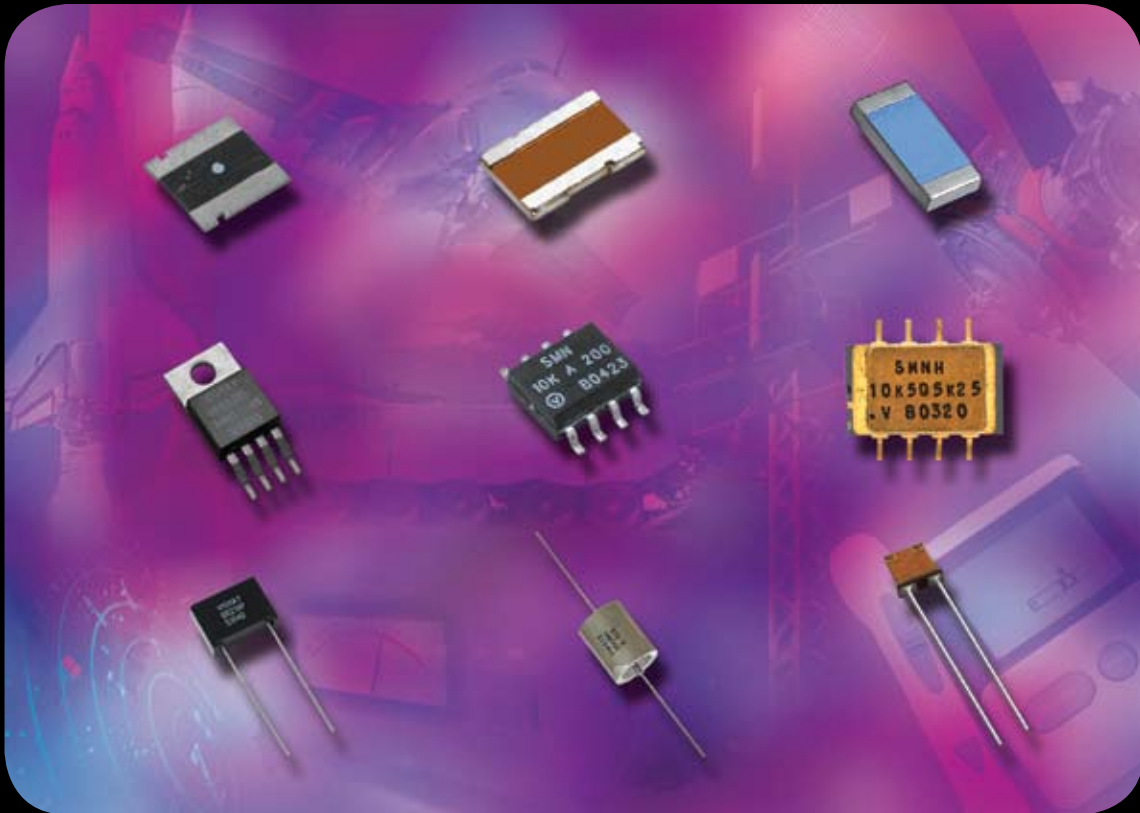




VISHAY INTERTECHNOLOGY, INC.



## BULK METAL<sup>®</sup> FOIL RESISTORS

[www.vishay.com](http://www.vishay.com)

RESISTIVE PRODUCTS

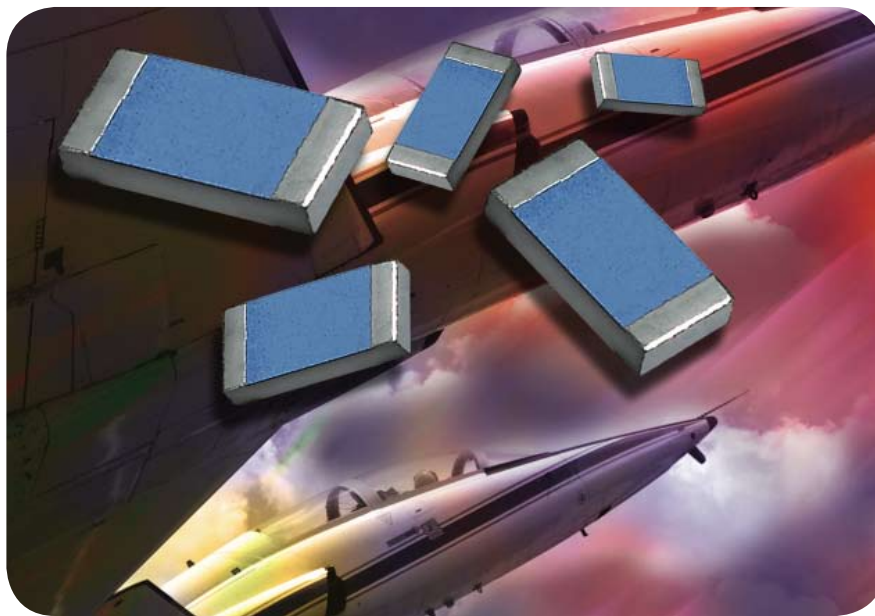
# VSMP Series (0603–2512)

## Ultra-High-Precision Z-Foil Wrap-around Chip



## Bulk Metal<sup>®</sup> Foil Resistors

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- Temperature coefficient of resistance (TCR):  $\pm 0.05$  ppm/ $^{\circ}\text{C}$  typical (0  $^{\circ}\text{C}$  to 60  $^{\circ}\text{C}$ )
- Tolerance: to  $\pm 0.01$  %
- Resistance range: From 10  $\Omega$
- Vishay Foil Resistors are not restricted to standard values, we can supply specific “as required” values at no extra cost or delivery (e.g., 100  $\Omega$  1234 vs 100  $\Omega$ )
- Electrostatic discharge (ESD): up to 25 kV
- Power coefficient of resistance (PCR): 5 ppm at rated power
- Load-life stability: (70  $^{\circ}\text{C}$  for 2000 hours at rated power):  $\pm 0.005$  % (50 ppm)
- Rated power: 100 mW to 1000 mW (depending on size) at + 70  $^{\circ}\text{C}$
- Non-inductive, non-capacitive design
- Matched sets are available upon request
- Rise time: 1 ns effectively no ringing
- Instantaneous thermal stabilization time: < 1 s
- **For AMS (Avionics, Military, Space) applications, please see the VSMP special configuration Series**

Datasheets: <http://www.vishay.com/doc?63060>  
<http://www.vishay.com/doc?63141>

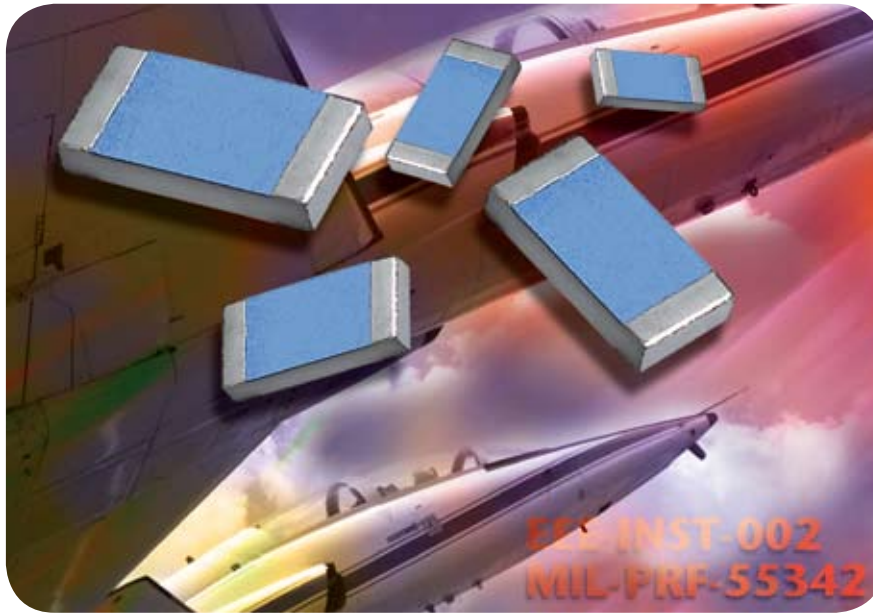
# VSMP Configuration Series (0805–2512)

Ultra-High-Precision Z-Foil Wrap-around Chip for Military, Avionics, and Space Applications with High Reliability Performances



## Bulk Metal® Foil Resistors

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- Temperature coefficient of resistance (TCR):  $\pm 0.05$  ppm/ $^{\circ}\text{C}$  typical (0  $^{\circ}\text{C}$  to 60  $^{\circ}\text{C}$ )
- Tolerance: to  $\pm 0.02$  % (after GRA Tests)
- Vishay Foil Resistors are not restricted to standard values, we can supply specific “as required” values at no extra cost or delivery (e.g., 100  $\Omega$  1234 vs 100  $\Omega$ )
- Electrostatic discharge (ESD): up to 25 kV
- Power coefficient of resistance (PCR): 5 ppm at rated power
- Load-life stability: (70  $^{\circ}\text{C}$  for 2000 hours at rated power):  $\pm 0.005$  % (50 ppm)
- Rated power: 100 mW to 1000 mW (depending on size) at + 70  $^{\circ}\text{C}$
- Non-inductive, non-capacitive design
- Matched sets are available upon request
- Rise time: 1 ns effectively no ringing
- Instantaneous thermal stabilization time: < 1 s
- Screening in accordance with **EEE-INST002**, **EPPL**, and **DSCC** available (MIL-PRF-55342)

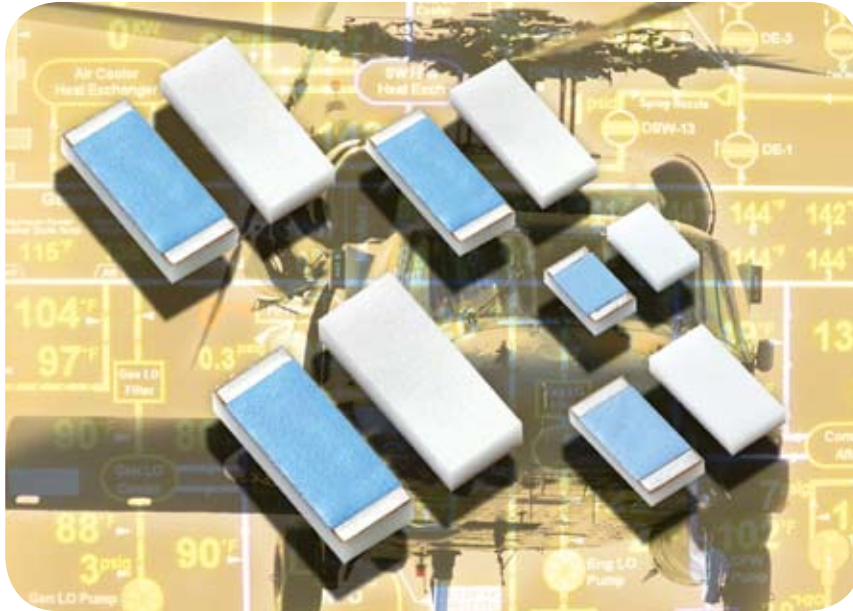
Datasheets: <http://www.vishay.com/doc?63147>

# VFCP Series (0805-2512)

## Ultra-High-Precision Z-Foil Flip-chip Resistor



## Bulk Metal<sup>®</sup> Foil Resistors



- Temperature coefficient of resistance (TCR):  $\pm 0.05$  ppm/ $^{\circ}\text{C}$  typical ( $0$   $^{\circ}\text{C}$  to  $60$   $^{\circ}\text{C}$ )
- Tolerance: to  $\pm 0.01$  %
- Resistance range: From  $10$   $\Omega$
- Vishay Foil Resistors are not restricted to standard values, we can supply specific “as required” values at no extra cost or delivery (e.g.,  $100$   $\Omega$  1234 vs  $100$   $\Omega$ )
- Electrostatic discharge (ESD): up to  $25$  kV
- Power coefficient of resistance (PCR):  $5$  ppm at rated power
- Load-life stability: ( $70$   $^{\circ}\text{C}$  for  $2000$  hours at rated power):  $\pm 0.005$  % ( $50$  ppm)
- Thermal shock ( $-55$   $^{\circ}\text{C}$  to  $+150$   $^{\circ}\text{C}$ ),  $2000$  cycles: to  $0.035$  %
- Rated power:  $100$  mW to  $600$  mW (depending on size) at  $+70$   $^{\circ}\text{C}$
- Matched sets are available upon request
- $35$  % PCB space saving vs. wrap-around terminations
- Rise time:  $1$  ns effectively no ringing
- Instantaneous thermal stabilization time:  $< 1$  s

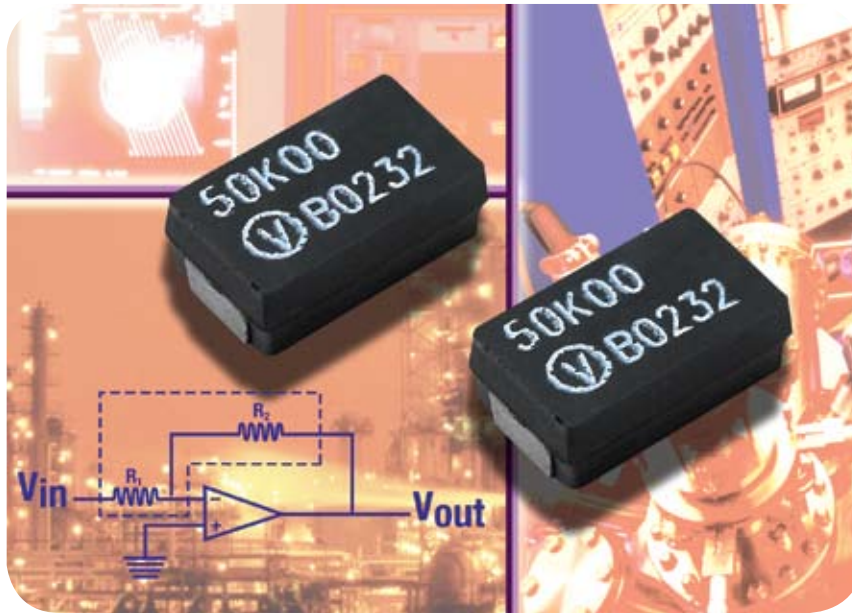
Datasheet: <http://www.vishay.com/doc?63106>

# SMRDZ Series (SMR1DZ and SMR3DZ)

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



## Bulk Metal® Foil 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)
- Tolerance: to ± 0.01 %
- Resistance range: 5 Ω to 80 kΩ. (For Avionics, Military, Space Applications, please contact us.)
- Vishay Foil Resistors are not restricted to standard values, we can supply specific “as required” values at no extra cost or delivery (e.g., 100 Ω 1234 vs 100 Ω)
- Rated power (at 70 °C): SMR1DZ = 250 mW, SMR3DZ = 600 mW
- Load-life stability (70 °C for 2000 hrs at rated power): ± 0.005 % (50 ppm)
- Electrostatic discharge (ESD): up to 25 kV
- Non-inductive, non-capacitive design
- Short-time overload: < ± 0.01 %
- Rise time: 1 ns effectively no ringing
- **For AMS (Avionics, Military, Space) applications, please see the SMRXDZ special configuration**
- **Flexible terminations ensure minimal stress transference from the PCB due to a difference in coefficient thermal of expansion (CTE)**

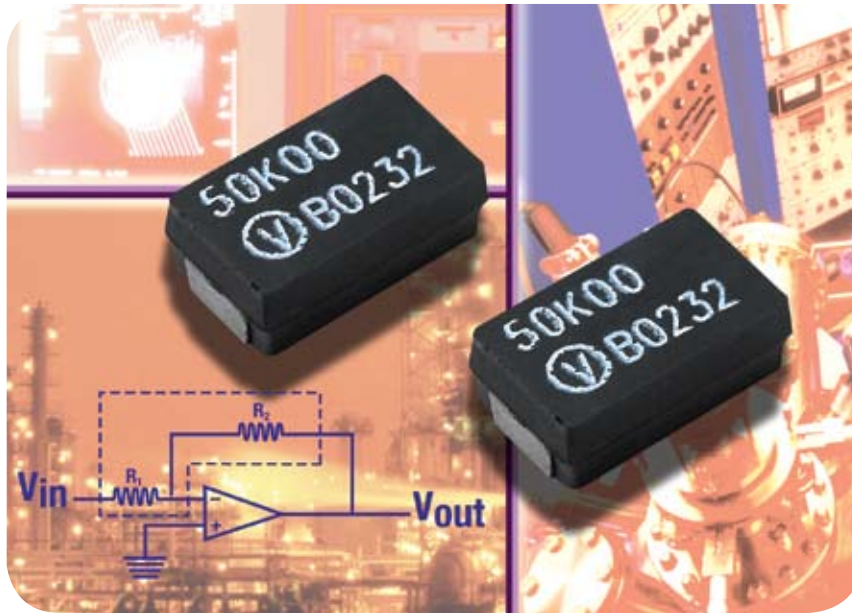
Datasheet: <http://www.vishay.com/doc?63118>

# SMRD Series (SMR1D and SMR3D)

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



## Bulk Metal® Foil Resistors



- Temperature coefficient of resistance (TCR):  
 $\pm 2$  ppm/°C typical (-55 °C to + 125 °C, + 25 °C ref)
- Tolerance: to  $\pm 0.01$  %
- Resistance range: 5  $\Omega$  to 80 k $\Omega$ . (For Avionics, Military, Space Applications, please contact us.)
- Vishay Foil Resistors are not restricted to standard values, we can supply specific “as required” values at no extra cost or delivery (e.g., 100  $\Omega$  1234 vs 100  $\Omega$ )
- Rated power (at 70 °C): SMR1DZ = 250 mW, SMR3DZ = 600 mW
- Load-life stability (70 °C for 2000 hrs at rated power):  $\pm 0.005$  % (50 ppm)
- Electrostatic discharge (ESD): up to 25 kV
- Non-inductive, non-capacitive design
- Short-time overload:  $< \pm 0.01$  %
- Rise time: 1 ns effectively no ringing
- **For AMS (Avionics, Military, Space) applications, please see the SMRXDZ special configuration**
- **Flexible terminations ensure minimal stress transference from the PCB due to a difference in coefficient thermal of expansion (CTE)**

Datasheet: <http://www.vishay.com/doc?63102>

# DSMZ

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



### Bulk Metal<sup>®</sup> Foil Resistors



- Temperature coefficient of resistance (TCR):  
Absolute:  $\pm 0.05$  ppm/ $^{\circ}\text{C}$  typical ( $0$   $^{\circ}\text{C}$  to  $+ 60$   $^{\circ}\text{C}$ )  
Tracking:  $0.1$  ppm/ $^{\circ}\text{C}$  typical
- Tolerance match: to  $\pm 0.01$  %
- Resistance ratio stability:  $\pm 0.005$  % ( $70$   $^{\circ}\text{C}$  for 2000 hrs at rated power)
- Resistance values:  $100$   $\Omega$  to  $20$  k $\Omega$  per resistor
- Vishay Foil Resistors are not restricted to standard values/ratios, we can supply specific "as required" values/ratios at no extra cost or delivery (e.g.,  $100$   $\Omega$   $123/1$  k  $456$ )
- Electrostatic discharge (ESD): up to  $25$  kV
- Power rating (at  $+ 70$   $^{\circ}\text{C}$ ):  $0.1$  W (entire package),  $0.05$  W (each resistor)
- Short-time overload:  $< \pm 0.01$  %
- Rise time:  $1$  ns effectively no ringing

Datasheet: <http://www.vishay.com/doc?63121>

# DSM

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



### Bulk Metal<sup>®</sup> Foil Resistors



- Temperature coefficient of resistance (TCR):  
Absolute:  $\pm 2$  ppm/ $^{\circ}\text{C}$  typical ( $-55$   $^{\circ}\text{C}$  to  $+ 125$   $^{\circ}\text{C}$ ,  $+ 25$   $^{\circ}\text{C}$  ref)  
Tracking:  $0.5$  ppm/ $^{\circ}\text{C}$  typical
- Tolerance match: to  $\pm 0.01$  %
- Resistance ratio stability:  $\pm 0.005$  % ( $70$   $^{\circ}\text{C}$  for 2000 hrs at rated power)
- Resistance values:  $100$   $\Omega$  to  $20$  k $\Omega$  per resistor
- Vishay Foil Resistors are not restricted to standard values/ratios, we can supply specific "as required" values/ratios at no extra cost or delivery (e.g.,  $100$   $\Omega$   $123/1$  k  $456$ )
- Electrostatic discharge (ESD): up to  $25$  kV
- Power rating (at  $+ 70$   $^{\circ}\text{C}$ ):  $0.1$  W (entire package),  $0.05$  W (each resistor)
- Short-time overload:  $< \pm 0.01$  %
- Rise time:  $1$  ns effectively no ringing

Datasheet: <http://www.vishay.com/doc?63088>





### Bulk Metal<sup>®</sup> Foil Resistors

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- Temperature coefficient of resistance (TCR):  
Absolute:  $\pm 0.05$  ppm/ $^{\circ}\text{C}$  typical (0  $^{\circ}\text{C}$  to + 60  $^{\circ}\text{C}$ )  
 $\pm 0.2$  ppm/ $^{\circ}\text{C}$  typical (- 55  $^{\circ}\text{C}$  to + 125  $^{\circ}\text{C}$ , + 25  $^{\circ}\text{C}$  ref)  
Tracking: 0.1 ppm / $^{\circ}\text{C}$  typical
- Tolerance: absolute and match to 0.01 %
- Resistance range: 1 K to 10 K
- Vishay Foil Resistors are not restricted to standard values/ratios, we can supply specific “as required” values/ratios at no extra cost or delivery (e.g., 2 K 234/5 K 456)
- Power coefficient of resistance (PCR) tracking: 5 ppm at rated power
- Electrostatic discharge (ESD): up to 25 kV
- Load-life stability: 0.01 % (0.1 W at + 70  $^{\circ}\text{C}$  for 2000 hrs)
- Current noise: - 40 dB
- Non-inductive, non-capacitive design
- Rise time: 1 ns effectively no ringing
- Instantaneous thermal stabilization time: < 1 s

Datasheet: <http://www.vishay.com/doc?63109>

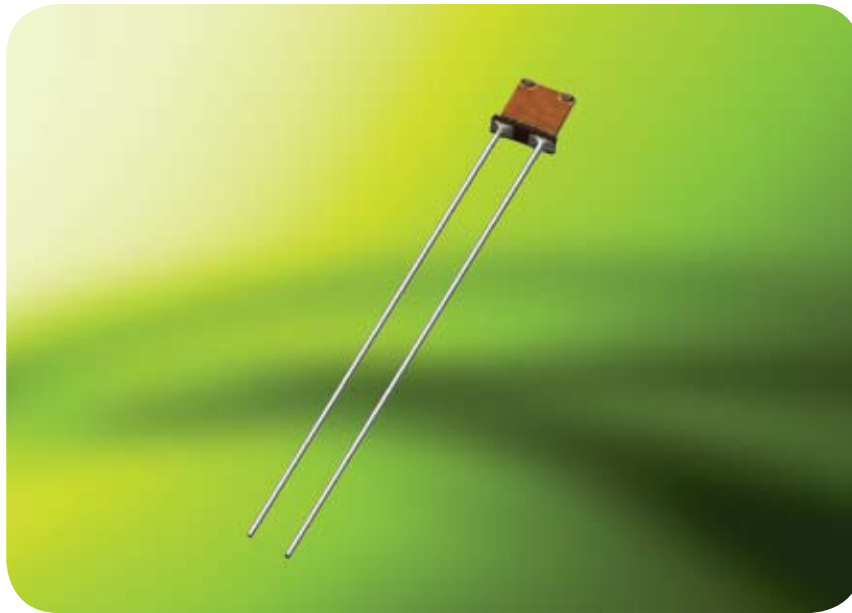
# VAR (Audio Resistor)

## Ultra-High-Precision Z-Foil Audio Resistor



## Bulk Metal<sup>®</sup> Foil Resistors

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- Rise time: 1 ns effectively no ringing
- Unmolded or unencapsulated, adding an additional dimension for reducing signal distortion and increasing clarity in signal processing
- Temperature coefficient of resistance (TCR):  $\pm 0.05$  ppm/ $^{\circ}\text{C}$  typical ( $0$   $^{\circ}\text{C}$  to  $+ 60$   $^{\circ}\text{C}$ )
- Tolerance: to  $\pm 0.01$  %
- Resistance range:  $10 \Omega$  to  $100 \text{ k}\Omega$
- Vishay Foil Resistors are not restricted to standard values, we can supply specific “as required” values at no extra cost or delivery (e.g.,  $100 \Omega$  123 vs  $100 \Omega$ )
- Electrostatic discharge (ESD): up to 25 kV
- Load-life stability: ( $70$   $^{\circ}\text{C}$  for 2000 hrs at rated power):  $\pm 0.01$  % (100 ppm)
- Rated power: 0.2 Watts at  $+ 125$   $^{\circ}\text{C}$
- Thermal EMF:  $0.05 \mu\text{V}/^{\circ}\text{C}$
- Matched sets are available upon request

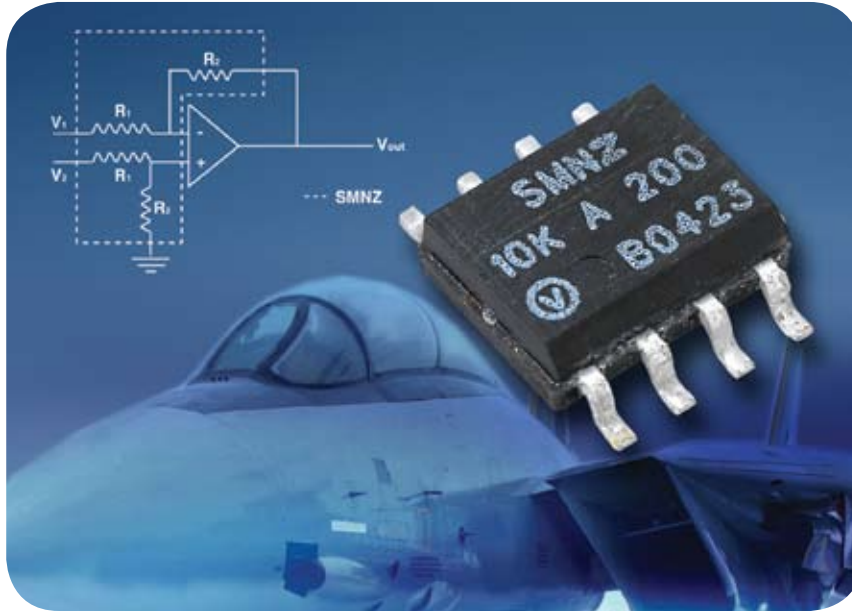
Datasheet: <http://www.vishay.com/doc?63140>

# SMNZ

## 4 Resistor Surface-Mount Network Dual-In-Line Molded Package with Z-Foil Technology



### Bulk Metal<sup>®</sup> Foil Resistors



- Temperature coefficient of resistance (TCR):  
Absolute:  $\pm 0.05$  ppm/ $^{\circ}\text{C}$  typical (0  $^{\circ}\text{C}$  to + 60  $^{\circ}\text{C}$ )  
 $\pm 0.2$  ppm/ $^{\circ}\text{C}$  typical (- 55  $^{\circ}\text{C}$  to + 125  $^{\circ}\text{C}$ , + 25  $^{\circ}\text{C}$  ref)
- TCR tracking: < 0.5 ppm/ $^{\circ}\text{C}$  typical
- Resistance range: 100  $\Omega$  to 10 k $\Omega$  (per resistor)
- Vishay Foil Resistors are not restricted to standard values/ratios, we can supply specific “as required” values/ratios at no extra cost or delivery (e.g. 1 K 123 vs 1 K)
- Power coefficient of resistance (PCR) tracking: 5 ppm at rated power
- Resistance tolerance match:  $\pm 0.01$  %
- Load-life stability: 0.005 % (0.1 W at 2000 hrs, 70  $^{\circ}\text{C}$ )
- Electrostatic discharge (ESD): up to 25 kV
- Non-inductive, non-capacitive design
- Rise time: 1 ns effectively no ringing

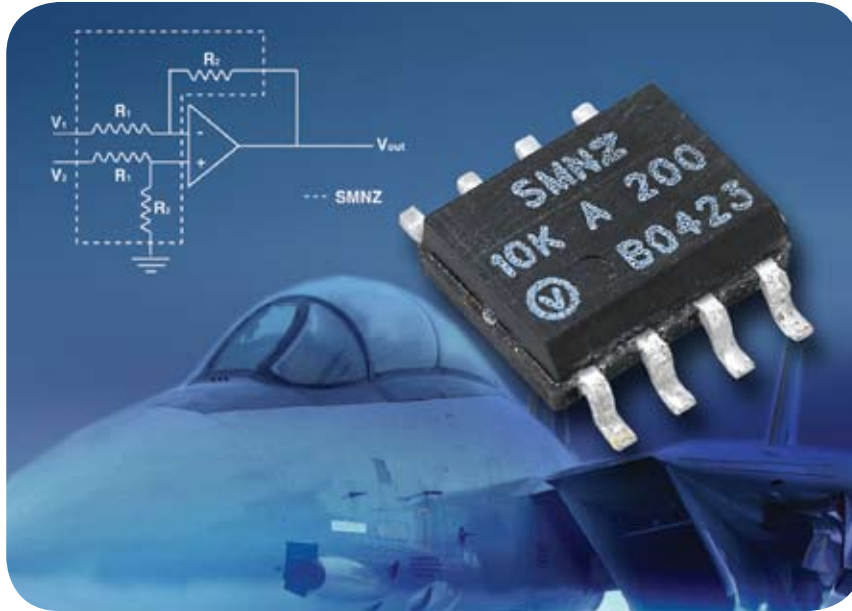
Datasheet: <http://www.vishay.com/doc?63117>

# SMN

## 4 Resistor Surface-Mount Network Dual-In-Line Molded Package with Foil Technology



### Bulk Metal<sup>®</sup> Foil Resistors



- Temperature coefficient of resistance (TCR):  
Absolute:  $\pm 2$  ppm/ $^{\circ}\text{C}$  typical ( $-55$   $^{\circ}\text{C}$  to  $+125$   $^{\circ}\text{C}$ ,  $+25$   $^{\circ}\text{C}$  ref)
- Tracking: 0.5 ppm/ $^{\circ}\text{C}$  typical
- Resistance range: 100  $\Omega$  to 20 k $\Omega$  (per resistor)
- Vishay Foil Resistors are not restricted to standard values/ratios, we can supply specific “as required” values/ratios at no extra cost or delivery (e.g., 1K123 vs 1 K)
- Power coefficient of resistance (PCR) tracking: 5 ppm at rated power
- Resistance tolerance match:  $\pm 0.01$  %
- Load-life stability: 0.005 % (0.1 W at 2000 hrs, 70  $^{\circ}\text{C}$ )
- Electrostatic discharge (ESD): up to 25 kV
- Non-inductive, non-capacitive design
- Rise time: 1 ns effectively no ringing

Datasheet: <http://www.vishay.com/doc?63081>

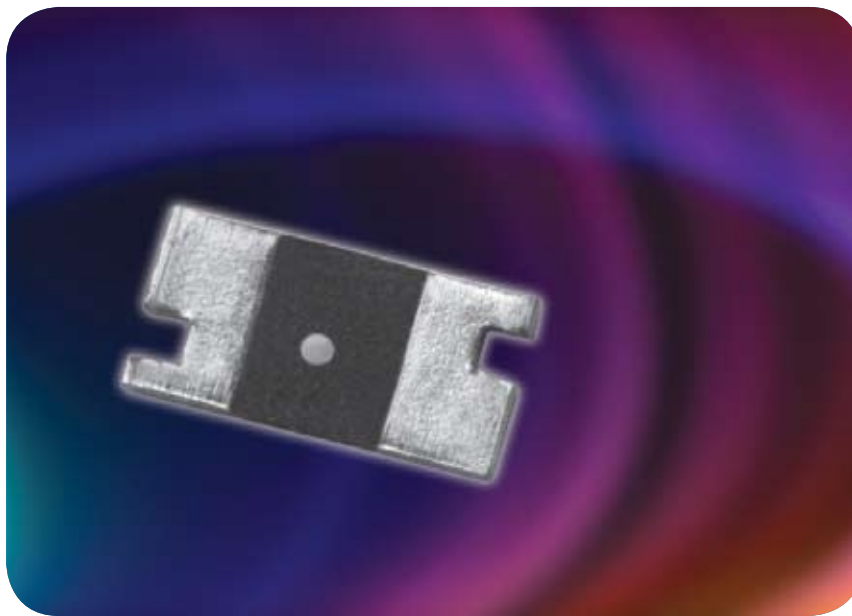
# CSM2512S

Precision Current-Sensing Surface-Mount Power Metal Strip® Resistor  
(Improved Stability)



## Bulk Metal® Foil Resistors

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- Surface-mount: 4-terminal 2512 size
- Temperature coefficient of resistance (TCR):  
 **$\pm 15 \text{ ppm}/^\circ\text{C}$  maximum (- 55 °C to + 125 °C, + 25 °C ref)**  
 **$\pm 10 \text{ ppm}/^\circ\text{C}$  maximum available**
- Tolerance: 0.1 %
- Resistance range: 10 m $\Omega$  to 100 m $\Omega$
- Vishay Foil Resistors are not restricted to standard values, we can supply specific “as required” values at no extra cost or delivery (e.g., 50 m $\Omega$  1234 vs 50 m $\Omega$ )
- Proprietary processing technique produces extremely high long term stability and reliability
- Load life stability, 2000 hours at rated power: to  $\pm 0.05$  %. (Typical current sensing resistors offer a load-life stability of  $\geq 0.5$  % through a 1000-hour workload.)
- Current: to 18 A
- Power rating: to 1 W
- Thermal EMF: 3  $\mu\text{V}/^\circ\text{C}$
- Screening in accordance with EEE-INST002 available (MIL-PRF 55342 and MIL-PRF 49465)

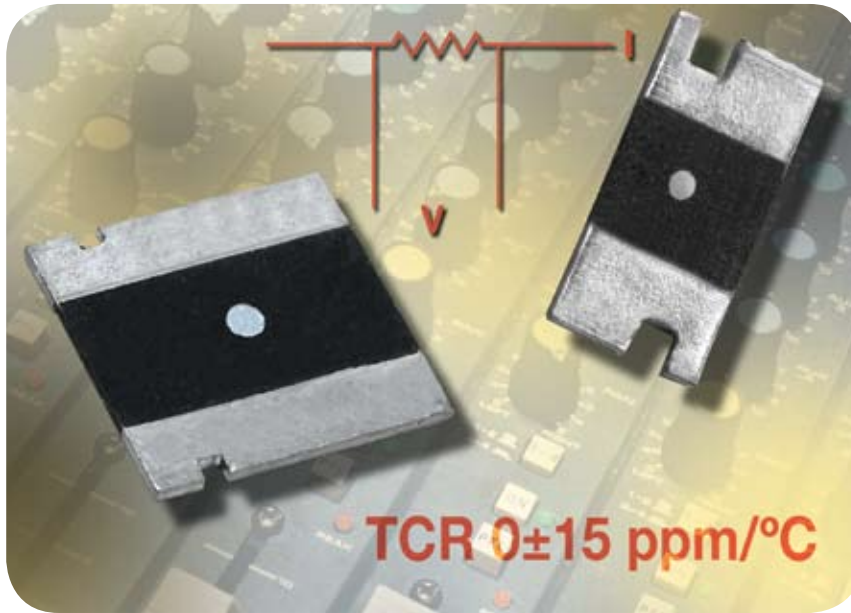
Datasheet: <http://www.vishay.com/doc?63145>

# CSM Series (CSM2512 and CSM3637)

Precision Current-Sensing Surface-Mount Power Metal Strip® Resistor



## Bulk Metal® Foil Resistors



- Surface-mount: 4-terminal 2512 and 3637 sizes
- Temperature coefficient of resistance (TCR):  
 $0 \pm 15 \text{ ppm/}^\circ\text{C}$  maximum (- 55 °C to + 125 °C, + 25 °C ref)
- Tolerance: 0.1 %
- Resistance range: 1 m $\Omega$  to 200 m $\Omega$
- Vishay Foil Resistors are not restricted to standard values, we can supply specific “as required” values at no extra cost or delivery (e.g., 50 m $\Omega$  1234 vs 50 m $\Omega$ )
- Current: to 38 A
- Power rating: to 3 W
- Thermal EMF: 3  $\mu\text{V/}^\circ\text{C}$
- Screening in accordance with EEE-INST002 or DSCC available (MIL-PRF 55342 and MIL-PRF 49465)

Datasheet: <http://www.vishay.com/doc?63089>

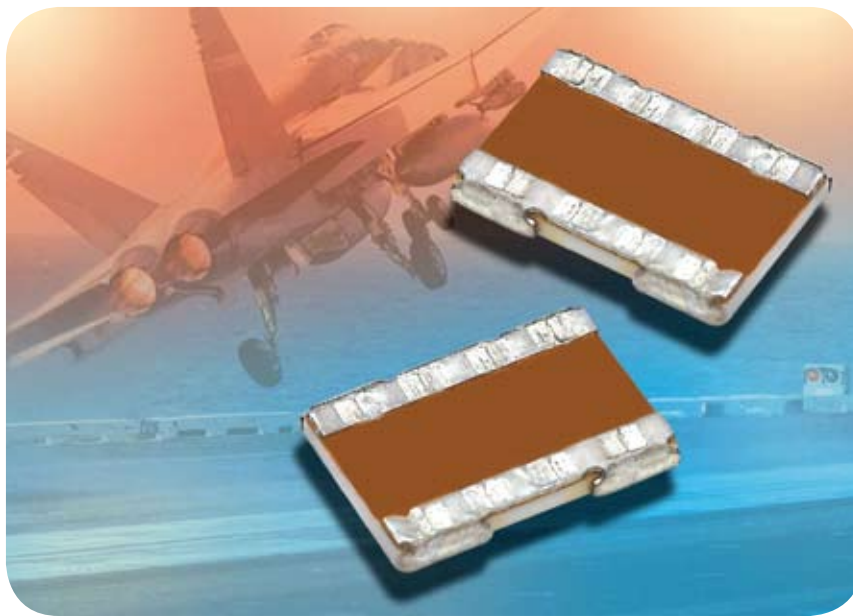
# VCS1625Z and VCS1625

## Ultra-High-Precision Current-Sensing Resistors



### Bulk Metal<sup>®</sup> Foil Resistors

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- VCS1625Z – Z-Based Bulk Metal<sup>®</sup> Foil
- VCS1625 – Bulk Metal Foil
- Temperature coefficient of resistance (TCR):  $\pm 0.05$  ppm/ $^{\circ}\text{C}$  typical ( $0$   $^{\circ}\text{C}$  to  $+ 60$   $^{\circ}\text{C}$ ) (Z-Foil)  
 $\pm 0.2$  ppm/ $^{\circ}\text{C}$  typical ( $- 55$   $^{\circ}\text{C}$  to  $+ 125$   $^{\circ}\text{C}$ ,  $+ 25$   $^{\circ}\text{C}$  ref)
- Tolerance: to  $\pm 0.1$  %
- Resistance range:  $0.01$   $\Omega$  to  $10.0$   $\Omega$
- Vishay Foil Resistors are not restricted to standard values, we can supply specific “as required” values at no extra cost or delivery (e.g.,  $5$   $\Omega$  1234 vs  $5$   $\Omega$ )
- Power coefficient of resistance (PCR):  $5$  ppm at rated power with the Z-Foil
- Load-life stability: ( $70$   $^{\circ}\text{C}$  for  $2000$  hrs, rated power):  $\pm 0.02$  %
- Electrostatic discharge (ESD): up to  $25$  kV
- Short-time overload:  $< \pm 0.005$  %
- Thermal EMF:  $< 0.05$   $\mu\text{V}/^{\circ}\text{C}$
- Non-inductive, non-capacitive design
- Rise time:  $1$  ns effectively no ringing
- Instantaneous thermal stabilization time:  $< 1$  s
- Screening in accordance with EEE-INST002, EPPL, and DSCC available

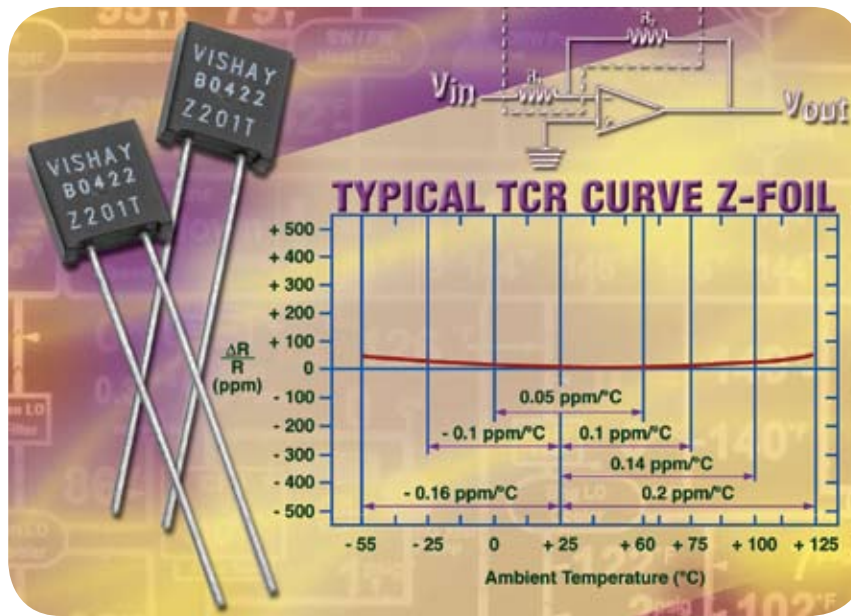
Datasheets: <http://www.vishay.com/doc?63094>  
<http://www.vishay.com/doc?63023>

# Z201

## Ultra-High-Precision Z-Foil Resistor



## Bulk Metal® Foil Resistors



- Temperature coefficient of resistance (TCR):  $\pm 0.05$  ppm/°C typical (0 °C to + 60 °C)
- Tolerance: to  $\pm 0.005$  % (50 ppm)
- Resistance range: 10  $\Omega$  to 100 k $\Omega$
- Vishay Foil Resistors are not restricted to standard values, we can supply specific “as required” values at no extra cost or delivery (e.g., 50 k $\Omega$  1234 vs 50 k $\Omega$ )
- Power coefficient of resistance (PCR): 5 ppm at rated power
- Instantaneous thermal stabilization time: < 1 s
- Electrostatic discharge (ESD): up to 25 kV
- Load-life stability: (70 °C for 2000 hrs at rated power):  $\pm 0.005$  %
- Rated power: 0.3 W at + 125 °C
- Short-time overload:  $\pm 0.003$  %
- Thermal EMF: 0.05  $\mu$ V/°C
- Rise time: 1 ns effectively no ringing
- Matched sets are available upon request
- Screening in accordance with EEE-INST002 available (MIL-PRF 55182)

Datasheet: <http://www.vishay.com/doc?63113>



# Z202

## Ultra-High-Precision Z-Foil Miniature Resistor



### Bulk Metal<sup>®</sup> Foil Resistors

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- Temperature coefficient of resistance (TCR):  $\pm 0.05$  ppm/ $^{\circ}\text{C}$  typical ( $0^{\circ}\text{C}$  to  $+60^{\circ}\text{C}$ )
- Tolerance: to  $\pm 0.01\%$
- Resistance range:  $5\ \Omega$  to  $30\ \text{k}\Omega$
- Vishay Foil Resistors are not restricted to standard values, we can supply specific “as required” values at no extra cost or delivery (e.g.  $10\ \text{k}\Omega$  1234 vs  $10\ \text{k}\Omega$ )
- Power coefficient of resistance (PCR): 5 ppm at rated power
- Instantaneous thermal stabilization time:  $< 1$  s
- Electrostatic discharge (ESD): up to 25 kV
- Load-life stability: ( $70^{\circ}\text{C}$  for 2000 hrs at rated power):  $\pm 0.01\%$
- Rated power: 0.125 W at  $+125^{\circ}\text{C}$
- Thermal EMF:  $0.05\ \mu\text{V}/^{\circ}\text{C}$
- Rise time: 1 ns effectively no ringing
- Matched sets are available upon request

Datasheet: <http://www.vishay.com/doc?63131>

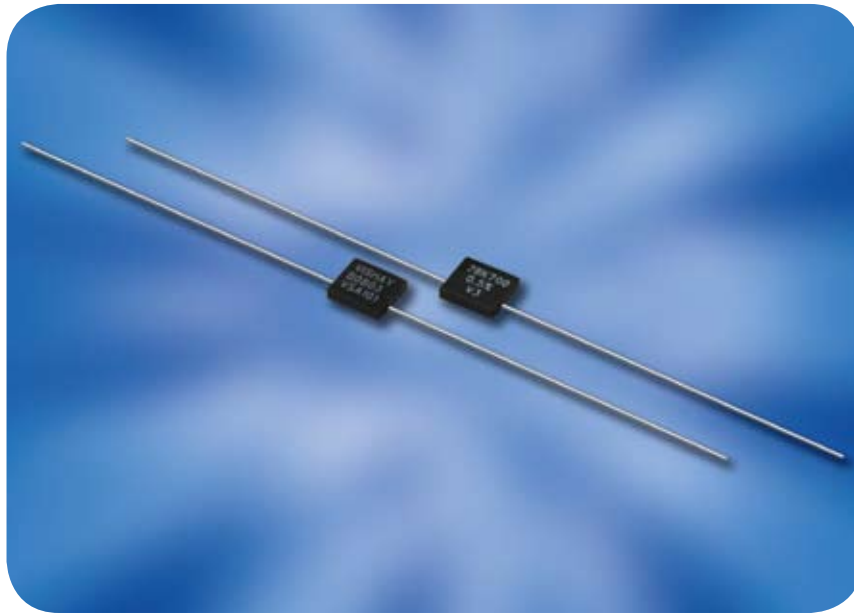
# VSA101

## Ultra-High-Precision Z-Foil Resistor



## Bulk Metal<sup>®</sup> Foil Resistors

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- Temperature coefficient of resistance (TCR):  $\pm 0.05$  ppm/ $^{\circ}\text{C}$  typical (0  $^{\circ}\text{C}$  to + 60  $^{\circ}\text{C}$ )
- Tolerance: to  $\pm 0.005$  %
- Resistance range: 5  $\Omega$  to 100 k $\Omega$
- Vishay Foil Resistors are not restricted to standard values, we can supply specific “as required” values at no extra cost or delivery (e.g., 10 k $\Omega$  1234 vs 10 k $\Omega$ )
- Power coefficient of resistance (PCR): 5 ppm at rated power
- Instantaneous thermal stabilization time: < 1 s
- Electrostatic discharge (ESD): up to 25 kV
- Load-life stability: (70  $^{\circ}\text{C}$  for 2000 hrs at rated power):  $\pm 0.005$  %
- Rated power: 0.3 Watts at + 125  $^{\circ}\text{C}$
- Short-time overload:  $\pm 0.003$  %
- Thermal EMF: 0.05  $\mu\text{V}/^{\circ}\text{C}$
- Rise time: 1 ns effectively no ringing
- Matched sets are available upon request

Datasheet: <http://www.vishay.com/doc?63143>

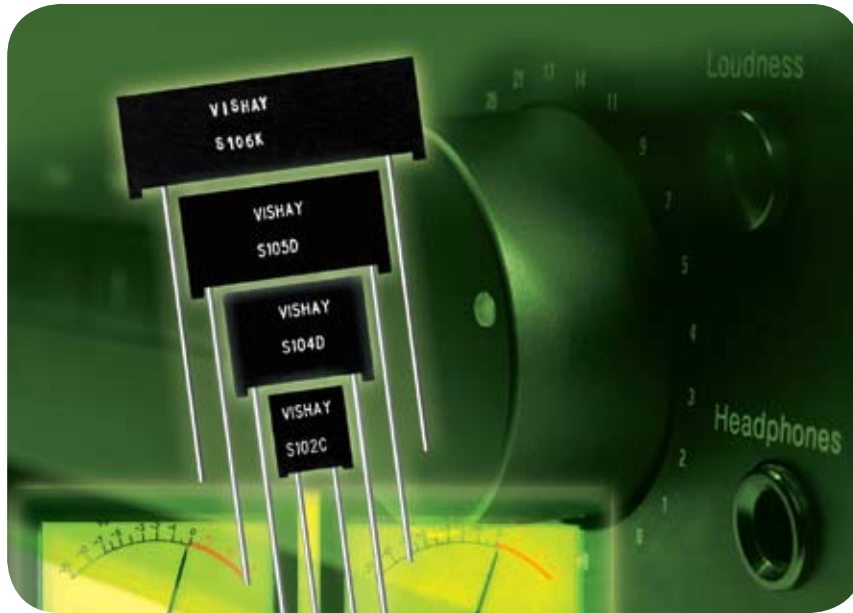
# S Series

## High-Precision Bulk Metal® Foil Resistors



## Bulk Metal® Foil Resistors

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- Temperature coefficient of resistance (TCR):  
± 2 ppm/°C typical (-55 °C to + 125 °C, + 25 °C ref)
- Tolerance: ± 0.005 %
- Resistance range: 0.5 Ω to 1 MΩ
- Vishay Foil Resistors are not restricted to standard values, we can supply specific “as required” values at no extra cost or delivery (e.g., 100 kΩ 1234 vs 100 kΩ)
- Instantaneous thermal stabilization time: < 1 s
- Electrostatic discharge (ESD): up to 25 kV
- Load-life stability: (70 °C for 2000 hrs at rated power): ± 0.005 %
- Rated power: 0.3 W to 1 W at + 125 °C (depending on size)
- Short-time overload: ± 0.003 %
- Thermal EMF: 0.05 μV/°C
- Rise time: 1 ns effectively no ringing
- Matched sets available per request
- Non-inductive, non-capacitive design

Datasheet: <http://www.vishay.com/doc?63001>

# 2R, 3R, 4R Series with Z-Foil

## Ultra-High-Precision Z-Foil Voltage Dividers and Resistor Networks



### Bulk Metal<sup>®</sup> Foil Resistors

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- Temperature coefficient of resistance (TCR):  
Absolute:  $\pm 0.05$  ppm/ $^{\circ}\text{C}$  typical (0  $^{\circ}\text{C}$  to + 60  $^{\circ}\text{C}$ )  
Tracking: 0.1 ppm/ $^{\circ}\text{C}$  typical
- Tolerance: absolute and resistance match to  $\pm 0.005$  %
- Resistance range: 1  $\Omega$  to 150 k $\Omega$  (per resistor)
- Vishay Foil Resistors are not restricted to standard values/ratios, we can supply specific “as required” values/ratios at no extra cost or delivery (e.g., 1 K 123 vs 1 K)
- Power coefficient of resistance (PCR) tracking: 5 ppm at rated power
- Load-life stability (70  $^{\circ}\text{C}$  for 2000 hrs, rated power):  $\pm 0.005$  % (50 ppm)
- Electrostatic discharge (ESD): up to 25 kV
- Non-inductive, non-capacitive design
- Rise time: 1 ns effectively no ringing

Datasheet: <http://www.vishay.com/doc?63044>

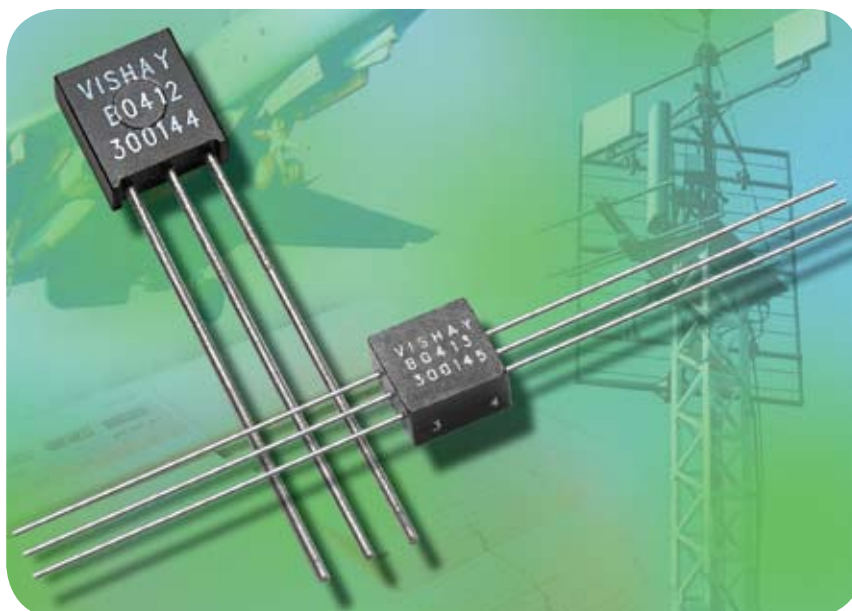
# 300144Z, 300145Z

## Ultra-High-Precision Z-Foil Voltage Dividers



## Bulk Metal<sup>®</sup> Foil Resistors

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- Temperature coefficient of resistance (TCR):  
Absolute:  $\pm 0.05$  ppm/ $^{\circ}\text{C}$  typical (0  $^{\circ}\text{C}$  to + 60  $^{\circ}\text{C}$ )  
 $\pm 0.2$  ppm/ $^{\circ}\text{C}$  typical (-55  $^{\circ}\text{C}$  to + 125  $^{\circ}\text{C}$ , + 25  $^{\circ}\text{C}$  ref)
- Tracking: 0.1 ppm/ $^{\circ}\text{C}$
- Tolerance: absolute and matching to  $\pm 0.005$  %
- Resistance range: 100  $\Omega$  to 20 k $\Omega$  (per resistor)
- Vishay Foil Resistors are not restricted to standard values/ratios, we can supply specific "as required" values/ratios at no extra cost or delivery (e.g., 1 K 123 vs 1 K)
- Power coefficient of resistance (PCR) tracking: 5 ppm at rated power
- Rated power: 0.2 W @ + 70  $^{\circ}\text{C}$  (R1 + R2)
- Ratio stability:  $< \pm 0.001$  % (10 ppm) 0.2 W at 70  $^{\circ}\text{C}$  for 2000 hours
- Electrostatic discharge (ESD): up to 25 kV
- Maximum working voltage: 200 V
- Rise time: 1 ns effectively no ringing

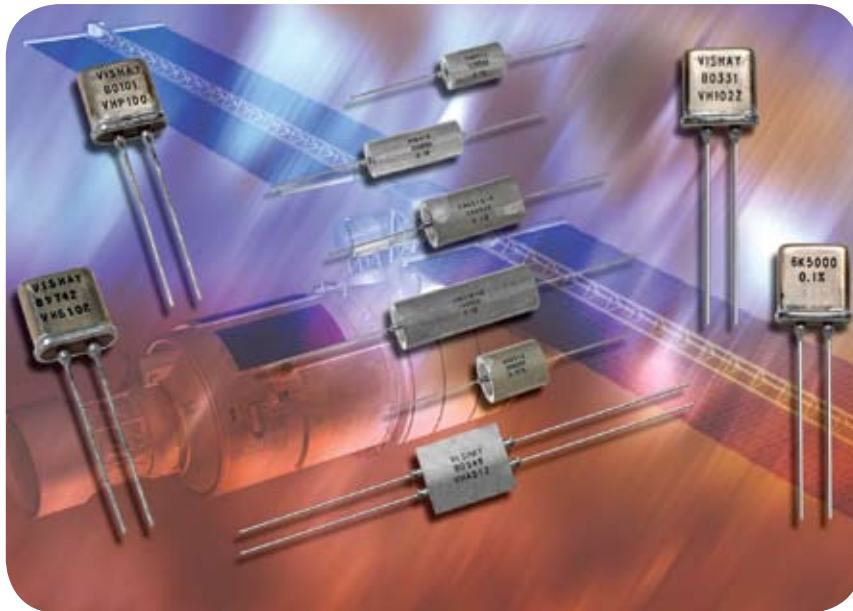
Datasheet: <http://www.vishay.com/doc?63115>

# Ultra-High-Precision Hermetically-Sealed Z-Foil Resistors



## Bulk Metal<sup>®</sup> Foil Resistors

The VHA Series is available with laboratory and metrology level precision and long-term stability with additional in-house oriented processes.



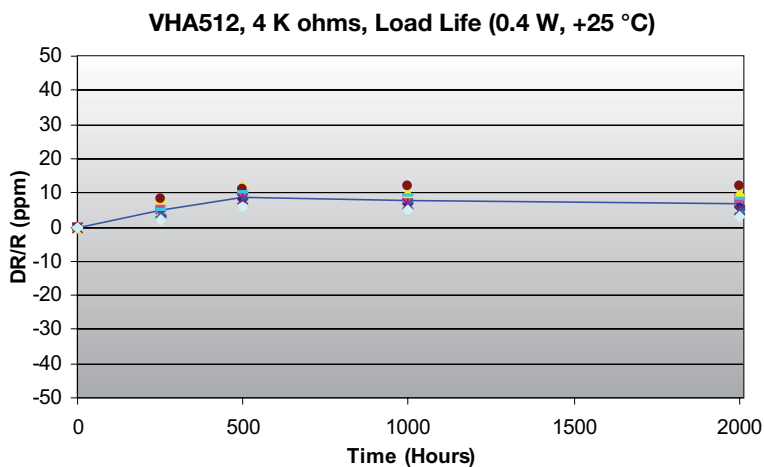
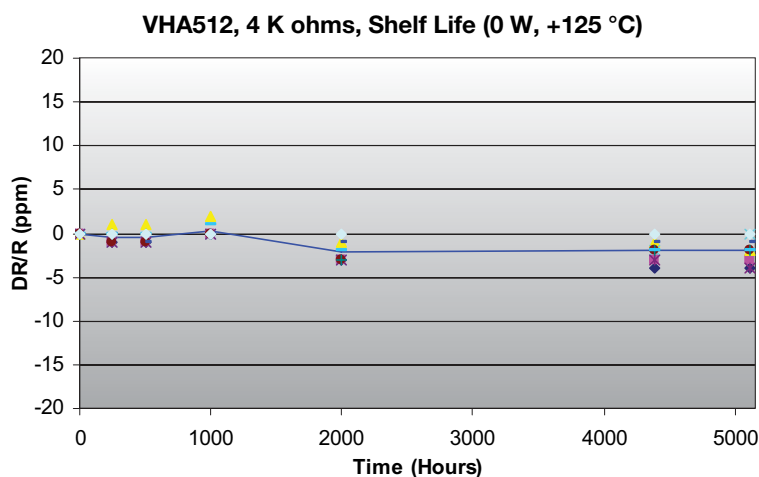
- Oil-filled for ultra hermeticity
- Temperature coefficient of resistance (TCR):  
± 0.2 ppm/° C typical (- 55 °C to + 125 °C, + 25 °C ref)
- Tolerance: To ± 0.001 % (10 ppm)
- Resistance range: 5 Ω to 1.84 MΩ
- Vishay Foil Resistors are not restricted to standard values, we can supply specific “as required” values at no extra cost or delivery (e.g., 1 K 123 vs 1 K)
- Power coefficient of resistance (PCR): 5 ppm at rated power
- Load-life stability: 20 ppm typical, 2000 hours at + 25 °C
- Available with 2/3/4-terminal connections
- Shelf-life stability: 2 ppm for at least 10 years
- Non-inductive, non-capacitive design

Datasheets: <http://www.vishay.com/doc?63120>  
<http://www.vishay.com/doc?63006>  
<http://www.vishay.com/doc?63003>

# Ultra-High-Precision Hermetically-Sealed Z-Foil Resistors (Cont.)



## Bulk Metal<sup>®</sup> Foil Resistors



# VHP203

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



### Bulk Metal<sup>®</sup> Foil Resistors

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- Temperature coefficient of resistance (TCR): Absolute:  $\pm 0.05$  ppm/ $^{\circ}\text{C}$  (0  $^{\circ}\text{C}$  to + 60  $^{\circ}\text{C}$ )
- Tolerance:  $\pm 0.001$  % (10 ppm)
- Resistance range: 10  $\Omega$  to 100 k $\Omega$
- Vishay Foil Resistors are not restricted to standard values, we can supply specific “as required” values at no extra cost or delivery (e.g., 50 k $\Omega$  1234 vs 50 k $\Omega$ )
- Power coefficient of resistance (PCR): 5 ppm at rated power
- Load-life stability:  $\pm 0.002$  % maximum  $\Delta R$  (60  $^{\circ}\text{C}$  for 2000 hr at 0.1 W)
- Shelf-life stability: 2 ppm for at least 10 years
- Non-inductive, non-capacitive design
- Rise time: 1 ns effectively no ringing
- Electrostatic discharge (ESD): up to 25,000 V
- 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

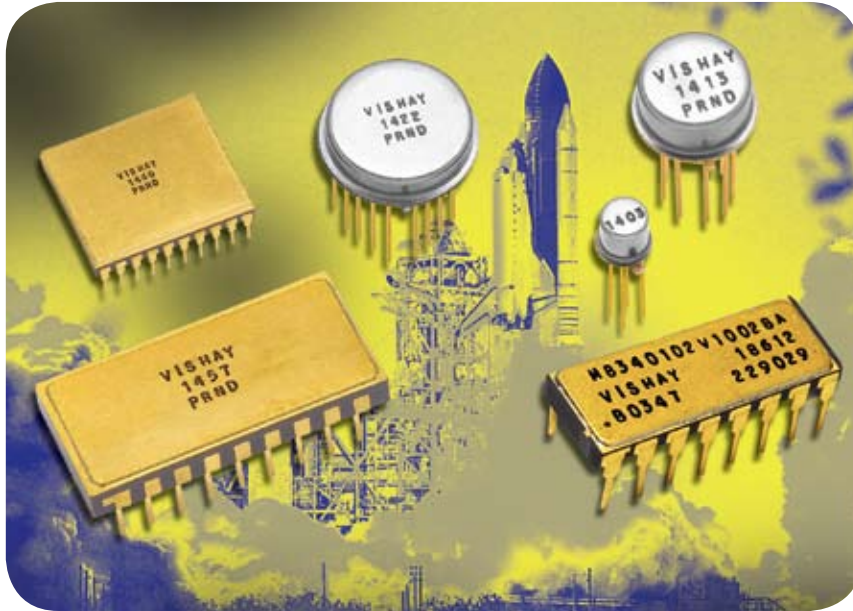
Datasheet: <http://www.vishay.com/doc?63146>



# PRND (Custom Networks)



## Bulk Metal<sup>®</sup> Foil Resistors



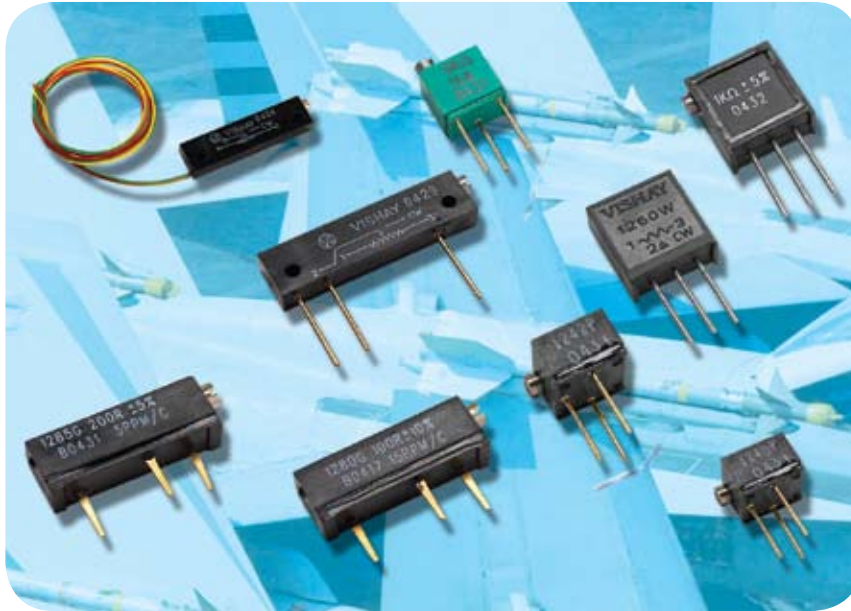
- Temperature coefficient of resistance (TCR):  
Absolute:  $\pm 2$  ppm/ $^{\circ}$ C typical (- 55  $^{\circ}$ C to + 125  $^{\circ}$ C, + 25  $^{\circ}$ C ref)
- Tracking: 0.5 ppm/ $^{\circ}$ C
- Flexible schematic designs
- Tolerance: absolute  $\pm 0.005$  %; match 0.002 %
- Resistance range: 5  $\Omega$  to 80 k $\Omega$
- Vishay Foil Resistors are not restricted to standard values/ratios, we can supply specific "as required" values/ratios at no extra cost or delivery (e.g. 50 k $\Omega$  1234 vs 50 k $\Omega$ )
- Load-life stability (> 1000 hrs 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.vishay.com/doc?63128>

# Trimmers

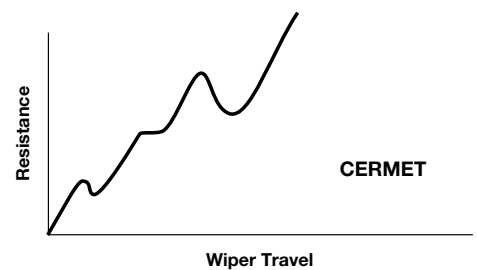
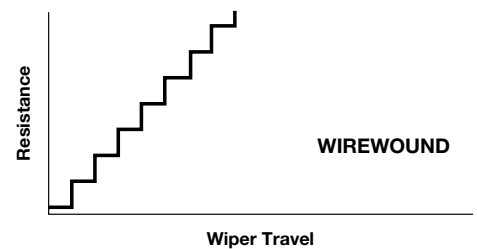
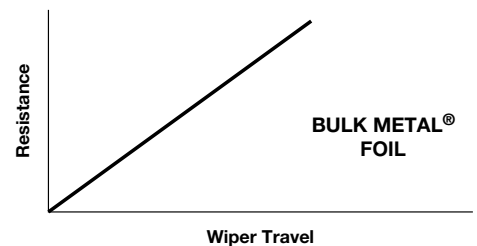


## Bulk Metal® Foil Resistors



- TCR through the wiper:  $\pm 25$  ppm/ $^{\circ}$ C
- Setability: down to  $\pm 0.005$  %
- Setting stability: to 0.1 %
- Load-life stability: 20 ppm
- Tap test: 0.05%
- All trimmers undergo noise and linearity tests during the standard production process
- “O” ring prevents ingress of fluids during any board cleaning operation

Datasheets: <http://www.vishay.com/doc?63052>  
<http://www.vishay.com/doc?63053>  
<http://www.vishay.com/doc?63054>  
<http://www.vishay.com/doc?63055>  
<http://www.vishay.com/doc?63056>



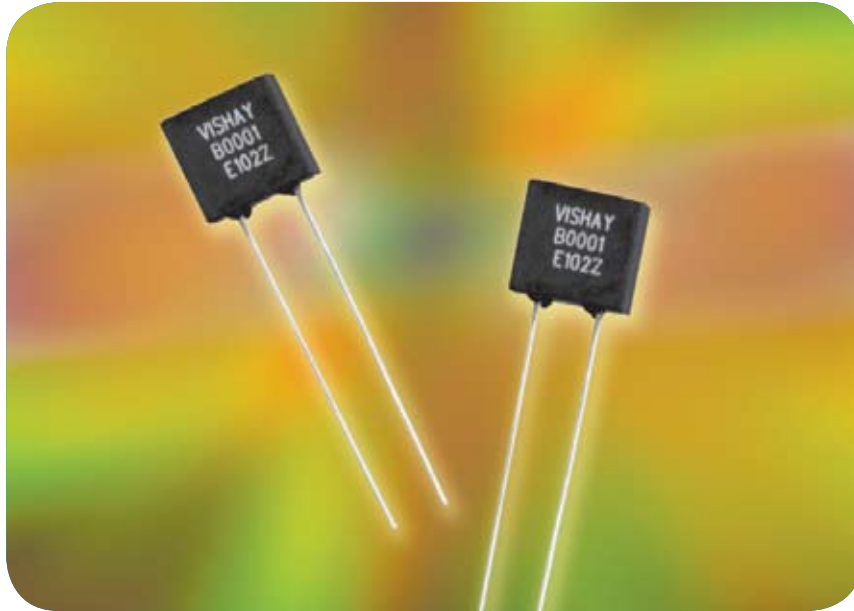
# E102Z

## Ultra-High-Precision Z-Foil Resistor



## Bulk Metal<sup>®</sup> Foil Resistors

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- Temperature coefficient of resistance (TCR):  $\pm 0.05$  ppm/ $^{\circ}\text{C}$  typical (0  $^{\circ}\text{C}$  to + 60  $^{\circ}\text{C}$ )
- Tolerance: to  $\pm 0.005$  %
- Resistance Range: 100 k $\Omega$  to 250 k $\Omega$
- Vishay Foil Resistors are not restricted to standard values, we can supply specific “as required” values at no extra cost or delivery (e.g., 100 k $\Omega$  1234 vs 100 k $\Omega$ )
- Power coefficient of resistance (PCR): 5 ppm at rated power
- Electrostatic discharge (ESD): up to 25 kV
- Load-life stability: (70  $^{\circ}\text{C}$  for 2000 hrs at rated power):  $\pm 0.005$  %
- Rated power: 0.3 Watts at + 125  $^{\circ}\text{C}$
- Short-time overload:  $\pm 0.003$  %
- Thermal EMF: 0.05  $\mu\text{V}/^{\circ}\text{C}$
- Rise time: 1 ns effectively no ringing
- Matched sets are available upon request
- Instantaneous thermal stabilization time: < 1 s

Datasheet: <http://www.vishay.com/doc?63144>

# VPR221SZ/VPR221Z

## Ultra-High-Precision Z-Foil Power Resistors



## Bulk Metal<sup>®</sup> Foil Resistors

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- 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: ± 0.01%
- Resistance range: 0.5 Ω to 500 Ω
- Vishay Foil Resistors are not restricted to standard values, we can supply specific “as required” values at no extra cost or delivery (e.g., 100 Ω 1234 vs 100 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 ± 0.005 % at 25 °C, 2000 hours at 1.5 W
- Electrostatic discharge (ESD): up to 25 kV
- Rise time: 1 ns effectively no ringing
- Current noise: < -40 dB
- Instantaneous thermal stabilization time: < 1 s
- Non hot spot design
- Screening in accordance with EEE-INST002 available (MIL-PRF 39009)

Datasheets: <http://www.vishay.com/doc?63127> (VPR221SZ)  
<http://www.vishay.com/doc?63116> (VPR221Z)

# VPR220Z/VPR220SZ

## Ultra-High-Precision Z-Foil Power Resistors



## Bulk Metal<sup>®</sup> Foil Resistors

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- 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: ± 0.01%
- Resistance range: 5 Ω to 10 kΩ
- Vishay Foil Resistors are not restricted to standard values, we can supply specific “as required” values at no extra cost or delivery (e.g., 100 Ω 1234 vs 100 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 ± 0.005 % at 25 °C, 2000 hours at 1.5 W
- Electrostatic discharge (ESD): up to 25 kV
- Rise time: 1 ns effectively no ringing
- Current noise: < - 40 dB
- Instantaneous thermal stabilization time: < 1 s
- Non hot spot design
- Screening in accordance with EEE-INST002 available (MIL-PRF 39009)

Datasheets: <http://www.vishay.com/doc?63064> (VPR220Z)  
<http://www.vishay.com/doc?63068> (VPR220SZ)

# RNC90Y/RNC90Z

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



## Bulk Metal<sup>®</sup> Foil Resistors

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- QPL product with established reliability (MIL-PRF-55182/9)
- Load-life stability:  $\pm 0.005\%$  typical  $\Delta R$  for 2000 hours at 125 °C
- Temperature coefficient of resistance (TCR):  $\pm 2$  ppm/°C max (- 55 °C to + 175 °C)
- Thermal EMF:  $< 0.1$   $\mu\text{V}/^\circ\text{C}$
- Qualified resistance range:
  - 4.99  $\Omega$  to 121 k $\Omega$  (RNC90Y)
  - 30.1  $\Omega$  to 121 k $\Omega$  (RNC90Z)
- Resistance tolerance: to  $\pm 0.005$  %
- Electrostatic discharge (ESD): up to 25 kV
- Rise time: 1 ns effectively no ringing
- Instantaneous thermal stabilization time:  $< 1$  s

Datasheets: <http://www.vishay.com/doc?63007>

# RCK HR 02, 02A

Military and Space Established Reliability (ER) Foil Resistors (ESA) with Flexible Terminations



## Bulk Metal<sup>®</sup> Foil Resistors

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- QPL product with ESA specification 4001/011
- Load life stability:  $\pm 0.005$  % for 2000 hours at + 125 °C, at rated power
- Temperature coefficient of resistance (TCR):  $\pm 5$  ppm/°C typical (- 55 °C to + 125 °C, + 25 °C ref)
- Tolerance:  $\pm 0.005$  %
- Resistance range: 33  $\Omega$  to 100 k $\Omega$
- Vishay Foil Resistors are not restricted to standard values, we can supply specific “as required” values at no extra cost or delivery (e.g. 100  $\Omega$  1234 vs 100  $\Omega$ )
- Instantaneous thermal stabilization time: <1 s
- Voltage coefficient: 0.1ppm/V

Datasheets: <http://www.vishay.com/doc?63132>

## 300 Series

(VCS331Z, VCS332Z, VCS331, VCS332, VCS301, VCS302)

Ultra-High-Precision Current Sense Resistors



## Bulk Metal<sup>®</sup> Foil Resistors

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- Temperature coefficient of resistance (TCR): from 0.05 ppm/°C (0 °C to + 60 °C)
- Tolerance:  $\pm 0.1$  %
- Resistance range: 0.005  $\Omega$  to 500  $\Omega$
- Vishay Foil Resistors are not restricted to standard values, we can supply specific “as required” values at no extra cost or delivery (e.g. 100  $\Omega$  1234 vs 100  $\Omega$ )
- Power rating: to 10 W
- Load life stability:  $\pm 0.05$  % at + 25 °C, 2000 hr at rated power
- Electrostatic discharge (ESD): up to 25 kV
- Rise time: 1 ns effectively no ringing
- Instantaneous thermal stabilization time: < 1 s
- **For improved performances, please check VCS331Z and VCS332Z (Z-Foil Technology)**

Datasheets: <http://www.vishay.com/doc?63018>

<http://www.vishay.com/doc?63086>

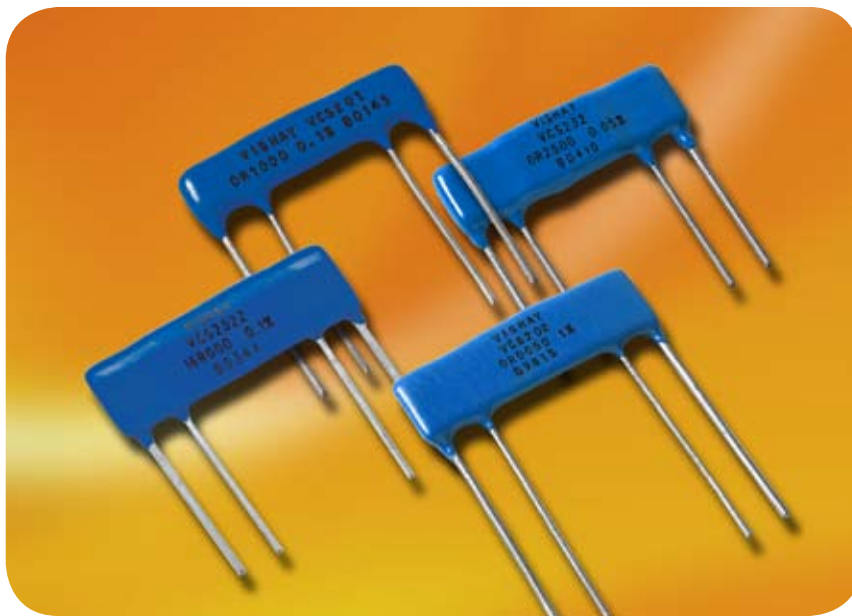


# 200 Series (VCS232Z, VCS232, VCS202, VCS201) Ultra-High-Precision Power Current Sense Resistors



## Bulk Metal<sup>®</sup> Foil Resistors

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- Temperature coefficient of resistance (TCR): from  $\pm 0.05$  ppm/ $^{\circ}\text{C}$  ( $0^{\circ}\text{C}$  to  $+60^{\circ}\text{C}$ )
- Tolerance:  $\pm 0.1\%$
- Resistance range:  $0.005\ \Omega$  to  $500\ \Omega$
- Vishay Foil Resistors are not restricted to standard values, we can supply specific “as required” values at no extra cost or delivery (e.g.  $100\ \Omega$  1234 vs  $100\ \Omega$ )
- Power rating: to 2 W
- Maximum current: 15 Amp
- Load life stability:  $\pm 0.05\%$  at  $+25^{\circ}\text{C}$ , 2000 hr at rated power
- Electrostatic discharge (ESD): up to 25 kV
- Rise time: 1 ns effectively no ringing
- Instantaneous thermal stabilization time:  $< 1$  s
- **For improved performances, please check VCS232Z (Z-Foil Technology)**

Datasheets: <http://www.vishay.com/doc?63017>  
<http://www.vishay.com/doc?63095>

# RS92N, RS92NA, AN (CECC Qualified)



## Bulk Metal<sup>®</sup> Foil Resistors

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- **CECC qualified**
- Temperature coefficient of resistance (TCR):  
 $\pm 2$  ppm/°C typical (-55 °C to + 155 °C, + 20 °C ref)
- Tolerance:  $\pm 0.01$  %
- Resistance range: 80.6  $\Omega$  to 120 k $\Omega$
- Vishay Foil Resistors are not restricted to standard values, we can supply specific “as required” values at no extra cost or delivery (e.g. 100  $\Omega$  1234 vs 100  $\Omega$ )
- Load life stability:  $\pm 0.005$  % at + 70 °C, 2000 hr at rated power
- Electrostatic discharge (ESD): up to 25 kV
- Rise time: 1 ns effectively no ringing
- Instantaneous thermal stabilization time: <1 s
- Voltage coefficient: 0.1 ppm/V

Datasheets: <http://www.vishay.com/doc?63138>

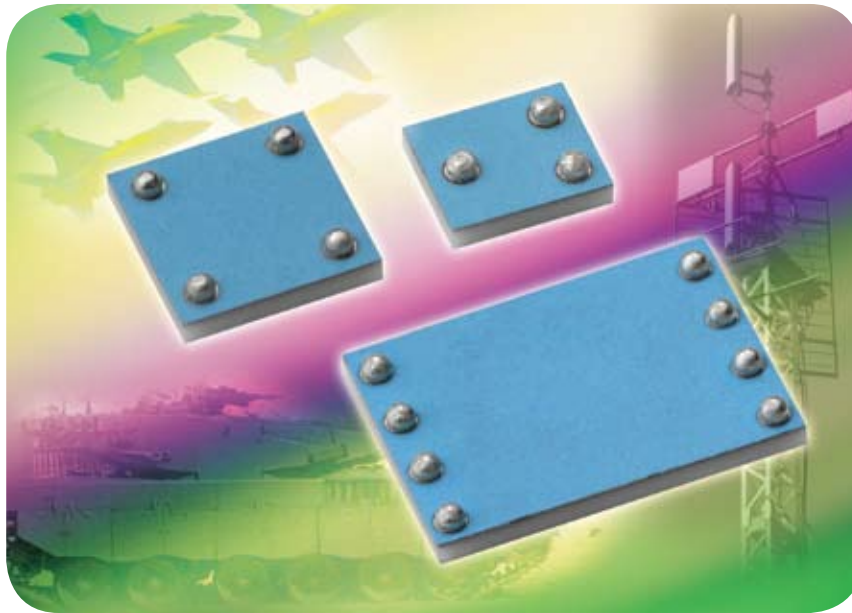
# VFB1012D / VFB1515N / VFB2028N

## Ultra-High-Precision Z-Foil BGA Surface Mount Resistor Divider and Network



### Bulk Metal<sup>®</sup> Foil Resistors

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- Temperature coefficient of resistance (TCR):  
Absolute:  $\pm 0.05$  ppm/ $^{\circ}\text{C}$  typical (0  $^{\circ}\text{C}$  to + 60  $^{\circ}\text{C}$ )  
 $\pm 0.2$  ppm/ $^{\circ}\text{C}$  typical (-55  $^{\circ}\text{C}$  to + 125  $^{\circ}\text{C}$ , + 25  $^{\circ}\text{C}$  ref)
- TCR Tracking: 0.1 ppm/ $^{\circ}\text{C}$  typical
- Power coefficient tracking “ $\Delta R$  due to self-heating” : 5 ppm
- Load-life stability ratio: to  $\pm 0.005$  % (50 ppm), at + 70  $^{\circ}\text{C}$ , at rated power
- Electrostatic discharge (ESD): up to 25 000 V
- Rise time: 1 ns effectively no ringing
- Thermal stabilization: < 1 s
- Current noise: < -40 dB
- Non inductive: < 0.08  $\mu\text{H}$

Datasheets: <http://www.vishay.com/doc?63122>  
<http://www.vishay.com/doc?63139>  
<http://www.vishay.com/doc?63157>

# Post Manufacturing Operations Enhance the Already Greater Stability of Foil Resistors



## **Bulk Metal® Foil Resistors**

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These PMO operations are uniquely applicable to resistors made of resistive Bulk Metal® Foil and they take the already superior stability of Bulk Metal Foil devices one step further. The PMO operations described are not applicable to thick film, thin film, or wire as you will see. 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.

### **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 spots (if any) so this PMO operation is further assurance.

### **Accelerated Load**

The standard load-life curve of a Foil resistor exhibits a change in the beginning and not much change after the first 100 hours. This knee in the load-life curve can be removed so that the resistor is now always on the flat part of the curve by employing the PMO exercise of accelerated loading. How much acceleration is a function of the application and should be worked out between our Applications Engineering department and your design team.

These same operations when applied to resistors of thick film, thin film, and wire have vastly different consequences and are applicable to Foil only. They are an enhancement to Foil performance but can drive other devices out of tolerance or open. The failure mechanisms in these other devices are too numerous to discuss here but suffice it to say, Foil is the least affected by these PMO operations and they should be considered when the level of stability required is beyond the published limits for standard product.

# Prototype Samples and Fast Delivery



## **Bulk Metal<sup>®</sup> Foil Resistors**

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Vishay has the ability to provide small quantities of samples for prototypes within a very short time frame at any required resistance value — at a special price, and in some cases even free of charge! If you require this service please contact one of our Field Application Engineers (FAE) directly and ask for our special prototype service.

**Contact: [foil@vishay.com](mailto:foil@vishay.com)**



# Precision Centers

## Vishay Foil Resistors Available Locally



## **Bulk Metal<sup>®</sup> Foil Resistors**

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### **What is a Precision Center**

Vishay Foil resistors are a product of Vishay Intertechnology, Inc., and are supplied at any value to any tolerance. Recognizing that no inventory of “all values to all tolerances” is possible, and that prototype quantities (which customarily are required in short turnaround) must be made to order, the solution is locally built product in one of Vishay’s authorized “Precision Centers.” Some common values and tolerances are stocked such as 10 K to 0.01 % but 9.998 K to 0.005 % has to be built to order.

### **The Precision Center Products**

While any Foil resistor product including resistors, trimmers, and networks can be obtained from any precision center, not all products are produced locally in these Precision Centers. The most frequently called for product types are produced locally with the balance coming from the factory where prototype quantities are given special attention.

**Contact: [foil@vishay.com](mailto:foil@vishay.com)**



# Territories and Precision Centers North America



## Bulk Metal<sup>®</sup> Foil Resistors

### FAE TERRITORY KEY

#### Kip Reiner

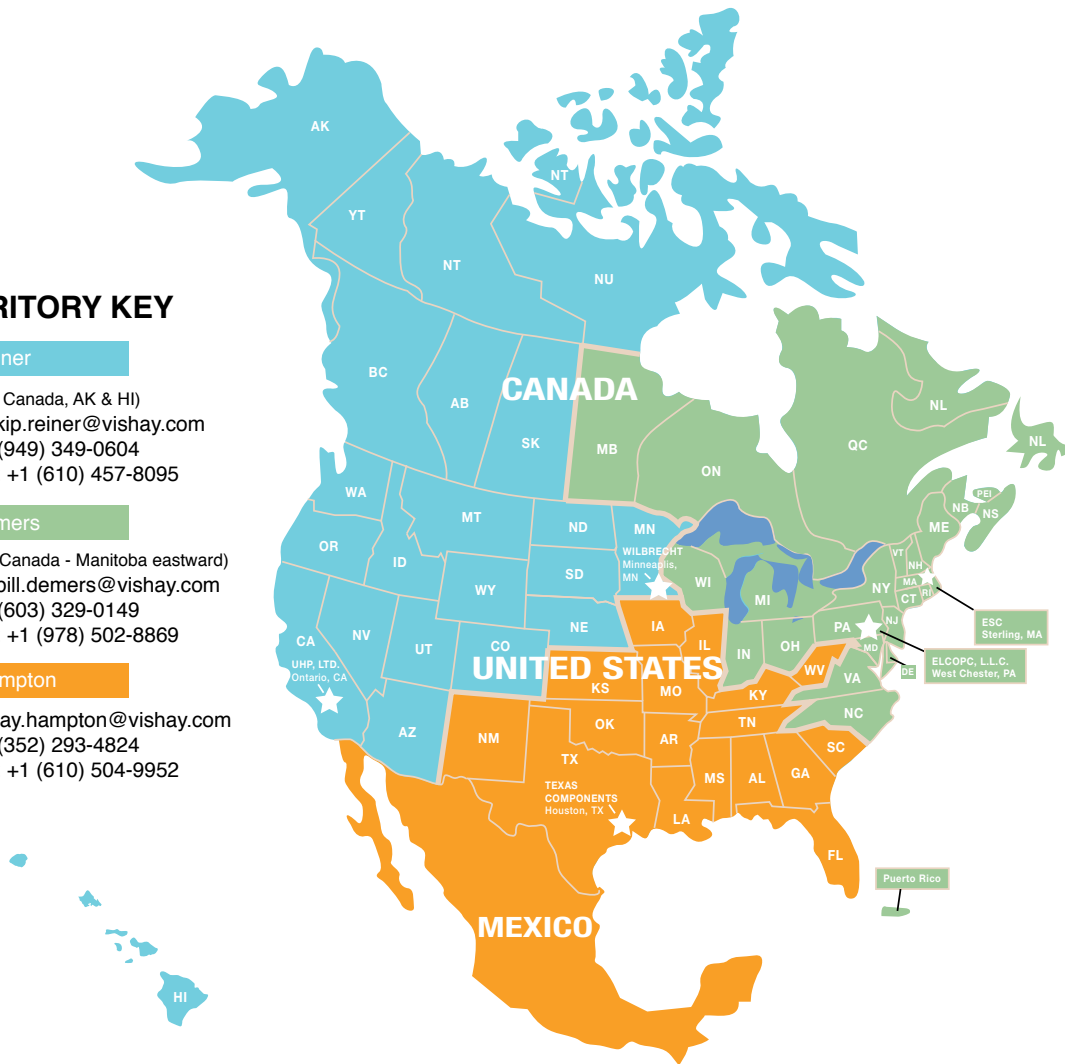
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# Territories and Precision Centers

## South America



## Bulk Metal<sup>®</sup> Foil Resistors

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# Territories and Precision Centers

## Europe



## Bulk Metal® Foil Resistors

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#### Dirk Sachau

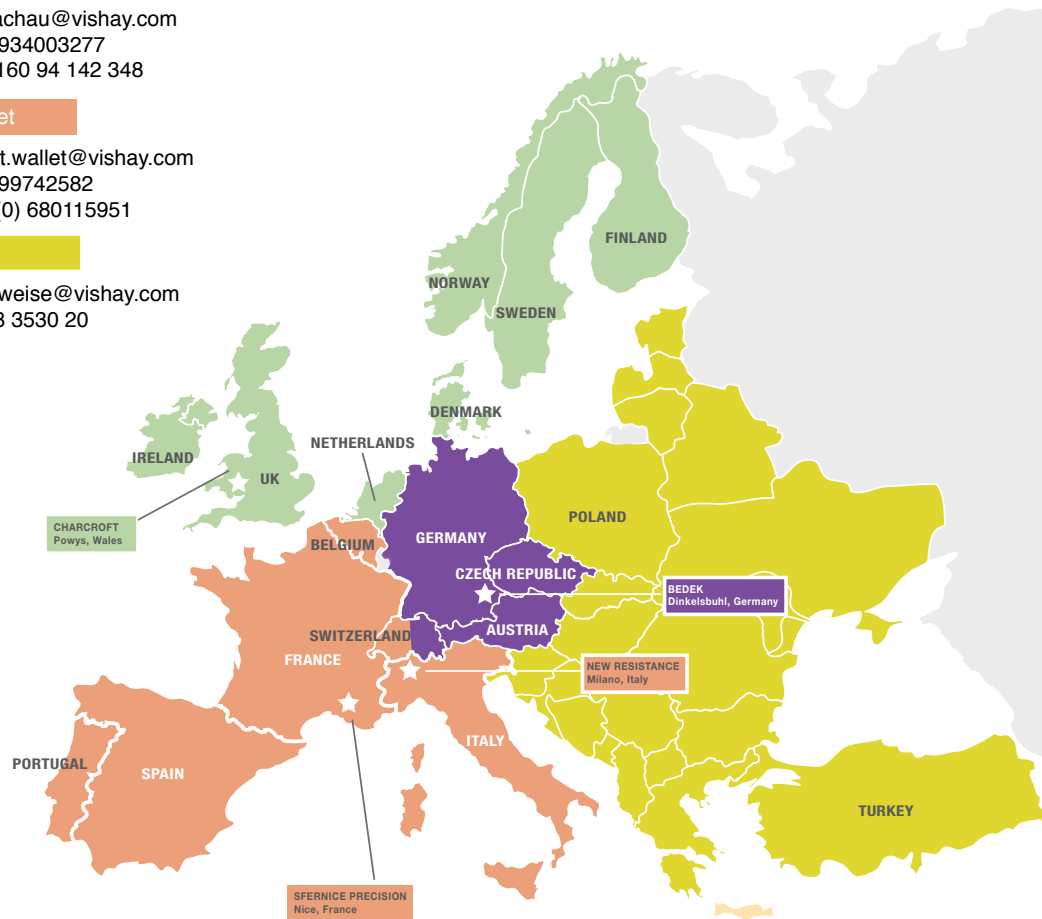
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# Territories and Precision Centers

## Asia Pacific and Israel



## Bulk Metal<sup>®</sup> Foil Resistors



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## ONLINE INFORMATION

For product information and a current list of sales offices,  
representatives and distributors, visit our website:

[www.vishay.com](http://www.vishay.com)

### WORLDWIDE SALES CONTACTS

#### THE AMERICAS

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##### UNITED STATES

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