Precision High-Power Bulk Metal® Foil Resistors, and Thick Film Power Resistors

Product Overview

powertron.de

POWERTRON | Part of VPG Foil Resistors

Precision High-Power Bulk Metal® Foil Resistors, and Thick Film Power Resistors

Powertron GmbH, a brand of Vishay Precision Group, Inc. (VPG) and part of VPG's Vishay Foil Resistors product line, is dedicated to the development, manufacturing, and marketing of high-precision foil, current sense, and thick film resistors for use in diverse applications. Powertron offers a full complement of resistors for accurate, precise, and high-power circuits, with customization capabilities supporting virtually any package type.

Powertron focuses on delivering solutions with the best combination of power ratings, TCR, and resistance ranges. Our foil resistor products include devices built on CuNiMn Bulk Metal® Foil for low-ohm, high-precision applications, with TCR down to 5 ppm and long-term stability of 0.1%; as well as NiCr foil for even higher levels of stability, with TCR of 1 ppm and long-term stability of 0.01%. A supplemental thick film product line is also available in a wide range of packages. Powertron produces thick film power resistors in standard sizes, in addition to custom solutions with "as-required" resistor values.

Made in Germany, with local customer service and technical support providing high flexibility, our products are used throughout the world in high-precision medical, aerospace, military, and industrial applications.

Powertron 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 resistors surrounding the operational amplifier and anywhere else they are needed in medical applications, the preferred choice of device is Powertron foil.

End Product

Hemodialysis Equipment (Reference resistor for high-accuracy temperature measurement)

Customer Requirements

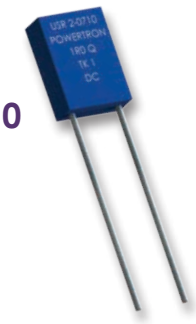
- High-precision resistance values
- High stability over time (0.01% for 2000 h)
- Low TCR in the range of –55°C to +125°C
- Customized resistance values from 90R0 to 210R0

Powertron Foil Solution: **USR 2-0710**

High-precision, highly reliable resistor

Precise measurement with following parameters:

- Customized resistance values available
- TCR down to 1 ppm
- Stability of 0.01% over time



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, Powertron foil current sense resistors turn out to be the most economical solution.

End Product

Test instruments for high-voltage equipment

Customer Requirements

- High-precision current measurement
- High stability over time (0.1% for 1000 h)
- Low TCR in the range of 10°C to 80°C
- Low resistance value (0.005 Ω to 0.010 Ω)
- High power rating with up to 40 W
- Must endure short-time overload without changing parameters

Powertron Foil Solution: **FHR 4-3825**

Low-ohmic, high-precision, and high-power current sense resistor

Precise measurement with following parameters:

- Resistance values starting from 0.001 Ω
- Power rating up to 50 W
- TCR down to 15 ppm
- 4-terminal Kelvin connection for high-precision measurement

Precision Instrumentation

Whether they are used in the guidance system of a cruise missile, high-precision power supplies, or in precision measurement equipment, Powertron foil resistors are consistently the best choice for precision instrumentation because of their initial accuracy and long term stability.

End Product

Labor current supply for 1- and 3-phase electrical networks

Customer Requirements

- High-precision current measurement for outgoing current quality control
- High stability over time (0.1% for 1000 h)
- Low TCR in the range of 20°C to 60°C
- Low resistance values (0.001 Ω to 0.002 Ω)
- High power rating with up to 60 W
- High-current applications up to 165 A

Powertron Foil Solution: **FPR 4-T227**

Low-ohmic, high-precision, and high power current sense resistor

Precise current measurement with the following parameters:

- Resistance values starting from 0.001 Ω
- Power rating up to 60 W
- TCR down to 15 ppm
- 4-terminal Kelvin connection for high precision measurement
- Available with special high current terminals on for high-precision measurement

Power Distribution

Electrical power is becoming more expensive and the need to more precisely control its distribution will be a key factor in the future. For such applications it is mandatory to use highly reliable electronic components, as these systems have a long lifetime in the field. Measuring current is one of their most important features, so stable and reliable resistors are required. Such resistor provide accurate measurements over a long time, while minimizing repair expenses and downtime. Powertron Bulk Metal Foil current sense resistors are the most economical solution.

End Product

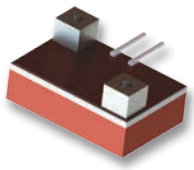
Current measurement in bus-bar systems

Customer Requirements

- Low resistance value (<0.0005 Ω)
- High stability over time
- Low TCR in the range of –20°C to +75°C
- Customized resistance design

Powertron Foil Solution: **Special Products**

High-precision, reliable resistor



Precise measurement with following parameters:

- Customized resistance values below 1 mΩ
- TCR down to 20 ppm
- Stability of 0.1% over time

Aerospace

The demands of the aerospace segment differ from commercial segments in one major aspect: 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 in 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 Powertron resistors, with their long-term consistency and reliability, are the only choice for aerospace applications.

End Product

Current measurement in satellites

Customer Requirements

- High precision resistance value
- High stability over time
- Low TCR in the range of –20°C to +85°C
- Customized resistance values

Powertron Foil Solution: **FHR 4-2321**

High-precision, reliable resistor

Precise measurement with following parameters:

- Customized resistance values from 1 mΩ to 50 Ω
- TCR down to 15 ppm
- Stability of 0.1% over time

Audio

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's measuring capability, but is nonetheless aurally detectable. Vishay Foil Resistors devices offer the lowest noise available for such resistors, and are essential components of any high-end audio system.

End Product

Loudspeaker systems

Customer Requirements

- Customized resistance values
- High stability over time
- Low TCR in the range of –20°C to +60°C
- Customized resistance design

Powertron Foil Solution: **FPR 2-T218**

High-precision, reliable resistor

Precise resistance with following parameters:

- Customized resistance values from 0.002 Ω to 20 Ω
- TCR down to 25 ppm
- Stability of 0.1% over time

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.

End Product

Used in multiple electronic systems, such as temperature control

Customer Requirements

- High-precision resistance values
- High stability over time
- Customized resistance values

Powertron Foil Solution: **KHR 2-T227**

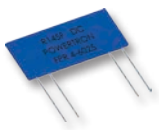
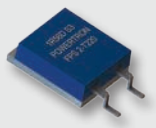
High-precision, reliable resistor

Precise power resistor with following parameters:

- Customized resistance values from 1 Ω to 50 kΩ
- Power rating up to 200 W
- Standard TO-227 / 238 housing

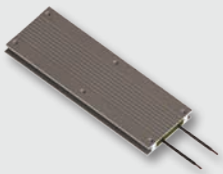
High-Precision Power CuNiMn Current Sense Resistors

Powertron's high-precision power CuNiMn current sense resistors offer a wide range of capabilities for different applications, and are available with any resistance value requested by the customer.

Product		Description
	**FPR 2-1617** **FPR 2-1623** **FPR 2-2614**	Resistance values from 0.01 Ω to 100 Ω Power rating to 2 W Resistance tolerances to ±0.1% TCR to ±50 ppm/K Load stability to 0.1%
	**FPR 4-3316**	Resistance values from 0.001 Ω to 100 Ω Power rating to 2 W Resistance tolerances to ±0.1% TCR to ±15 ppm/K Load stability to 0.1%
	**PCS201** **PCS202**	Resistances from 0.001 Ω to 10 Ω Power rating to 2 W Resistance tolerances to ±0.1% TCR to ±15 ppm/K Load stability to 0.1%
	**FPR 4-6025**	Resistance values from 0.100 Ω to 10 Ω Power rating to 4 W Resistance tolerances to ±0.2% TCR to ±15 ppm/K Other dimensions upon request
	**FPS 2-T220**	Resistance values from 0.002 Ω to 10 Ω Power rating to 15 W Resistance tolerances to ±0.5% TCR to ±50 ppm/K Load stability to 0.1% SMD D2Pak
	**FPS 4-T220**	Resistance values from 0.002 Ω to 10 Ω Power rating to 15 W Resistance tolerances to ±0.1% TCR to ±15 ppm/K Load stability to 0.1% SMD D2Pak
	**FPR 2-T220** **FPR 2-T221**	Resistance values from 0.002 Ω to 10 Ω Power rating to 15 W Resistance tolerances to ±0.1% TCR to ±50 ppm/K Load stability to 0.1% TO-220 housing
	**FPR 4-T220** **FPR 4-T221**	Resistance values from 0.002 Ω to 10 Ω Power rating to 15 W Resistance tolerances to ±0.1% TCR to ±15 ppm/K Load stability to 0.1% TO-220 housing
	**FPR 2-T218**	Resistance values from 0.002 Ω to 20 Ω Power rating to 30 W Resistance tolerances to ±0.25% TCR to ±50 ppm/K Load stability to 0.1% TO-218 (TO-247) housing

High-Precision Power CuNiMn Current Sense Resistors

Powertron's high-precision power CuNiMn current sense resistors offer a wide range of capabilities for different applications, and are available with any resistance value requested by the customer.

Product		Description
	**FHR 2-3025** **FHR 2-3818**	Resistance values from 0.01 Ω to 100 Ω Power rating to 40 W Resistance tolerances to ±0.25% TCR to ±50 ppm/K Very low inductance Stability to 0.1%
	**PCS301** **PCS302**	Resistance values from 0.001 Ω to 50 Ω Power rating to 40 W Resistance tolerances to ±0.1% TCR to ±3 ppm/K Very low inductance Load stability to 0.1%
	**FHR 4-2321**	Resistance values from 0.001 Ω to 50 Ω Power rating to 40 W Resistance tolerances to ±0.1% TCR to ±15 ppm/K Very low inductance Load stability to 0.1%
	**FHR 4-3825** **FHR 4-4618**	Resistance values from 0.001 Ω to 100 Ω Power rating to 50 W Resistance tolerances to ±0.1% TCR to ±15 ppm/K Very low inductance Load stability to 0.1%
	**FPR 2-T227** **FNR 2-T227**	Resistance values from 0.001 Ω to 100 Ω Power rating to 80 W Resistance tolerances to ±0.1% TCR to ±50 ppm/K Load stability to 0.1%
	**FPR 4-T227** **FNR 4-T227**	Resistance values from 0.001 Ω to 100 Ω Power rating to 80 W Resistance tolerances to ±0.1% TCR to ±15 ppm/K Load stability to 0.1%
	**FHR 2-8065** **FHR 2-80110** **FHR 2-80216** **FHR 2-80320** **FHR 2-80370**	Resistance values from 0.001 Ω to 500 Ω Power rating to 2500 W Resistance tolerances to ±0.1% TCR to ±50 ppm/K Load stability to 0.1% Very low inductance (<50 nH)
	**FHR 4-8065** **FHR 4-80110** **FHR 4-80216** **FHR 4-80320** **FHR 4-80370**	Resistance values from 0.001 Ω to 500 Ω Power rating to 2500 W Resistance tolerances to ±0.1% TCR to ±15 ppm/K Load stability to 0.1% Very low inductance (<50 nH)
	**FPN Net Works** **FHN Net Works**	Resistor values over four decades 0.010 Ω to 90 Ω Kelvin connection Resistance tolerances to ±0.1% TCR to ±15 ppm/K Load stability to 0.1%

High-Precision Power CuMnSn Current Sense Resistors

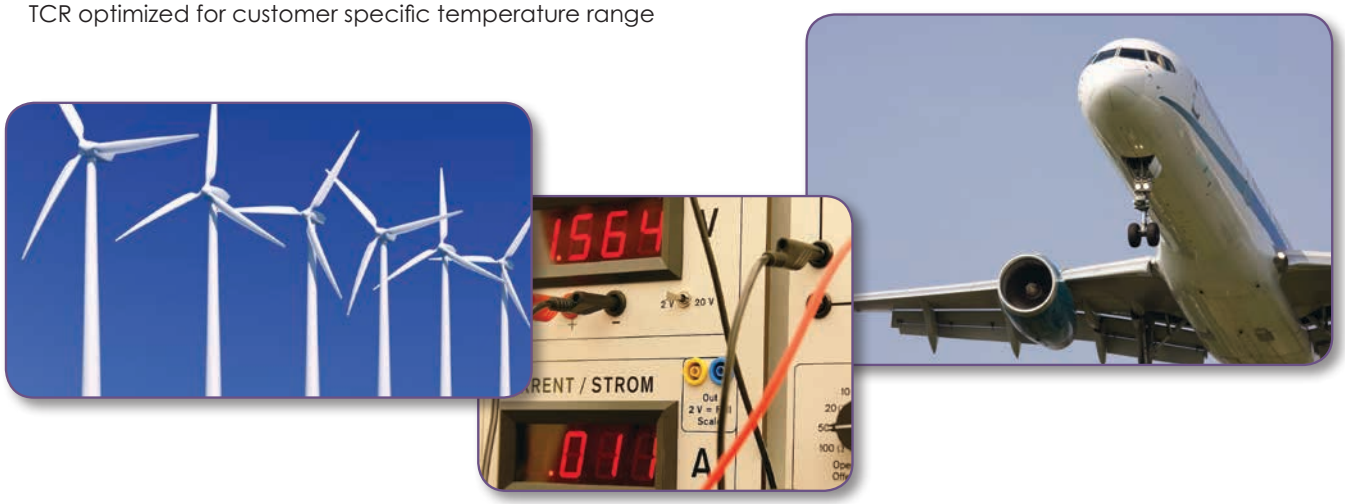
Powertron's high-precision power CuMnSn current sense resistors offer the best available TCR for high-power current measurement. The devices are available as free-standing resistors, with a metal plate for heat sink mounting, as well as surface-mount applications.

New SHLR Series Resistors Offering Low TCR Line Down to 1 mΩ (0R001)

Product		Description
	**SHLR 4-2321**	Resistances from 0.001 to 0.005 Ω Power rating to 40 W Resistance tolerances to ±0.1% TCR to ±2 ppm/K
	**SHLR 4-3825H**	Resistances from 0.001 to 0R005 Ω Power rating to 5 W (stand alone version) Resistance tolerances to ±0.1% TCR to ±2 ppm/K
	**SHLR 4-3825**	Resistances from 0.001 to 0R005 Ω Power rating to 50 W Resistance tolerances to ±0.1% TCR to ±2 ppm/K

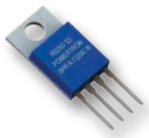
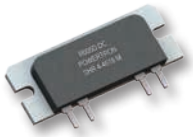
Upon customer request, we can provide parts optimized for:

- Resistance value down to 500 µΩ (0R0005)
- TCR measurement reports
- TCR optimized for customer specific temperature range



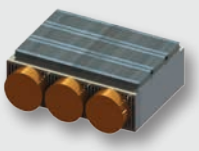
High-Precision Power CuMnSn Current Sense Resistors

Powertron's high-precision power CuMnSn current sense resistors offer the best available TCR for high-power current measurement. The devices are available as free-standing resistors, with a metal plate for heat sink mounting, as well as surface-mount applications.

Product		Description
	**SPS 4-T220**	Resistance values from 0.01 Ω to 10 Ω Power rating to 15 W Resistance tolerances to ±0.1% TCR to ±5 ppm/K Load stability to 0.1% SMD D2Pak
	**SPR 4-T220** **SPR 4-T221**	Resistance values from 0.005 Ω to 10 Ω Power rating to 15 W Resistance tolerances to ±0.1% TCR to ±2 ppm/K Load stability to 0.1% TO-220 Housing
	**SHR 4-2321**	Resistance values from 0.005 Ω to 20 Ω Power rating to 40 W Resistance tolerances to ±0.1% TCR to ±2 ppm/K Load stability to 0.1% Very low inductance
	**SHR 4-4618**	Resistance values from 0.005 Ω to 50 Ω Power rating to 50 W Resistance tolerances to ±0.1% TCR to ±2 ppm/K Load stability to 0.1% Very low inductance
	**SHR 4-3825** **SHR 4-3825H**	Resistance values from 0.005 Ω to 50 Ω Power rating to 50 W Resistance tolerances to ±0.1% TCR to ±2 ppm/K Load stability to 0.1% Very low inductance
	**SPR 4-T227** **SNR 4-T227**	Resistance values from 0.002 Ω to 20 Ω Power rating to 80 W Resistance tolerances to ±0.1% TCR to ±2 ppm/K Load stability to 0.1% Very low inductance
	**SHR 4-8065** **SHR 4-80110** **SHR 4-80216** **SHR 4-80320** **SHR 4-80370**	Resistance values from 0.005 Ω to 300 Ω Power rating to 2500 W Resistance tolerances to ±0.1% TCR to ±2 ppm/K Load stability to 0.1% Very low inductance
	**SPN Networks** **SHN Networks**	Resistor values over four decades 0.010 Ω to 90 Ω Kelvin connection Resistance tolerances to ±0.1% TCR to ±2 ppm/K Load stability to 0.1%

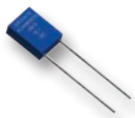
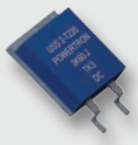
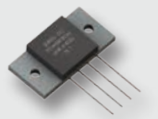
Special Resistors, Custom Design

Powertron's special resistors are designed upon customer request and can vary in dimensions, resistive elements and technologies used, contacts, and further parameters as needed by the customer.

Product		Description
	**SHR 4-2820**	• Resistance values from 0.001 Ω to 0.01 Ω • Power rating to 10 W • Resistance tolerances to ±1% • TCR to ±70 ppm/K • Load stability to 0.5%
	**FHR 4-4026H**	• Resistance values from 0.0005 Ω to 10 Ω • Power rating to 15 W • Resistance tolerances to ±0.25% • TCR to ±20 ppm/K
	**CAL 4-40100**	• Calibration resistor • Resistance values from 0.0001 Ω to 10 kΩ • Current to 60 A • Resistance tolerances to ±0.02% • TCR to ±10 ppm/K
	**FHR 4-2036**	• Resistance values upon customer request • Power rating to 5 W • Resistance tolerances to ±0.2% • TCR to ±15 ppm/K • 350 J pulse capabilities
	**UHR 4-5020D**	• Resistance values from 1 Ω to 40 Ω • Power rating to 8 W • Resistance tolerances to ±0.1% • TCR to ±5 ppm/K • Load stability to 0.1% • Pulse energy up to 1000 J/1 s
	**WPR 2-TO5**	• Resistance values from 50 Ω to 600 kΩ • Resistance tolerances to ±0.01% • TCR to ±5 ppm/K • Load stability to 0.1% • Hermetically sealed
	**High Power Resistor Bank**	• Power resistors mounted on heat sink • Resistance values from 0.001 Ω to 500 Ω • Power rating to 2500 W • Resistance tolerances to ±0.1% • TCR to ±2 ppm/K • Load stability to 0.1%

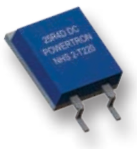
NiCr Foil Resistors for High-Power Applications

Powertron's NiCr foil resistors are specially designed for high-power applications with power dissipation up to 50 W. These products also offer the best performance for TCR, load stability, and tolerance.

Product		Description
	**USR 2-0808**	Resistance values from 1 Ω to 150 kΩ Power rating to 0.6 W Resistance tolerances to ±0.005% TCR to ±1 ppm/K Load stability to 0.01%
	**USR 2-0710** **UNR 2-0710**	Resistance values from 1 Ω to 150 kΩ Power rating to 0.6 W Resistance tolerances to ±0.005% TCR to ±1 ppm/K Load stability to 0.01%
	**USS 2-T220** **UNS 2-T220**	Resistance values from 0.5 Ω to 150 kΩ Power rating to 15 W Resistance tolerances to ±0.01% TCR to ±3 ppm/K Load stability to 0.01% SMD D2Pak
	**USS 4-T220** **UNS 4-T220**	Resistance values from 0.2 Ω to 80 Ω Power rating to 15 W Resistance tolerances to ±0.01% TCR to ±1 ppm/K Load stability to 0.01%
	**USR 2-T220** **USR 2-T221** **UNR 2-T220** **UNR 2-T221**	Resistance values from 0.5 Ω to 150 kΩ Power rating to 10 W Resistance tolerances to ±0.01% TCR to ±3 ppm/K Load stability to 0.01% TO-220 housing
	**USR 4-T220** **USR 4-T221** **UNR 4-T220** **UNR 4-T221**	Resistance values from 0.2 Ω to 80 Ω Power rating to 15 W Resistance tolerances to ±0.01% TCR to ±1 ppm/K Load stability to 0.01%
	**USR 4-3425** **UNR 4-3425**	Resistance values from 0.05 to 500 Ω Power rating to 50 W Resistance tolerances to ±0.01% TCR to ±1 ppm/K Load stability to 0.01%
	**PCS331** **PCS332**	Resistance values from 0.05 Ω to 500 Ω Power rating to 50 W Resistance tolerances to ±0.01% TCR to ±1 ppm/K Load stability to 0.01%
	**USR 4-4020** **UNR 4-4020**	Resistance values from 0.05 Ω to 100 Ω Power rating to 50 W Resistance tolerances to ±0.01% TCR to ±1 ppm/K Load stability to 0.01%

Thick Film Resistors

Powertron thick film resistors are completing the power line of Powertron Foil resistors. They are available in standard housings and will be delivered with any resistance value.

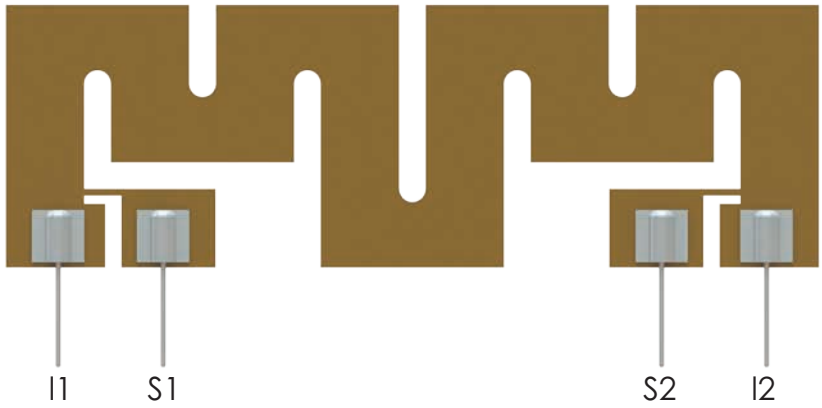
Product		Description
	**NPS 2-T126**	Resistance values from 0.025 Ω to 10 kΩ Power rating to 25 W Resistance tolerances to ±1% TCR to ±100 ppm/K Load stability to 0.5% TO-126 housing (D-Pak) Solder reflow secure at 260°C / 20s
	**NPS 2-T220** **NHS 2-T220**	Resistance values from 0.02 Ω to 100 kΩ Power rating to 50 W Resistance tolerances to ±1% TCR to ±50 ppm/K Load stability to 0.5% TO-220 SMD housing
	**NPR 2-T220** **NHR 2-T221**	Resistance values from 0.02 Ω to 100 kΩ Power rating to 50 W Resistance tolerances to ±1% TCR to ±50 ppm/K Load stability to 0.5% TO-220 housing
	**KPR 2-T218** **KHR 2-T218**	Resistance values from 0.05 Ω to 100 kΩ Power rating to 100 W Resistance tolerances to ±1% TCR to ±100 ppm/K Load stability to 1% TO-218 (TO-247) housing
	**KPR 2-T227** **KHR 2-T227**	Resistance values from 0.05 Ω to 5 MΩ Power rating to 200 W Resistance tolerances to ±1% TCR to ±50 ppm/K TO-227 (TO-238) housing
	**KPR 4-T227** **KHR 4-T227**	Resistance values from 0.05 Ω to 5 MΩ Power rating to 200 W Resistance tolerances to ±1% TCR to ±50 ppm/K TO-227 (TO-238) housing
	**KPN 2-T227** **KHN 2-T227**	Resistance values from 0.05 Ω to 5 MΩ Power rating to 200 W Resistance tolerances to ±1% TCR to ±50 ppm/K TO-227 (TO-238) housing

Powertron technologies used in production processes are optimized for each single product to have the best available performance. This includes the chip design, used layouts, trimming process and materials.

Resistor Design

Powertron is providing different connection types for the best performance of the products at the customer. For our low ohmic resistors we are using as a standard a true Kelvin connection. The advantage is to have no influence from the outside to the TCR of the resistor itself.

4-Pin Kelvin Resistor



R (I1-I2) > Rnominal

R (S1-S2) > Rnominal

R (I1-S1) ≠ 0 Ohm

R (I2-S2) ≠ 0 Ohm

The key advantage of four-terminal sensing is that the separation of current and voltage electrodes eliminates the impedance contribution of the wiring and contact resistances.

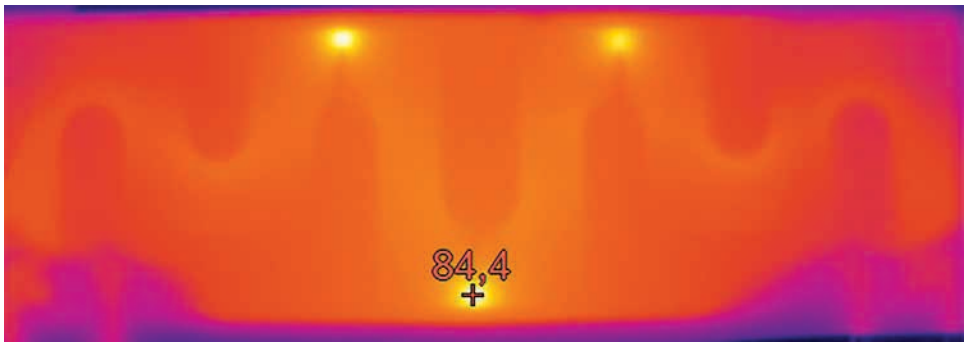
Four-terminal sensing is also known as Kelvin sensing.

Trimming Methods

Powertron is using different trimming methods in the production as different materials can not be treated the same. For thin Bulk Metal® Foils (<0.010 mm), different chemical trimming processes are used. For thicker Bulk Metal Foils, it is either chemical trimming or mechanical trimming.

Whatever trimming technology is used, the trimming is always done on the whole active surface to avoid any cuts into the material. Doing this, there are never hot spots in the layout which will guarantee a even thermal dissipation through the maximun available surface.

Trimming by standard laser cut (not used at Powertron)



Max. temperature 84.4°C

Trimming with Powertron technology

Max. temperature 43.7°C

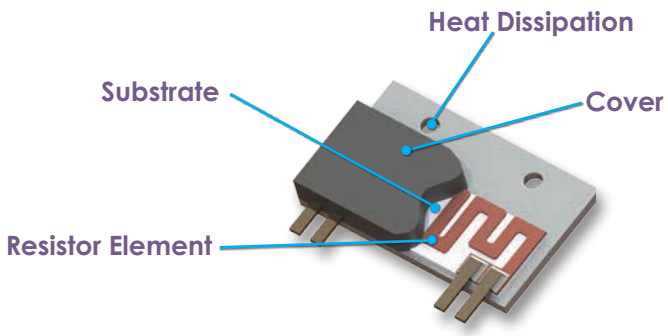
Materials

Powertron is offering the customer various materials to choose from to customize the product for his application. For audio, aerospace and high end electronics, changes in the used components can outperform the final application.

Overview

Resistor Element	Substrate	Heat Dissipation	Cover
NiCr	AlN (Aluminium nitride ceramic) Al2O3 (Aluminiumoxide ceramic)	Aluminium heat sink Free air[1] AlN or Al2O3	Epoxy / PPS AlN (Aluminium nitride ceramic) Al2O3 (Aluminiumoxide ceramic)
CuNiMn	AlN (Aluminium nitride ceramic) Al2O3 (Aluminiumoxide ceramic) Aluminium Copper (with nickel flash)	Aluminium heat sink Copper heat sink Free air[1] AlN or Al2O3	Epoxy / PPS AlN (Aluminium nitride ceramic) Al2O3 (Aluminiumoxide ceramic) Aluminum Copper
CuMnSn	AlN (Aluminium nitride ceramic) Al2O3 (Aluminiumoxide ceramic) Aluminium Copper (with nickel flash)	Aluminium heat sink Copper heat sink Free air AlN or Al2O3	Epoxy / PPS AlN (Aluminium nitride ceramic) Al2O3 (Aluminiumoxide ceramic) Aluminium Copper
ThickFilm	Al2O3 (Aluminiumoxide ceramic)	Aluminium heat sink Copper heat sink Free air[1]	Epoxy / PPS AlN (Aluminium nitride ceramic) Al2O3 (Aluminiumoxide ceramic)

[1] No open surface to connect to an external heat sink



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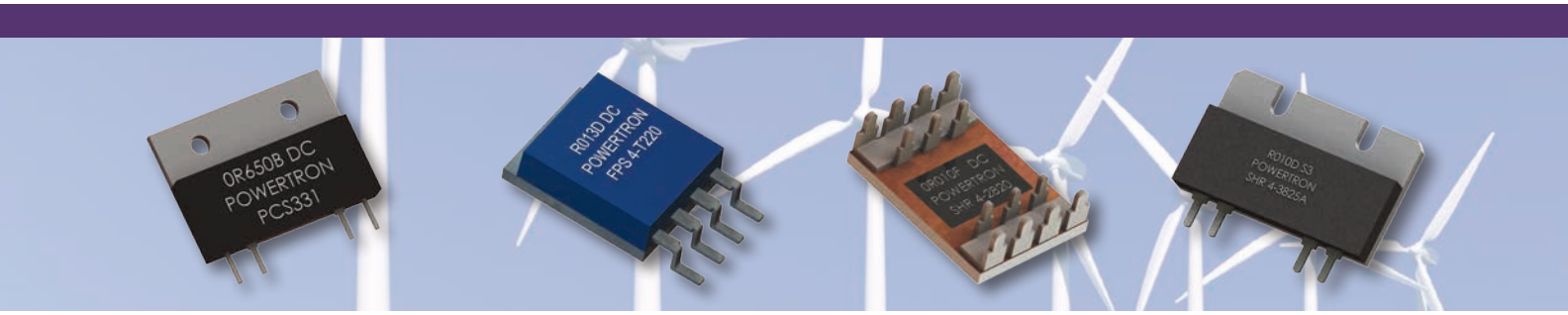
Part of VPG Foil Resistors



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