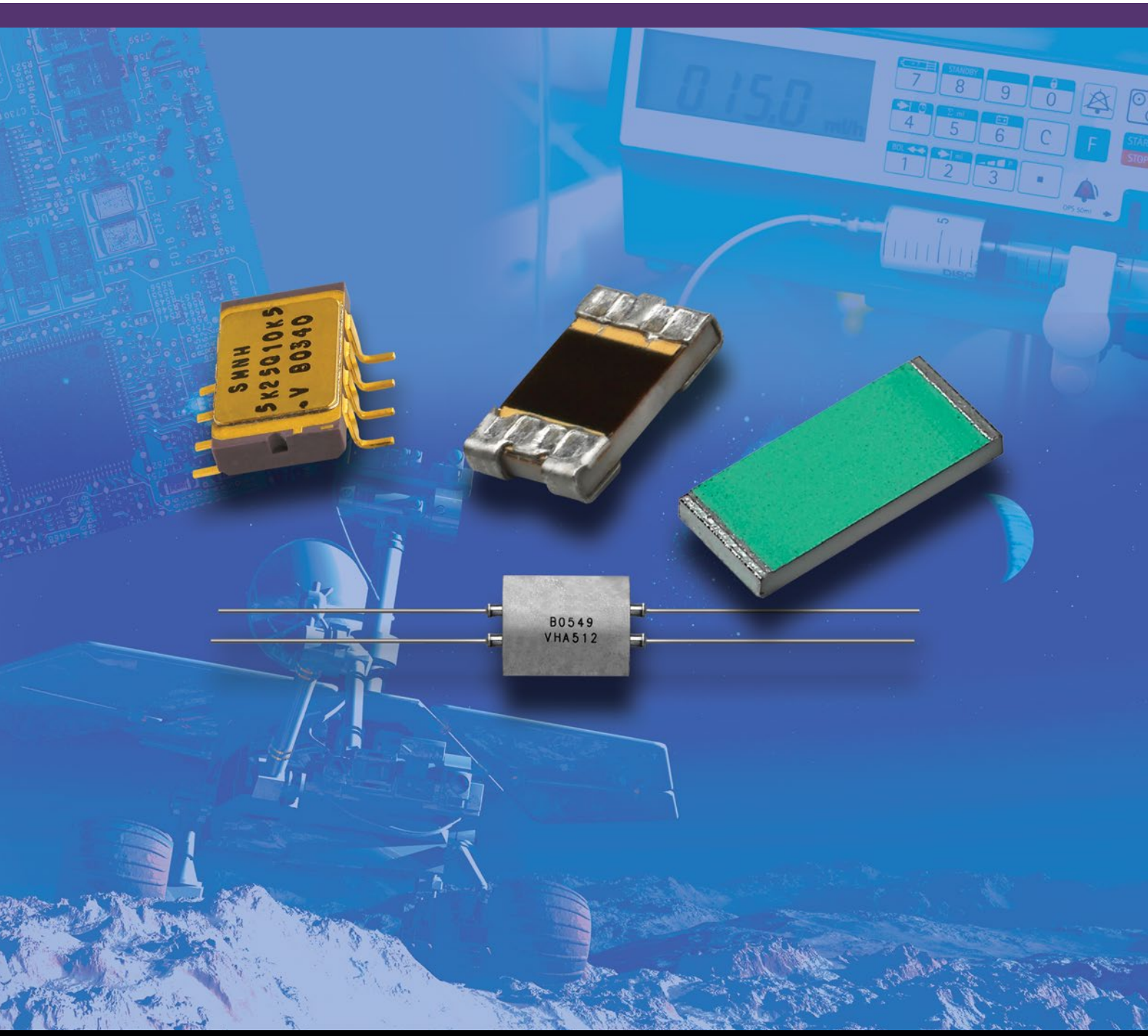
Bulk Metal® Foil High-Precision Resistors

Product Overview



vishayfoilresistors.com

VISHAY FOIL RESISTORS | Part of VPG Foil Resistors

Outstanding Performance – Reliable. Stable. Precise.

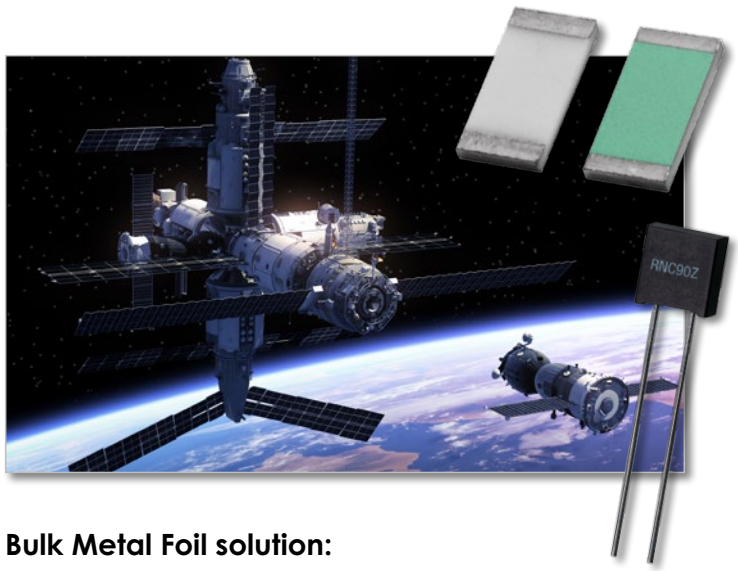
Vishay Foil Resistors — a part of the VPG Foil Resistors product group incorporating worldclass brands Alpha Electronics and Powertron — stands for unparalleled precision, stability, and reliability. Our resistor portfolio encompasses a wide variety of configurations and packages designed to surpass the requirements of even the most demanding applications.

Our unique Bulk Metal® Foil technology outperforms all other resistor technologies. Continuously refined since its introduction in 1962, this ultra- precision technology provides extremely low temperature coefficient of resistance (TCR) and exceptional long-term stability through temperature extremes. The Vishay Foil Resistors portfolio includes discrete resistors and resistor networks in surface-mount and through-hole (leaded) configurations, precision trimming potentiometers, and discrete chips for use in hybrid circuits, with customized chip resistor networks and arrays available. We continue to develop, manufacture, and market new types of Bulk Metal Foil resistors, including military-established-reliability components (EEE-INST-002, DLA, CECC, ESA, ER, QPL, etc.) and devices for high-temperature applications.

Bulk Metal® Foil in Action

Aerospace

The demands of the aerospace segment differ from the commercial segments in one major area — ongoing reliability. In some cases, there is only one chance to complete the mission, and the system cannot be brought back into the shop for repairs. Some systems must travel deep space for 10 years or more before being activated. Every component must activate when required and perform flawlessly to the end of the mission. This is why Bulk Metal Foil resistors, with their long-term consistency and reliability, are the best choice for aerospace applications.



End Product

Voltage regulator in thruster control system for satellites

Customer Requirements

- Propulsion system must be precise due to high sensitivity of forces in anti-gravity environments
- High reliability since there will be no servicing during its lifetime
- Established reliability in previous aerospace applications

Bulk Metal Foil solution: 303261-303266 (FRSM) and RNC90Z

Precision resistors for high reliability requirements

303261-303266 (FRSM)

- Z1 Foil Technology SMD in compliance with EEE-INST-002 (Tables 2A and 3A, Film/Foil, Level 1) and MIL-PRF-55342

RNC90Z

- QPL resistors with established reliability (ER) that meet the requirements of MIL-PRF-55182/9
- Level "R" high reliability

Bulk Metal® Foil in Action

Aviation

The electronics used in avionics are exposed to dramatic temperature excursions, shock and vibration, moisture, and the test of time. In engine, cabin, and flight control applications, resistors need to maintain their values despite all of these factors. Bulk Metal Foil resistors have a long history of applications in commercial aviation, supported by more than 30 years of load-life testing.

End Product

High-temperature measurement control in aircraft engine

Bulk Metal Foil solution: 300144Z

Ultra-high-precision Z Foil voltage divider resistors

Customer Requirements

- Precise voltage reference capable of measuring down to nanovolts
- Implementation into a microbridge configuration
- Must perform properly at a temperature of +80°C and power of 0.1 W

- Precise voltage divider with flexibility of use and accurate performance at high temperatures
- Absolute and ratio tolerance: 0.005%
- TCR: 0.2 ppm/°C typical at –55°C to +125°C, +25°C ref

Industrial

Industrial systems sometimes favor price over quality when it comes to electronic components, but when all factors are taken into consideration, quality resistors turn out to be the least expensive solution. In the long run, a reliable and stable resistor costs less than one that must be replaced or that requires additional circuitry to compensate for lack of precision.

End Product

High-voltage electrical circuit breaker in precision measurement control

Bulk Metal Foil solution: DSMZ

Surface-mount voltage divider that provides a matched pair of Bulk Metal Foil resistors in a small epoxy molded package

Customer Requirements

- Network with specific configuration
- Precise measurements necessary to ensure the safety of the circuit and the proper trigger for the circuit breaker
- Must endure both sporadic and continuous short-time overload

- Electrical specifications of this integrated construction offer improved performance and better real estate utilization over discrete resistors and matched pairs
- Absolute TCR to 0.2 ppm/°C typical and TCR tracking to 0.1 ppm/°C typical
- Short-time overload: 0.005%

Bulk Metal® Foil in Action

Medical

Accurate and stable instrumentation in the medical field requires the ability to detect very small signals without producing false readings. For the complement of resistors surrounding the operational amplifier and anywhere else resistors are needed in medical applications, high-precision Bulk Metal Foil resistors are the preferred choice.

End Product

Current sensing for motor control in fluid injector device

Customer Requirements

- Reliable measurements of motor control to perform injections at the precise location
- High-speed response necessary to perform given task
- Surface-mount to preserve limited real estate
- Four-pad Kelvin connection to improve accuracy

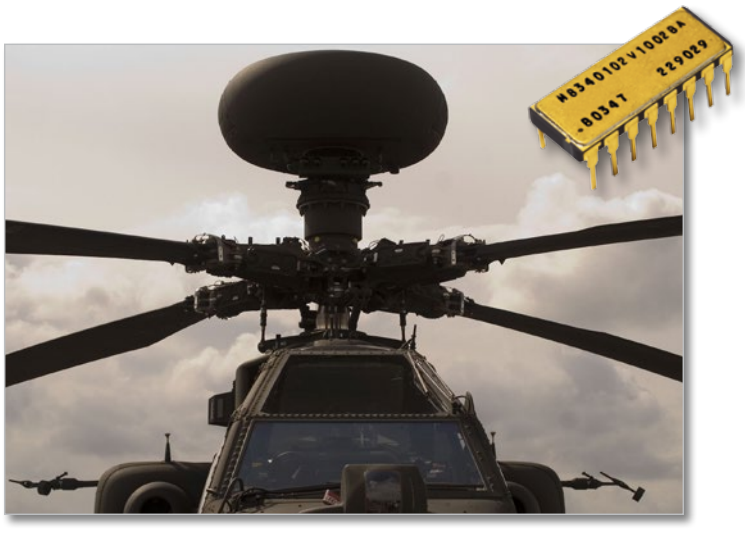
Bulk Metal Foil solution: VCS1610Z

High-precision four-terminal SMD power current-sensing resistor

- Low TCR to 0.2 ppm/°C typical
- Load-life stability: 0.015% at 70°C, 200 h (rated power)
- Rapid ΔR stabilization under transient loads

Military

Military applications have reliability requirements that exceed what can be achieved using standard processes of electronic component manufacturing. Military (MIL)-style testing consists of electrical and environmental stresses that may be applied to each resistor, or to a sample of parts from each production lot. By reviewing the behavior of the parts when they are subjected to the specified tests, lot-to-lot uniformity is guaranteed and a higher level of reliability is achieved. Different qualification conformance inspection plans are applicable depending on the application, ranging from a DSCC/DLA specification, up to a MIL-spec-qualified component with an established reliability level.



End Product

Signal generator and feedback in high-power pulse radio frequency transmitter

Customer Requirements

- Accurate digital-to-analog conversion capabilities
- High-speed response necessary to perform given task
- Able to withstand electrostatic discharges (ESD)
- High stability

Bulk Metal Foil solution: 1445Q and 1446Q (QPL)

High-precision networks qualified to MIL-PRF-83401, characteristic C, schematic A, (Qualified Parts List - QPL)

- Actual performance exceeds all the requirements of MIL-PRF-83401
- Hermetically sealed for maximum environmental protection - 100% leak protection
- Gold ball wire bonding
- Bulk Metal Foil chips V15X5

VISHAY FOIL RESISTORS
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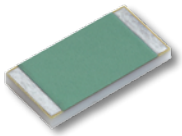
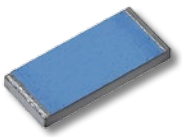
Featured Products
Surface-Mount

Our high-precision **surface-mount** Bulk Metal® Foil resistors offer a wide range of capabilities and configurations for different applications and can be tailored to specific customer requirements.

Product	Model	Description
	**FRSM Series** **0603 – 2512**	Resistance values: 5 Ω to 125 kΩ Resistance tolerance to 0.01% TCR to 0.2 ppm/°C typical Load-life stability to 0.0025% Wraparound configuration
	**SMR1D(Z)** **SMR3D(Z)**	Resistance values: 5 Ω to 80 kΩ Resistance tolerance to 0.01% TCR to 0.2 ppm/°C typical Load-life stability to 0.005% Molded, flexible termination construction
	**FRFC Series** **0805-2512**	Resistance values: 5 Ω to 125 kΩ Resistance tolerance to 0.01% TCR to 0.2 ppm/°C typical Load-life stability to 0.005% Flip-chip configuration for space savings
	**VPR220SZ**	Resistance values: 5 Ω to 10 kΩ Resistance tolerance to 0.01% TCR to 0.2 ppm/°C typical Load-life stability to 0.05% max Power rating: 8 W, chassis mounted
	**VSMP Series** **0603-2512**	Resistance values: 5 Ω to 125 kΩ Resistance tolerance to 0.01% TCR to 0.2 ppm/°C typical Load-life stability to 0.005% Wraparound configuration
	**Flex series**	Resistance values: 5 Ω to 80 kΩ Resistance tolerance to 0.01% TCR to 0.2 ppm/°C typical Load- life stability to 0.005% Unique flexible termination system
	**VSM Series** **0805-2512**	Resistance values: 10 Ω to 125 kΩ Resistance tolerance to 0.01% TCR to 2 ppm/°C typical Load-life stability to 0.01% Wraparound configuration
	**VFCD1505**	Resistance values: 1 kΩ to 10 kΩ Resistance tolerance and ratio to 0.01% TCR to 0.2 ppm/°C typical TCR tracking: 0.1 ppm/°C typical Surface-mount, flip-chip voltage divider

Featured Products
Through-Hole

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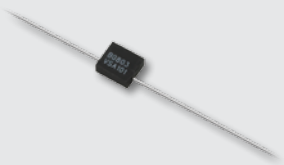
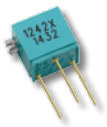
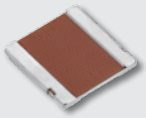
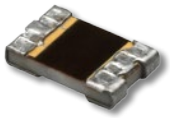
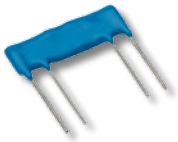
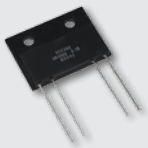
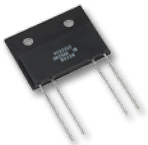
High-precision **through-hole** Bulk Metal® Foil resistors are the ultimate choice in the most demanding analog applications. Tighter performances and higher or lower value resistance values are available for all models upon request.

Product	Model	Description
	**Z Series**	Resistance values: 5 Ω to 600 kΩ Resistance tolerance to 0.005% TCR to 0.2 ppm/°C typical Load-life stability to 0.005% Power rating to 1 W at +125°C
	**S Series**	Resistance values: 0.5 Ω to 1 MΩ Resistance tolerance to 0.005% TCR to 1 ppm/°C typical Load-life stability to 0.005% Power rating to 1 W at +125°C
	**VAR**	Resistance values: x Ω to x kΩ Resistance tolerance to 0.01% TCR to 0.2 ppm/°C typical Load-life stability to 0.005% "Naked" configuration for audio
	**VSA101**	Resistance values: 5 Ω to 100 kΩ Resistance tolerance to 0.005% TCR to 0.2 ppm/°C typical Load-life stability to 0.05% max Ultra-high-precision axial Z Foil
	**E102(Z)**	Resistance values: 100 kΩ to 300 kΩ Resistance tolerance to 0.005% TCR to 0.2 ppm/°C typical Load-life stability to 0.005% Power rating to 0.3 W at +125°C
	**VSH(Z)** **VSC(Z)**	Resistance values: 5 Ω to 120 kΩ Resistance tolerance to 0.01% TCR to 2 ppm/°C typical Load-life stability to 0.01% Conformal coated
	**VTA(Z) Series**	Resistance values: 5 Ω to 300 kΩ Resistance tolerance to 0.01% TCR to 0.2 ppm/°C typical Load-life stability to 0.005% Cylindrical axial lead configuration
	**VPR220(Z)**	Resistance values: 5 Ω to 10 kΩ Resistance tolerance to 0.01% TCR to 0.2 ppm/°C typical Load-life stability to 0.005% max Power rating: 8 W, chassis mounted
	**1202-1285** **Trimmers**	Resistance values: 2 Ω to 20 kΩ Resistance tolerance to 5% TCR to 10 ppm/°C max Load-life stability to 0.1% Smooth leadscrew adjustment

Featured Products
Power Current Sense

Power current-sensing resistors were developed with a low absolute TCR and Kelvin connections (4-terminal connection) to measure a precise voltage drop across the resistive element. The 4-terminal configuration is offered in a wide range of capabilities for different applications.

Product	Model	Description
	CSM3637(P) CSM2512	Resistance values: 1 mΩ to 200 mΩ Resistance tolerance to 0.1% TCR to 15 ppm/°C max Load-life stability to 0.2% SMD with power rating to 3 W (5 W with heat sink)
	CSM3637F	Resistance values: 50 mΩ to 200 mΩ Resistance tolerance to 0. 1% TCR to 5 ppm/°C max Load-life stability to 0.02% SMD with power rating to 3 W
	VCS1610(Z) VCS1625(ZP)	Resistance values: 1 mΩ to 10 Ω Resistance tolerance to 0.1% TCR to 0.2 ppm/°C typical Load-life stability to 0.015% SMD with power rating to 1 W
	VPR221(Z)	Resistance values: 0.5 Ω to 500 Ω Resistance tolerance to 0.01% TCR to 0.2 ppm/°C typical Load-life stability to 0.005% Power rating: 8 W, chassis mounted
	VCS232(Z)	Resistance values: 0.2 Ω to 500 Ω Resistance tolerance to 0.02% TCR to 0.2 ppm/°C typical Load-life stability to 0.005% Through-hole with power rating to 2 W
	VCS301 VCS302	Resistance values: 5 mΩ to 250 mΩ Resistance tolerance to 0.5% TCR to 3 ppm/°C typical Load-life stability to 0.02% Power rating to 10 W (through-hole, heatsink)
	VCS331Z VCS332Z	Resistance values: 250 mΩ to 500 Ω Resistance tolerance to 0.01% TCR to 0.2 ppm/°C typical Load-life stability to 0.005% Power rating to 10 W (through-hole, heatsink)
	VFP3 VFP4(Z)	Resistance values: 50 mΩ to 80 kΩ Resistance tolerance to 0.01% TCR to 2 ppm/°C typical Load-life stability to 0.005% Power rating to 10 W (through-hole, heatsink)
	CSNG	Resistance values: 0.5 mΩ to 500 kΩ Resistance tolerance to 0.1% TCR to 0.2 ppm/°C typical Load-life stability to 0.005% Power rating to 60 W (through-hole, heat- sink)

Featured Products
Hermetically Sealed

VISHAY FOIL RESISTORS
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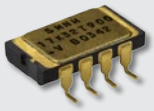
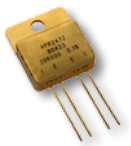
Hermetically sealed resistors eliminate the ingress of both oxygen, which degrades resistors over long periods, and moisture, which degrades resistors more quickly. When combined with the hermetic sealing and oil filling, the Bulk Metal Foil resistors become the most precise and stable resistors available.

Product	Model	Description
	**HZ Series**	Resistance values: 5 Ω to 1.1 MΩ Resistance tolerance to 0.001% TCR to 0.2 ppm/°C typical Load-life stability to 0.002% Shelf-life stability to 2 ppm for at least 6 years
	**VHP100 Series**	Resistance values: 100 Ω to 150 kΩ Resistance tolerance to 0.005% Essentially zero TCR Load-life stability to 0.005% Shelf-life stability to 2 ppm for at least 6 years
	**VHS102(Z) Series**	Resistance values: 1 Ω to 150 kΩ Resistance tolerance to 0.005% TCR to 0.2 ppm/°C typical Load-life stability to 0.005% Shelf-life stability to 2 ppm for at least 6 years
	**SMNH**	4-resistor SMD hermetic network, gull wing config. Resistance values: 5 Ω to 33 kΩ Resistance tolerance to 0.005% / 0.005% match Absolute TCR to 2 ppm/°C and tracking to 0.5 ppm/°C Load-life to Δ 0.015% typical / Δ ratio 0.005%
	**VHD144** **VHD200**	Resistance values: 5 Ω to 33 kΩ Resistance tolerance to 0.005% / 0.001% match TCR to 2 ppm/°C typical TCR tracking: 0.1 ppm/°C typical Hermetically sealed voltage divider
	**Transistor Outline 1401** **to** **Transistor Outline 1422**	3-pin to 16-pin transistor outline hermetic resistor Absolute TCR to 2 ppm/°C and tracking to 0.5 ppm/°C Load-life to Δ 0.015% typical / Δ ratio 0.005% Custom-designed configured to your specifications
	**VHP3** **VHP4(Z)** **VPR247(Z)**	Resistance values: 0.05 Ω to 80 kΩ Resistance tolerance to 0.01% TCR to 0.2 ppm/°C typical TCR tracking: 0.5 ppm/°C typical Power rating (heat-sink): 10 W
	**H Series**	Resistance values: 5 Ω to 1.84 MΩ Resistance tolerance to 0.001% TCR to 2 ppm/°C typical Load-life stability to 0.002% Shelf-life stability to 2 ppm for at least 6 years

VISHAY FOIL RESISTORS
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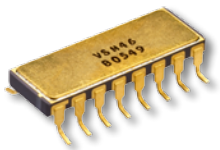
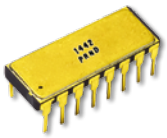
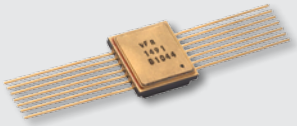
Featured Products
Voltage Dividers and Networks

High-precision Bulk Metal Foil resistor **voltage dividers and networks** meet the demand of ideal performance: stable, high-speed, high-accuracy components that will operate with assured, predictable reliability for years in a variety of environments. Hermetically sealed networks are custom-configured to your specifications.

Product	Model	Description
	**DSM(Z)**	Resistance values: 100 Ω to 12 kΩ Resistance tolerance to 0.02% (match 0.01%) TCR to 0.2 ppm/°C typical TCR tracking: 0.1 ppm/°C typical Molded with flexible termination construction
	**SMN(Z)**	Resistance values: 100 Ω to 10 kΩ per resistor Resistance tolerance to 0.02% (match 0.01%) TCR to 0.2 ppm/°C typical TCR tracking: 0.1 ppm/°C typical 4-resistor network, dual-in-line package
	**300144(Z)** **300145(Z)**	Resistance values: 100 Ω to 20 kΩ per resistor Resistance tolerance to 0.005% / 0.005% match TCR to 0.2 ppm/°C typical TCR tracking: 0.1 ppm/°C typical Through-hole radial and axial configurations
	**VFD244(Z)**	Resistance values: 1 Ω to 150 kΩ per resistor Resistance tolerance to 0.005% / 0.005% match TCR to 0.2 ppm/°C typical TCR tracking: 0.1 ppm/°C typical Through-hole with load life ratio to 0.005%
	**VSM40** **VSM42** **VSM45** **VSM46**	SMD hermetic networks in gull wing configuration 8-,14-, and 16-pin ceramic dual-in-line package Absolute TCR to 2 ppm/°C and tracking to 0.5 ppm/°C Load-life to Δ 0.015% typical / Δ ratio 0.005% Custom-configured to your specifications
	**VSM85 to** **VSM89**	SMD hermetic networks in leadless chip carrier 16-32 multi gold- plated terminals Absolute TCR to 2 ppm/°C and tracking to 0.5 ppm/°C Load-life to Δ 0.015% typical / Δ ratio 0.005% Custom-configured to your specifications
	**1442** **1445** **1446** **1457 (“L” brazed)** **1460**	Hermetic dual-in-line package (DIP) network 8-, 14-, 16-, and 20-pin side- brazed ceramic DIP Absolute TCR to 2 ppm/°C and tracking to 0.5 ppm/°C Load-life to Δ 0.015% typical / Δ ratio 0.005% Custom-configured to your specifications
	**1476** **1491**	Hermetic flatpack resistor network Max power rating to 2.4 W, high chip capacity Absolute TCR to 2 ppm/°C and tracking to 0.5 ppm/°C Load-life to Δ 0.015% typical / Δ ratio 0.005% Custom-configured to your specifications

Featured Products
High Temperature

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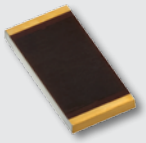
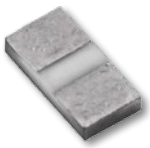
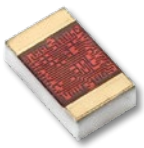
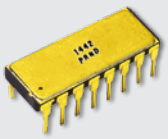
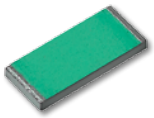
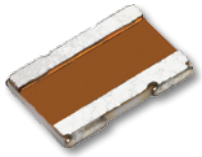
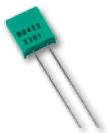
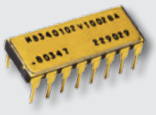
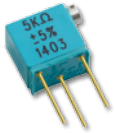
Precision Bulk Metal Foil resistors designed for **high temperatures** (above +175°C) provide stability levels well under the maximum allowable drift required by customer specifications and have been proven through thousands of hours of operation under harsh conditions.

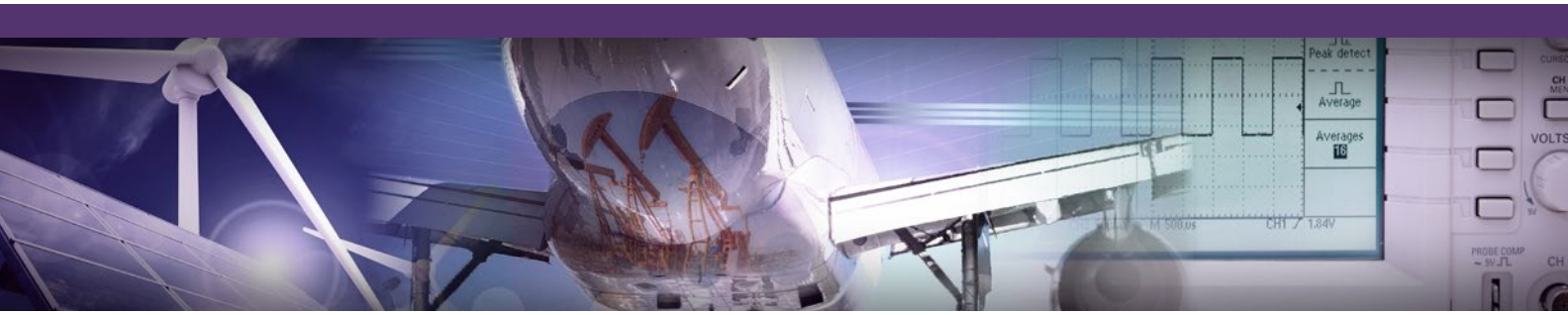
Product	Model	Description
	**HTHG Series 0603-2512**	Resistance values: 5 Ω to 100 kΩ Resistance tolerance to 0.02% TCR to 3 ppm/°C typical Load-life stability to 0.05% Up to 240 °C applications, gold-plated terminals
	**FRSG Series 0603-2512**	Resistance values: 10 Ω to 125 kΩ Resistance tolerance to 0.01% TCR to 2.5 ppm/°C max Load-life stability to 0.1% Wraparound gold-plated terminals up to 225° C
	**FRSH Series 0603-2512**	Resistance values: 10 Ω to 125 kΩ Resistance tolerance to 0.02% TCR to 2.5 ppm/°C max Extended pads for optimal heat dissipation Wraparound, up to 225°C applications
	**FRST Series 0603-2512**	Resistance values: 5 Ω to 125 kΩ Resistance tolerance to 0.01% TCR to 2.5 ppm/°C typical Load-life stability to 0.005% Wraparound lead (Pb)-free termination to 200°C
	**HTHA Series 0603-2512**	Resistance values: 5 Ω to 125 kΩ Resistance tolerance to 0.02% TCR to 1 ppm/°C typical Load-life stability to 0.05% Up to 240°C applications, aluminium wire bonding
	**PRND HT**	Precision resistor network devices (PRND) Absolute TCR to 2 ppm/°C and tracking to 0.5 ppm/°C Load-life to Δ 0.015% typical / Δ ratio 0.005% Custom-designed configured to your specifications Up to 230°C applications, gold wire bonding
	**Hybrid Chips HTHG 5x5 HTHG 15x5 HTHG 15x10**	Resistance values: 5Ω to 80 kΩ Resistance tolerance to 0.02% TCR to 3 ppm/°C typical Load-life stability to 0.05% Up to 240°C applications, gold wire bonding
	**Z201 HT**	Resistance values: 10 Ω to 100 kΩ Resistance tolerance to 0.01% TCR to 0.2 ppm/°C typical Load-life stability to 0.1% Up to 200°C applications, silicon-coated design

Featured Products
Avionics, Military and Space (AMS)

Avionics, military, and space (AMS) applications have reliability requirements that exceed the standard processes of electronic component manufacturing. Our portfolio includes military-established-reliability and space-qualified resistors (EEE-INST-002, DLA, CECC, ESA, ER, QPL, etc.) optimal for such critical circuitry.

Product	Model	Description
	303261 to 303266 (0603 to 2512)	Resistance values: 10 Ω to 75 kΩ Resistance tolerance to 0.01% TCR to 0.2 ppm/°C, load-life stability to 0.02% max Test flow in compliance with MIL-PRF-55342 EEE-INST-002 (tables 2A and 3A, level 1)
	303139 303140	Resistance values: 5 Ω to 40 kΩ Resistance tolerance to 0.02% TCR to 0.2 ppm/°C, load-life stability to 0.05% åmax Test flow in compliance with MIL-PRF-55182 EEE-INST-002 (tables 2A and 3A, level 1)
	303119(Z)	Resistance values: 0.01 Ω to 10 Ω Resistance tolerance to 0.5% TCR to 0.2 ppm/°C, load-life stability to 0.05% max Test flow in compliance with MIL-PRF-55342 EEE-INST-002 (tables 2A and 3A, level 1)
	303144 303145	Resistance values: 0.002 Ω to 0.2 Ω Resistance tolerance to 0.5% TCR to 20 ppm/°C max In compliance with MIL-PRF-49465 & 55342 EEE-INST-002 (tables 2A and 3A, level 1)
	303143 Series	Resistance values: 10 Ω to 100 kΩ Resistance tolerance to 0.005% TCR to 0.2 ppm/°C, load-life stability to 0.005% max In compliance with EEE-INST-002 / MIL-PRF-55182 Test Flow S-311-P813 proposed by NASA
	RNC90	Resistance values: 4.99 Ω to 121 kΩ Resistance tolerance to 0.005% "R" level high reliability Qualified to MIL-PRF-55182/9 QPL product with established reliability (ER)
	RS92N AN	Resistance values: 80.6 Ω to 120 kΩ Resistance tolerance to 0.01% TCR to 2 ppm/°C Load-life stability: 0.01% max CECC-qualified
	1445Q 1446Q	Hermetic dual-in-line package (DIP) network Max environmental protection sealing Qualification to characteristic "C" Tested per MIL-PRF-83401 Custom-configured to your specifications
	RJ26 Trimmer	Resistance values: 20 Ω to 5 kΩ Resistance tolerance to 10% TCR to 10 ppm/°C max Smooth leadscrew adjustment Qualified to MIL-PRF-22097 (QPL approved)

VISHAY FOIL RESISTORS | Part of VPG Foil Resistors



Contact

foil@vpgsensors.com

vishayfoilresistors.com

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