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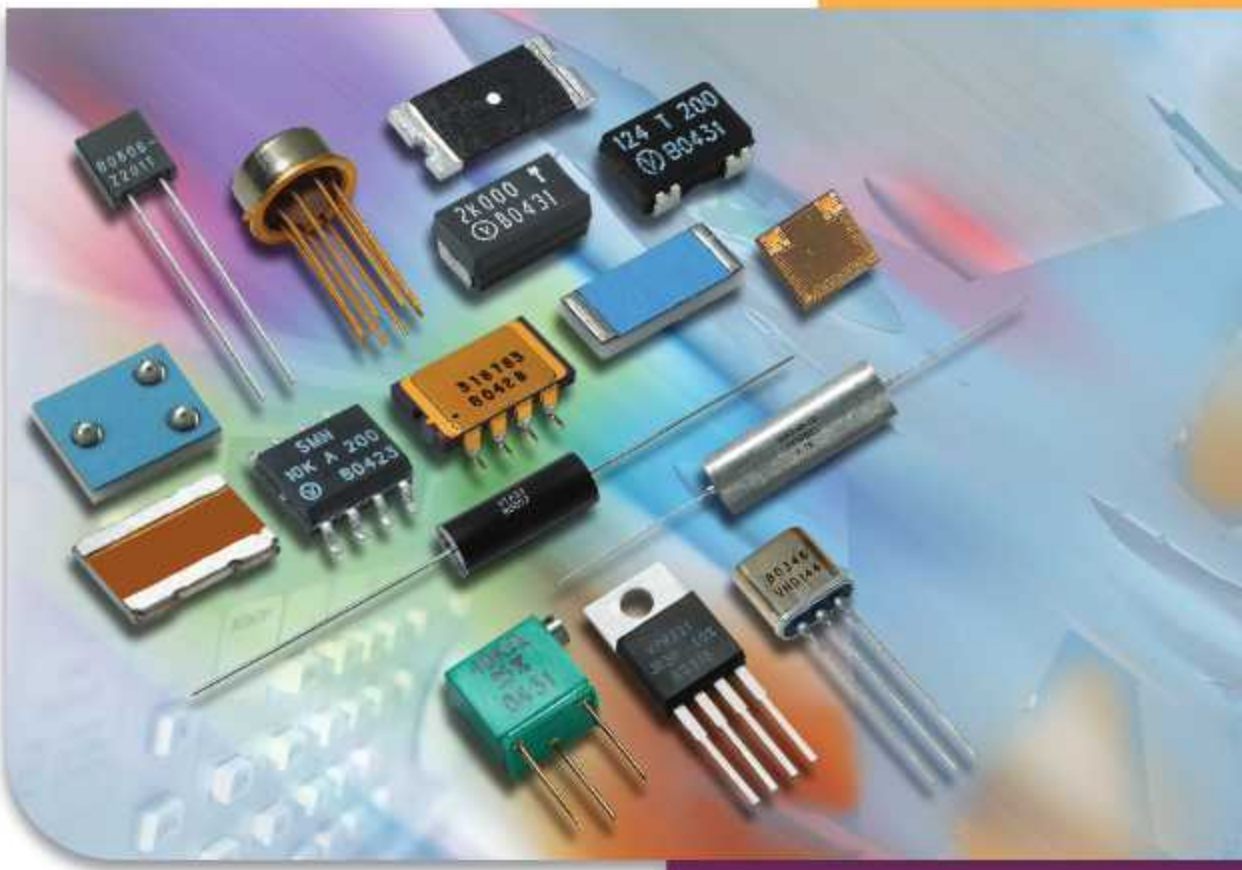

Foil in Action

Vishay Foil Resistors

This document is a part of the Design and Selector Guide for High Precision Resistors

www.vishayfoilresistors.com

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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 transit 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 Vishay Foil resistors, with their long term consistency and reliability, are the only choice for aerospace applications.

End Product

Thruster Control System for Satellites

Function

Voltage Control

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

The Vishay Foil Resistors Solution

RNC90Y and RNC90Z

QPL resistors with established reliability (ER) and meets the requirements of MIL-PRF-55182/9

- The most precise and reliable resistor available used for decades in the aerospace industry:
  - Absolute TCR for RNC90Z:
    2 ppm/°C maximum at -55°C to +175°C range
  - Absolute TCR for RNC90Y: 5 ppm/°C maximum at -55°C to +125°C range;
    10 ppm/°C maximum at 125°C to +175°C range
  - Absolute tolerance: 0.005% (50 ppm)
  - Load life stability: ±0.005% for 2000 h, 0.3W at +125°C
  - Failure rate: Level R (per Mil PRF 55182-9 and MIL-STD-690)

303134, 303135, 303136, 303137, 303138

Screen/test flow in compliance with EEE-INST-002, (Tables 2A and 3A, Film/Foil, Level 1) and MIL-PRF-55342

- Ultra high-precision surface-mount chip resistors, VSMP Z-Foil technology configuration:
  - Temperature coefficient of resistance (TCR):
    0.2 ppm/°C typical (-55°C to +125°C, +25°C ref.)
  - Resistance tolerance: to ±0.02%
  - Power coefficient "ΔR due to self heating": 5 ppm at rated power
  - Power rating: to 400 mW at +70°C
  - Load life stability: ±0.03% at +70°C, 2000h at rated power
  - Electrostatic discharge (ESD) at least to 25 kV
  - Short time overload: 0.02%
  - Thermal stabilization time <1s (nominal value achieved within 10 ppm of steady state value)
  - Rise time: 1 ns effectively no ringing

Audio - "Hear the Difference"

In audio systems, "high end" means faithful reproduction of the original signal and the absence of noise insertion by the electronic components — particularly the resistors. The audio discrimination level is sometimes beyond the instrument measuring capability but nonetheless aurally detectable. Vishay Foil resistors are the lowest-noise such devices available and essential components of any high-end audio system.

End Product

High-End Audio Preamplifier

Function

Line Level Audio Signal Amplification

Customer Requirements

- Low noise preamplifier for implementation into differential amplifier circuit
- Tight settability required to maintain accurate amplifier gain
- Trimmer technology which provides consistent and reliable performance

The Vishay Foil Resistors Solution

1240 Trimmer

Ultra high-precision trimming potentiometer designed to meet or exceed the requirements of MIL-PRF-39035, Char. H with a smooth and unidirectional output

- Current noise: 0.010 $\mu V_{RMS}/V$ of applied voltage (<-40 dB)
- Results in a high signal-to-noise ratio and a high common mode rejection ratio
- Settability: 0.05% typical; 0.1% maximum
- Setting stability: 0.1% typical; 0.5% maximum
- Trimmer design which ensures a smooth and unidirectional output:
  - Wirewound technology exhibits a step function in response to wiper travel, while cermet technology has wide deviations in response to wiper travel
  - Only VFR offers a linear and predictable response
- Immune to shock vibrations

*For further information, please see Application Note *Resistance Trimmers*.

VAR (VFR Audio Resistor)

Composed of VFR's Bulk Metal® Z-Foil technology, with improved sound quality, VAR provides a combination of low noise and low inductance/capacitance, making it unrivalled for applications requiring low noise and distortion-free properties.

- "Naked Z-Foil resistor" design without mold or encapsulation for reduced signal distortion:
  - Temperature coefficient of resistance (TCR): ± 0.2 ppm/°C typical at -55°C to +125°C, 25°C ref.
  - Power rating: to 0.4 W at +70°C
  - Resistance tolerance: to ±0.005%
  - Load life stability: to ±0.005% at +70°C, 2000h at rated power
  - Non inductive, non capacitive design
  - Rise time: 1 ns without ringing
  - Current noise: 0.010 $\mu V_{RMS}/V$ of applied voltage (<-40 dB)
  - Thermal EMF: 0.05 µV/°C
  - Voltage coefficient: <0.1 ppm/V
  - Inductance: <0.08 µH
- Thermal stabilization time <1s (nominal value achieved within 10 ppm of steady state value)
- Electrostatic discharge (ESD) at least to 25 kV

For other recommendations for audio applications please refer to the following resistors: VSH, S102C, Z201, Z203.

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Automatic Test Equipment (ATE)

Automatic Test Equipment (ATE) performs at high speeds, reading and recording of information from thousands of devices/boards that would otherwise need to be probed by hand. Any introduction of spurious signals from the ATE machine or its components could result in failure to reject a faulty device, or conversely, cause spurious rejection of perfectly good product. If ever there was a place not to be "penny wise and pound foolish" it is in the resistor complement of an ATE. The wisest resistor choice for ATEs is a Vishay Foil resistor.

End Product

DC Test Instrument

Function

Digitize an AC Signal

Customer Requirements

- Short term stability
- Low sensitivity to temperature (external and internal)
- Precision required due to resource constraints
- Requires resistor of minimal size due to real estate constraints

The Vishay Foil Resistors Solution

VFCP2010 (Flip Chip with Z-Foil)

Ultra high-precision Z-Foil flip chip resistor with 35% space saving vs. wraparound design

- The most stable and precise resistor available:
  - Load life stability: ±0.005% for 2000h, rated power at +70°C
  - Absolute TCR: 0.2 ppm/°C typical at -55°C to +125°C range +25°C ref.
  - Absolute tolerance: 0.01%
  - Flip chip design saves 35% more space than a wraparound design
- Electrostatic discharge (ESD) at least to 25 kV
- Thermal stabilization time <1s (nominal value achieved within 10 ppm of steady state value)
- Rise time: 1 ns effectively no ringing

SMR1DZ/SMR3DZ (Z-Foil)

Unique flexible terminations to ensure minimal stress transference from the PCB due to a difference in Temperature Coefficient of Expansions (TCE)

- Ultra high-precision Z-Foil molded surface mount resistor:
  - 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 tolerance: to ±0.01%
  - Power Coefficient of Resistance (PCR) "ΔR due to self heating": 5 ppm at rated power
  - Load life stability: ±0.005% (+70°C, 2000 hours at rated power)
  - Power rating: to 600 mW at 70°C
  - Matched sets with TCR tracking are available upon request
- Electrostatic discharge (ESD) at least to 25 kV
- Thermal stabilization time <1s (nominal value achieved within 10 ppm of steady state value)
- Rise time: 1 ns effectively no ringing

Flexible Terminations

Aviation

The electronics used in commercial 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. Vishay Foil resistors have a long history of applications in commercial aviation, supported by more than 30 years of load life testing.

End Product

Aircraft Engine

Function

High Temperature Measurement Control

Customer Requirements

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

The Vishay Foil Resistors Solution

300144Z

Ultra high-precision Z-Foil voltage divider resistors

- Precise voltage divider with flexibility of use and accurate performance at high temperatures:
  - Absolute tolerance: 0.005%
  - Ratio tolerance: 0.005%
  - Absolute TCR: 0.2 ppm/°C typical at -55°C to +125°C, +25°C ref.
  - Power rating: to 0.2W at +70°C
  - PCR: 5 ppm at rated power

Check also: VFD244Z, VSH144, DSMZ, SMNZ

303144, 303145

Screen/test flow in compliance with EEE-INST-002 (Tables 2A and 3A, Film/Foil, Level 1) MIL-PRF-55342 and MIL-PRF-49465

- Fixed resistors CSM2512 and CSM3637 for low value current-sense resistors, providing power and precision in a four terminal, surface-mount configuration:
  - Temperature coefficient: ±20 ppm/°C max. (-55°C to +125°C, +25°C ref.)
  - Resistance tolerance: ±0.5%
  - Four terminal (Kelvin) design: allows for precision accurate measurements
  - Power rating: 1W to 3W
  - Short time overload: ±0.1% typical
  - Thermal EMF: 3 µV/°C
  - Maximum current: up to 38 A

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Cryogenics

Cryogenic applications require structural integrity capable of withstanding extreme thermal cycling without damage and without detriment to performance. Vishay Foil resistors have been used as heaters of small-mass samples and as circuit elements at cryogenic temperatures.

End Product

Liquefied Natural Gas Transport System

Function

Temperature Regulator

Customer Requirements

- Reliable performance in extremely low temperatures
- Flexibility in resistor configuration
- Use in high humidity and high pressure environments

The Vishay Foil Resistors Solution

Custom-Designed Hermetically-Sealed Networks

Also available as DIP version

- Custom networks designed to the customers requirements; normal values are:
  - Absolute tolerance: 0.005%
  - Tolerance match: 0.002%
  - Absolute TCR: 2 ppm/°C typical at -55°C to +125°C, +25°C ref.
  - TCR tracking: <0.5 ppm/°C
  - Hermeticity of 10^{-7} atmospheric cc/s: The hermetic package provides a seal around the resistive element which protects it from the natural damage caused by moisture over time

VSMP Series (0603, 0805, 1206, 1506, 2010, 2512) (Z-Foil)

VSMP Series is the industry's first device to provide high rated power, excellent load life stability along with extremely low TCR all in one resistor.

- Ultra high-precision foil wraparound surface-mount chip resistor:
  - 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 tolerance: to ±0.01%
  - Power Coefficient of Resistance (PCR) "ΔR due to self heating":
    5 ppm at rated power
  - Power rating: to 750 mW at +70°C
  - Thermal stabilization time <1s (nominal value achieved within 10 ppm of steady state value)
  - Load life stability: to ±0.005% at +70°C, 2000h at rated power
  - Electrostatic discharge (ESD) at least to 25 kV
  - Short time overload: ≤0.005%
  - Matched sets are available on request

Down Hole

The high temperature of down hole applications is a huge challenge to electronic components and most resistor technologies. Temperatures upwards of 275°C are not uncommon and even above the melting point of some solders. Thin film resistors are oxidized into oblivion by these temperatures and wirewound devices see major value shifts. Even Vishay Foil resistors cannot be exposed indefinitely to these temperatures, but the encapsulation of the Vishay Foil element stands up to these environmental stresses long enough to enable down-hole measurements through dozens of deep travel cycles. The 100 times thicker resistive layer inherent in the foil resistor provides them with long term stability in cold and hot environment and helps establish it as the preferred resistor for seismic oil exploration as well as for down-hole applications.

End Product

Processor for Motor Control

Function

High-Precision Voltage Reference

Customer Requirements

- Low noise and high common mode rejection ratio
- Long term stability and minimal drift
- Will be used in high humidity and high pressure environments

The Vishay Foil Resistors Solution

VHD200

Oil-filled hermetically-sealed, small package, voltage dividers (oil filled as standard, air filled available upon request)

- Effective performance in any extreme environment:
  - Absolute TCR: 2 ppm/°C typical at -55°C to +125°C, +25°C ref.
  - Foil technology which exhibits low noise: <-40 dB
  - Ratio Stability: <0.001% for 2000h, rated power at +70°C
  - Absolute tolerance: 0.005%
  - Tolerance match: 0.001%
  - TCR tracking: 0.1 ppm/°C
  - Hermeticity of 10^{-7} atmospheric cc/s: The hermetic package provides a seal around the resistive element which protects it from the natural damage caused by moisture over time. In addition, VHD200 is oil-filled which further protects the device from degradation, and ensures long term performance in any extreme environment
- Shelf life stability: 2 ppm for at least 6 years
- Post Manufacture Operations (PMO) are available for enhanced performances

V5X5Z, V15X5Z (Z-Foil)

Offer an order of magnitude of improvement over other chip resistors in hybrid circuits, also available for high temperatures applications

- Ultra high-precision Bulk Metal® Z-Foil chip 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.)
  - TCR tracking: to 0.5 ppm/°C
  - Resistance tolerance: absolute to ±0.01% (user trimmable to ±0.005%), match to 0.01%
  - Power rating: 50 mW to 100 mW at +70°C
  - Load life stability: ±0.01% at +70°C, 10 000h at rated power
  - Short time overload: ≤0.02%
  - Thermal stabilization time <1s (nominal value achieved within 10 ppm of steady state value)
  - Pattern design minimizing hot spots

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Electron Beam

Electron beam machining is enabling a whole new range of applications, but its successful use depends on accuracy, speed and repeatability. The resistors that drive the beam's X and Y coordinates and which control the beam's intensity must not add signals of their own due to temperature power fluctuations when operated as current sensor or other system fluctuations. They must also respond immediately to high power pulse signals that drive the X/Y deflections. Vishay Foil resistors are the preferred resistive device for these applications.

End Product

Electron Beam Microscope

Function

Focusing Mechanism

Customer Requirements

- High power rating and working voltage capacity
- Resistance of approximately 1 MΩ required
- Extreme precision and reliability

The Vishay Foil Resistors Solution

VHA518-11Z

Oil-filled hermetically-sealed, ultra precision resistors; 11 resistor chips in series (Z-Foil)

- A robust design for the most accurate performance:
  - Power rating: 1.2–2.5W at +25°C
  - Maximum voltage capacity: 600V
  - Resistance range: 5Ω to 1.1 MΩ
  - Absolute tolerance: 0.001%
  - Absolute TCR: 0.2 ppm/°C typical at -55°C to +125°C, +25°C ref.
  - Load life stability: ±0.002% for 2000h, rated power at +25 °C
  - Hermeticity of 10^{-7} atmospheric cc/s: The hermetic package provides a seal around the resistive element which protects it from the natural damage caused by moisture over time. In addition, VHA518 is oil-filled which further protects the device from degradation, and ensures long-term performance in any extreme environment

Vishay Foil Resistors' H and HZ Series of Bulk Metal® Foil Resistors Selected for Electronic Design's Annual "Top 101 Components"

VHP100

Ultra high-precision hermetically-sealed Bulk Metal® Foil resistor with Zero TCR, no humidity within a unique construction, minimizing the effects of stress factors, with total error budget of 2 ppm drift.

- Oil filled hermetically-sealed resistor:
  - Essentially zero TCR
  - Absolute resistance change (window):
    VHP100 <60 ppm (-55°C to +125°C)
    VHP101 <10 ppm (+15°C to +45°C)
  - Resistance tolerance: to ±0.005% (50 ppm) - (available to ±0.001% (10 ppm)
  - No humidity effect: hermetically sealed against moisture
  - Load life stability: ±50 ppm typical for 2000h, 70°C at rated power
  - Shelf life stability: ±2 ppm typical after at least 6 years
  - Current noise: 0.010 μV_{RMS}/V of applied voltage (<-40 dB)
  - Thermal EMF: 0.05 µV/°C typical
  - Oil filled as standard, air filled available upon request

Vishay Foil Resistors' New-Generation, Ultra-Precision VHP100 Bulk Metal® Foil Resistor Wins Product of the Year Award from Electronic Products Magazine

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 which requires additional circuitry to compensate for lack of precision. Factor in warranty repair expense, downtime in the hands of the customer, and transportation costs for repairs, and the "savings" from using second-best resistors quickly disappear. Even when an assumed or measured returns rate is applied, the Vishay Foil resistor turns out to be the most economical solution.

End Product

High Voltage Electrical Circuit Breaker

Function

Precision Measurement Control

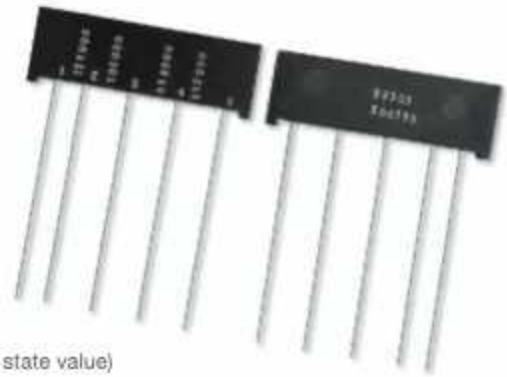
Customer Requirements

- Network with specific configuration
- Precise measurements are necessary to ensure the safety of the circuit and the proper trigger for the circuit breaker
- Performance should be reliable within the temperature range of -40°C to 70°C
- Must endure both sporadic and continuous short-time overload

The Vishay Foil Resistors Solution

300193Z

Ultra high-precision Z-Foil voltage divider and network resistor; 3 resistor chips, 2 configured as voltage divider, and the other as an individual resistor



- Precise voltage divider with flexibility of use and accurate performance at high temperatures:
  - Ratio tolerance: 0.005%
  - Absolute tolerance: 0.005%
  - TCR tracking: 0.5 ppm/°C
  - Absolute TCR: 2 ppm/°C typical at -55°C to 125°C range, +25°C ref.
  - Short time overload: 0.002%
- Thermal stabilization time < 1 s (nominal value achieved within 10 ppm of steady state value)

DSMZ (Z-Foil)

The DSMZ surface-mount voltage divider provides a matched pair of Bulk Metal® Z-Foil resistors in a small epoxy molded package. The electrical specification of this integrated construction offers improved performance and better real estate utilization over discrete resistors and matched pairs.

- Ultra high-precision Bulk Metal® Z-Foil surface-mount voltage divider:
  - Temperature coefficient of resistance (TCR):
    ±0.05 ppm/°C typ. (0°C to +60°C)
    ±0.2 ppm/°C typ. (-55°C to +125°C, +25°C ref.)
  - TCR tracking: 0.1 ppm/°C typical
  - Resistance tolerance: absolute: ±0.02%; match: 0.01%
  - Power rating at 70°C: entire package: 0.1W, each resistor: 0.05W
  - Ratio stability: 0.005% (0.05W at +70°C, 2000h)
  - Short time overload: 0.005%
  - Non inductive, non capacitive design
  - Rise time: 1 ns effectively no ringing

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Laboratory and Metrology

In lab and metrology applications, the only appropriate resistors are those that will retain their initial value over time. Hermetic packaging is a must since every laboratory will have some humidity fluctuations. Additional essentials include stability under temperature fluctuations, no thermally active junctions, and a low temperature coefficient of resistance. Only one resistor combines all of these characteristics: Bulk Metal® Foil Resistors.

End Product

Real-Time Hydrogen-Specific Process Monitor

Function

Hydrogen Gas Measurement

Customer Requirements

- Reliable performance for real-time accuracy
- High speed response capabilities to detect instantaneous changes in environment
- Low TCR and low PCR specifications

The Vishay Foil Resistors Solution

VSMP0603 (Z-Foil)

Ultra high-precision foil wraparound surface-mount chip resistor (Z-Foil)

- Reliable, high-speed performance for real-time measurements:
  - Load life stability: ±0.005% for 2000 h, rated power at +70°C
  - Absolute TCR: 0.2 ppm/°C typical at -55°C to +125°C range
  - Power Coefficient of Resistance (PCR) "ΔR due to self heating": 5 ppm at rated power
  - Absolute tolerance: 0.01%
  - Rise time: 1 ns effectively no ringing
- Electrostatic discharge (ESD) at least to 25 kV
- Thermal stabilization time <1s (nominal value achieved within 10 ppm of steady state value)
- Voltage coefficient: <0.1 ppm/V
- Non inductive: <0.08 µH

VHP203 (Z-Foil)

The hermetic sealing (oil-filled) 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, while at the same time allowing the device to accept short periods of overload without degradation.

- Hermetically-sealed miniature ultra high-precision Z-Foil technology resistors:
  - Temperature coefficient of resistance (TCR): ±0.05 ppm/°C (0°C to +60°C)
  - Resistance tolerance: to ±0.001% (10 ppm)
  - Load life stability: ±0.002% maximum ΔR (+60°C for 2000h at 0.1W per chip)
  - Electrostatic discharge (ESD) up to 25 kV
  - Power rating: to 0.3W at +25°C
  - Shelf life stability: 2 ppm for at least 6 years
  - Current noise: 0.010 μV_{RMS}/V of applied voltage (<-40 dB)
  - Thermal EMF: 0.05 µV/°C typical
  - Voltage coefficient: <0.1 ppm/V
  - Non inductive: <0.08 µH

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, the preferred choice of device is Vishay Foil.

End Product

Fluid Injector Device

Function

Current Sense for Motor Control

Customer Requirements

- Reliable measurements of motor control are necessary to perform injections at the precise location
- High speed response necessary to perform given task
- Low sensitivity to short-time overload
- Surface mount to preserve limited real estate
- 4 pad Kelvin connection desired as a way to improve accuracy

The Vishay Foil Resistors Solution

VCS1625ZP (Z-Foil)

Ultra high-precision Z-Foil surface-mount current sensing chip resistor

- High performance current sense:
  - Load life stability: 0.02% at 70°C, 2000h at rated power
  - Absolute tolerance: 0.2%
  - Absolute TCR: 0.05 ppm/°C typical at 0°C to +60°C range
  - Power Coefficient of Resistance (PCR) "ΔR due to self heating": 5 ppm at rated power
  - Rise time: 1 ns effectively no ringing
  - Short time overload: <0.005%
  - Standard Kelvin connection configuration

VCS331Z, VCS332Z (Z-Foil)

High-precision 4 terminal power current sensing resistors when mounted on a heat sink can sustain 10 W continuously without an appreciable change in resistance.

- 4-Terminal power current sensing resistors:
  - Low temperature coefficient of resistance : 0.05 ppm/°C typical (0°C to +60°C)
  - Resistance tolerance : to ±0.01%
  - Rapid ΔR stabilization under transient loads
  - Tenfold improvement of Power Coefficient of Resistance (PCR): 4 ppm/W
  - Thermal resistance: 6°C/W
  - Rise time: 1 ns, effectively no ringing
  - Power rating: to 10W on heatsink at +25°C, 3W in free air at +25°C
  - Thermal stabilization time <1s (nominal value achieved within 10 ppm of steady state value)
  - Load life stability: ±0.005% (50 ppm), 3W on heatsink at +25°C, 2000h, ±0.01% (100 ppm), 3W in free air at +25°C, 2000h

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Military

Vishay Foil resistors have been used for more than 40 years in military equipment and even before a suitable MIL SPEC was established. In the late 60s, MIL PRF 55182 was established and the RNC90 style applied to the Vishay Foil resistors. Testing to "R" failure rate was conducted and the devices have been used continuously ever since. Today, Vishay Foil resistors are serving in every category of military equipment that relies on electronics for its functionality.

End Product

High Power Pulse Radio Frequency Transmitter

Function

Signal Generator and Feedback

Customer Requirements

- Real-time measurement capabilities
- Accurate digital to analog conversion capabilities
- High speed response necessary to perform given task
- Able to withstand electrostatic discharges (ESD)
- High stability
- End of life tolerance: <0.1%

The Vishay Foil Resistors Solution

Z201 (Z-Foil)

High-precision foil resistor

- The most reliable resistor for tasks that have no margin for error:
  - Temperature coefficient of resistance (TCR): ±0.2 ppm/°C typical (-55°C to +125°C, +25°C ref.)
  - Resistance tolerance: to ±0.005%
  - Load life stability: to ±0.005% at 70°C, 2000h at rated power
  - Electrostatic discharge (ESD) at least to 25 kV
  - Non inductive, non capacitive design
  - Rise time: 1 ns without ringing
  - Current noise: 0.010 μV_{RMS}/volt of applied voltage (<-40 dB)
  - Thermal EMF: 0.05 µV/°C

1445Q and 1446Q (QPL)

These networks are qualified to MIL-PRF-83401, characteristic C, schematic A, (Qualified Parts List - QPL). Actual performance exceeds all the requirements of MIL-PRF-83401 characteristics "C."

- QPL networks:
  - Hermetically sealed for maximum environmental protection - 100% leak protection
  - Gross leak: no bubbles
  - Fine leak: <5 x 10^{-7} cc/sec
  - Tested per MIL-PRF-83401
  - Ceramic package: 94% alumina (Al_2O_3)
  - Lid: gold-plated Kovar
  - Solder: tin/gold
  - Leads: alloy 42 (iron nickel) with 100µ inches gold plating (MIL-STD-1276, Type G-21-A)
  - Gold ball wire bonding
  - Foil chips V15X5

Precision Instrumentation

Whether they are used in the guidance system of a cruise missile, the autopilot of an airplane, or the remote responder of a weather station, Vishay Foil resistors are consistently the best choice for precision instrumentation because of their initial accuracy and long term stability.

End Product

Chromatography Data System Validation Instrument

Function

Unity Gain Inverting Amplifiers and Summing Amplifiers

Customer Requirements

- TCR tracking and a tight tolerance ratio is essential for gain control
- Long term stability and low drift is required for consistent performance
- Low noise capabilities which will not interfere with signal measurements

The Vishay Foil Resistors Solution

SMNZ (Z-Foil)

Ultra high-precision Z-Foil surface-mount 4 resistor network dual-in-line package

- The most precise network package for amplifier applications:
  - Absolute TCR: 0.2 ppm/°C typical at -55°C to 125°C range
  - TCR tracking: 0.1 ppm/°C typical at -55°C to +125°C range
  - Tolerance matching: 0.01%
  - Ratio stability: 0.005% for 2000h, rated power at +70°C
  - Power Coefficient of Resistance (PCR) "ΔR due to self heating": ±5 ppm at rated power
  - Current noise: 0.010 μV_{RMS}/V of applied voltage (<-40 dB)
  - Electrostatic discharge (ESD) at least to 25 kV

VFD244Z (Z-Foil)

Voltage divider with excellent Initial resistance and ratio matching, tracking in operation and fast response without ringing.

- Bulk Metal® Foil technology ultra high-precision Z-Foil voltage divider:
  - 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: 0.1 ppm/°C typical
  - Resistance tolerance: absolute and matching to 0.005% (50 ppm)
  - Power rating: up to 1W at 70°C
  - Load life ratio stability: <0.005% (50 ppm) 1W at +70°C for 2000h
  - Maximum working voltage: 350V
  - Rise time: 1 ns effectively no ringing
  - Current noise: 0.010 μV_{RMS}/V of applied voltage (<-40 dB)
  - Thermal stabilization time <1s (nominal value achieved within 10 ppm of steady state value)

VISHAY PRECISION GROUP

Weighing Scales

Whatever they're weighing, whether it's gems or pharmaceuticals, scales must be accurate day in and day out. Some are in harsh environments while others are in laboratories. But regardless of the application, accuracy and consistency are the prime targets. For nearly 50 years, Vishay Foil resistors have been a key enabling component for weighing systems, and they continue to serve this important sector today.

End Product

Weighing Scale

Function

Current Sense and Voltage Reference

Customer Requirements

- High-precision measurement capabilities
- Accurate digital to analog conversion capabilities
- Low noise for best performance

The Vishay Foil Resistors Solution

CSM3637S

Bulk Metal® Foil technology high-precision, current sensing, power surface mount, metal strip resistor that meets the requirements of MIL-PRF-49465B.

- The most precise and reliable resistor available:
  - Absolute tolerance: 0.2%
  - Absolute TCR: 20 ppm/°C maximum at -55°C to +125°C, +25°C ref.
  - Power rating: 2W
  - Load life stability: ±0.05% for 2000h, rated power at +70°C
  - Thermal EMF: <3 µV/°C

CSM2512S

Bulk Metal® Foil technology high-precision, surface-mount configuration with four terminal (Kelvin) design which allows precision and accurate measurements with improved stability.

- Current sensing, power surface-mount, metal strip resistor:
  - Temperature coefficient of resistance (TCR): ±15 ppm/°C maximum (-55°C to +125°C, +25°C ref.)
  - Load life stability to ±0.05% (70°C, 2000h at rated power)
  - Power rating: 1W
  - Resistance tolerance: ±0.1%
  - Short time overload: ±0.1% typical
  - Thermal EMF: <3 µV/°C
  - Maximum current: up to 10A

Check also: CSM3637Z, CSM3637P, CSM3637, CSM2512