

VPG Foil Resistors

VFR • ALPHA ELEC. • POWERTRON • APR

**Consistent Precision
& Reliability**



AE Alpha Electronics
A VPG Brand

**Ultra Precision
Bulk Metal[®] Foil Resistors
Thin Film Resistors
Thermosensitive Resistors**

Product Overview

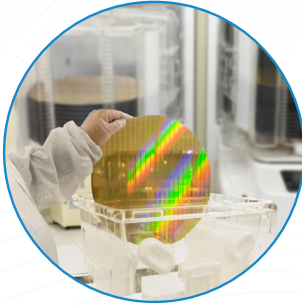
Fully automated manufacturing of consistent precision and reliability

A Bulk Metal® Foil high precision resistor, unlike precision-class metal thin film or thick film resistors, is an ultra precision resistor providing superior performance and reliability. Bulk Metal® Foil resistor technology can achieve the lowest available TCR thanks to a specially-formulated super thin alloy foil.

We manufacture ultra precise, ultra stable and ultra reliable resistors in our cutting-edge fully-automated factory in Akita, Japan.

Applications

Alpha Electronics' Bulk Metal® Foil resistors are an integral part of any new technological innovation, including equipment for:



**Semiconductor/
Automatic Test
Equipment**



Communications



Medical



Precision Weighing



Measurement



Aviation

Available Features

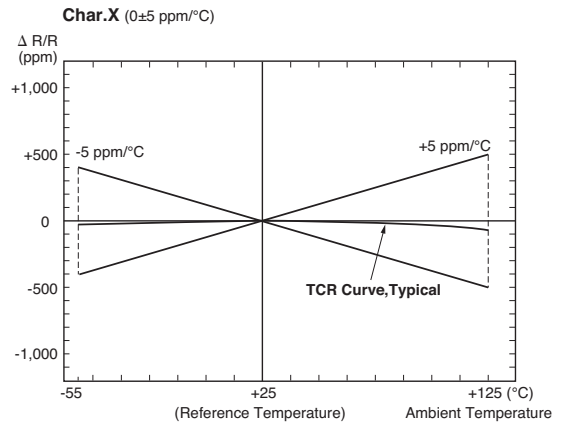
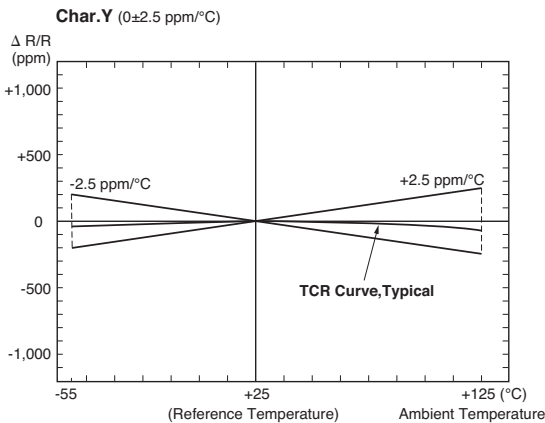
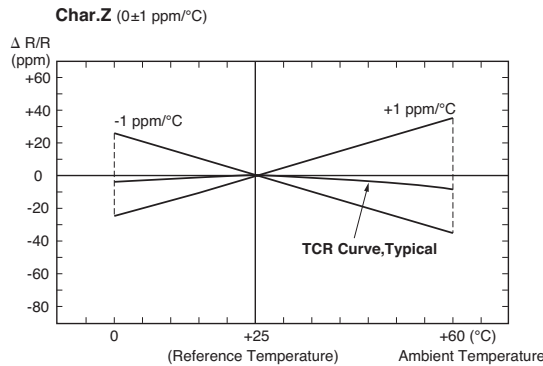
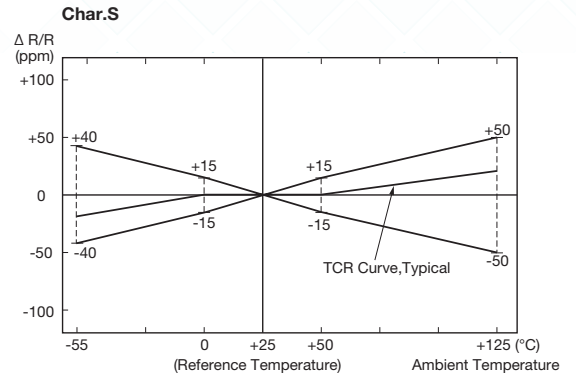
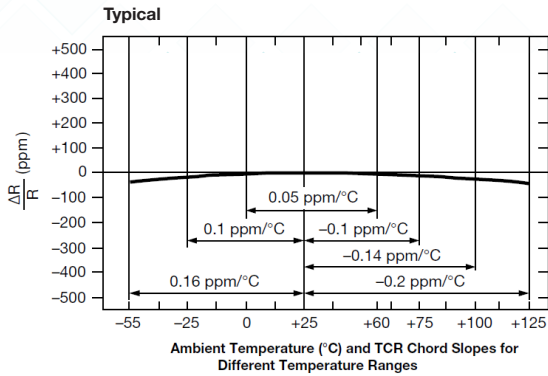
- SMD (Wrap Around, Transfer Molded)
- Through Hole, Current Sense, Power
- Network, Voltage Divider, Hermetically Sealed
- Thin Film, Thermosensitive
- Four terminal Kelvin configuration as standard
2-terminal configuration where beneficial
- RoHS compliant Pb-free

Characteristics

- TCR: 0.05 ppm/°C (Typical, 0°C to +60°C)
- Resistance Tolerance: $\pm 0.005\%$
- Shelf Life: 25 ppm/year; 50 ppm/3 years
(Hermetically sealed: 5 ppm/year; 10 ppm/3 years)
- Load Life: 0.005%/2,000 hours at Rated Power (typical)
- Thermal EMF: 0.1 $\mu\text{V}/^\circ\text{C}$ (between leads)
- Noise: -42 dB
- Voltage Coefficient: 0.3 ppm/V
- Frequency Characteristics:
Inductance: 0.08 μH
Capacitance: 0.5 pF

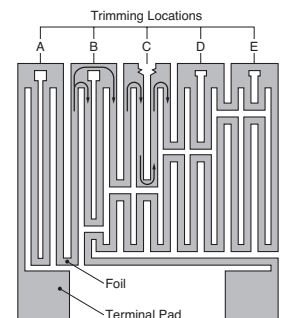
Temperature Characteristic of Resistance (TCR)

Alpha Electronics' Bulk Metal® Foil resistors offers the lowest TCR under wide ambient temperature ranges.













Trimming Process

Foil bonded on substrate is precisely photo-etched to make an extremely fine path pattern to achieve a desired value. A series of trimming locations are laid out on the pattern, as shown in A through E (figure on right). As shown at C, the trimming method increases the resistance by cutting the resistive elements path. The resistance value can be made accurate to within ±50 ppm of the desired value by cutting at several of the trimming locations. The locations that are cut for trimming are where the electric current flow (arrows in diagram) will not be affected so that the trimming will not cause electrical noise or changes over the years. As a result of the special trimming method, Bulk Metal® Foil resistors offer excellent load life and shelf life stability.



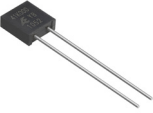
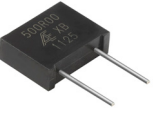
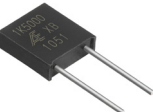
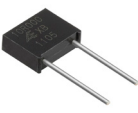



SMD Resistors

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

Product	Model	Description	Resistance Range	Best Tolerance	TCR (-55°C to +125°C, +25°C ref.)	Rated Power (@ +70°C)	Load Life Stability (2000 Hours, +70°C Rated Power, Typical)
	RWA	SMD Bulk Metal® Metal Foil Resistor (0603)	100 Ω to 5 kΩ	±0.05%	±5 ppm/°C (-25°C to +125°C)	0.1 W	±0.005%
	RWB	SMD Bulk Metal® Metal Foil Resistor (0805)	10 Ω to 10 kΩ	±0.02%	±2 ppm/°C (-25°C to +125°C)	0.2 W	±0.005%
	RWC	SMD Bulk Metal® Foil Resistor (1206)	5 Ω to 30 kΩ	±0.01%	±2 ppm/°C (-25°C to +125°C)	0.3 W	±0.005%
	RWAX	SMD Bulk Metal® Foil Resistor	100 Ω to 5 kΩ	±0.05%	±6 ppm/°C (-25°C to +125°C)	0.1 W	±0.005%
	RWBX	SMD Bulk Metal® Foil Resistor (0805)	10 Ω to 10 kΩ	±0.02%	±5 ppm/°C (-25°C to +125°C)	0.2 W	±0.005%
	RWCX	SMD Bulk Metal® Foil Resistor (1206)	5 Ω to 30 kΩ	±0.01%	±5 ppm/°C (-25°C to +125°C)	0.3 W	±0.005%
	MPP	SMD Bulk Metal® Foil Resistor (1210)	30 Ω to 20 kΩ	±0.01%	±0.2 ppm/°C (typical)	0.1 W	±0.005%
	MQP	SMD Bulk Metal® Foil Resistor (1812)	30 Ω to 40 kΩ	±0.01%	±0.2 ppm/°C (typical)	0.125 W	±0.005%
	MP	SMD Bulk Metal® Foil Resistor (1210)	30 Ω to 30 kΩ	±0.05%	±5 ppm/°C	0.1 W	±0.03%
	MQ	SMD Bulk Metal® Foil Resistor (1812)	30 Ω to 60 kΩ	±0.05%	±5 ppm/°C	0.125 W	±0.03%

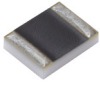
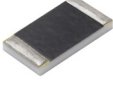
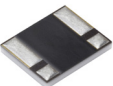




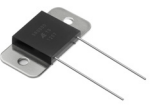



Leaded Resistors

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

Product	Model	Description	Resistance Range	Best Tolerance	TCR (-25°C to +125°C, 25°C ref.)	Rated Power (@ +70°C)	Load Life Stability (2000 Hours, +70°C Rated Power, Typical)
	MA	Transfer molded resistor	1 Ω to 200 kΩ	±0.005%	±1 ppm/°C (0°C to +60°C)	0.3 W @ 125°C 0.6 W @ 70°C	±0.015%
	MB	Transfer molded resistor	5 Ω to 400 kΩ	±0.005%	±1 ppm/°C (0°C to +60°C)	0.5 W @ 125°C 1 W @ 70°C	±0.015%
	MC	Transfer molded resistor	1 Ω to 200 kΩ	±0.005%	±1 ppm/°C (0°C to +60°C)	0.3 W @ 125°C 0.6 W @ 70°C	±0.015%
	MD	Transfer molded resistor	5 Ω to 80 kΩ	±0.01%	±1 ppm/°C (0°C to +60°C)	0.125 W @ 125°C 0.25 W @ 70°C	±0.015%
	FLA	Conformally coated resistor	5 Ω to 100 kΩ	±0.05%	±2.5 ppm/°C	0.125 W	±0.02%
	FLB	Conformally coated resistor	1 Ω to 150 kΩ	±0.05%	±2.5 ppm/°C	0.25 W	±0.02%
	FLC	Conformally coated resistor	1 Ω to 200 kΩ	±0.01%	±2.5 ppm/°C	0.25 W	±0.02%

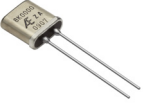


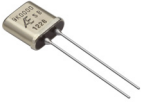
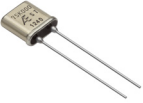
Current Sense Resistors

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	Resistance Range	Best Tolerance	TCR (-25°C to +125°C, 25°C ref.)	Rated Power (@ +70°C)	Load Life Stability (2000 Hours, +70°C Rated Power, Typical)
	RBD	Bulk Metal® Foil Current Sense Resistor (Flip Chip 2-terminal)	0.01 Ω to 1 Ω	±0.5%	±10 ppm/°C	0.5 W	±0.05%
	RBF	Bulk Metal® Foil Current Sense Resistor (Flip Chip 2-terminal)	0.01 Ω to 1 Ω	±0.5%	±10 ppm/°C	1 W	±0.05%
	RBH	Bulk Metal® Foil Current Sense Resistor (Flip Chip 4-terminal)	0.01 Ω to 0.1 Ω	±0.5%	±10 ppm/°C	1.5 W	±0.05%
	RBEE	Bulk Metal® Foil Chip Resistor (Flip-Chip) with Extended Range over 0.5 Ω	0.5 Ω to 10 kΩ	±0.05%	±10 ppm/°C	0.5 W	±0.05%
	RBFE	Bulk Metal® Foil Chip Resistor (Flip-Chip) with Extended Range over 0.5 Ω	0.5 Ω to 10 kΩ	±0.05%	±10 ppm/°C	1 W	±0.05%
	FNP	High Power Shunt Resistor Up to 500 W	0.001 Ω to 10 Ω	±0.05%	±1 ppm/°C (+25°C to +60°C)	500 W, on heat sink	±0.2%
	PSB	Shunt Resistor Up to 40 W	0.001 Ω to 1 Ω	±0.1%	±5 ppm/°C (0°C to +60°C)	40 W, on heat sink 12 W in free air, @ +25°C	±0.05% (+25°C, Rated Power)
	PB	Power Resistor 10 W	0.4 Ω to 50 kΩ	±0.01%	±2.5 ppm/°C	10 W, on heat sink 2 W in free air, @ +25°C	±0.01% (+25°C, Rated Power)
	PC	Power Resistor 10 W	0.002 Ω to 100 kΩ	±0.01%	±2.5 ppm/°C	10 W, on heat sink 2 W in free air, @ +25°C	±0.01% (+25°C, Rated Power)
	PD	Shunt Resistor 8 W	0.1 Ω to 10 kΩ	±0.02%	±2.5 ppm/°C	8 W, on heat sink 1.5 W in free air, @ +25°C	±0.01% (+25°C, Rated Power)
	PE	Shunt Resistor 10 W	0.5 Ω to 500 Ω	±0.01%	±2.5 ppm/°C	10 W, on heat sink 1.5 W in free air, @ +25°C	±0.02%







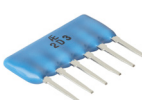
Hermetically-Sealed Resistors

Hermetically-sealed resistors eliminate the ingress of both oxygen, which degrades resistors over long periods, and moisture, which degrades resistors more quickly. Bulk Metal® Foil technology combined with hermetic sealing and oil filling offer the most precise and stable resistors available.

Product	Model	Description	Resistance Range	Best Tolerance	TCR	Rated Power (@ +125°C)	Load Life Stability (2000 Hours, +70°C Rated Power, Typical)
	HC	Hermetically sealed foil resistor	1 Ω to 120 kΩ	±0.005%	±1 ppm/°C (0°C to +60°C)	0.3 W	±0.01%
	HD	Hermetically sealed foil resistor	1 Ω to 120 kΩ	±0.005%	±1 ppm/°C (0°C to +60°C)	0.3 W	±0.01%
	HG	Hermetically sealed foil resistor	1 Ω to 10 kΩ	±0.005%	±1 ppm/°C (0°C to +60°C)	0.3 W	±0.01%
	HKS	Zero-TCR Hermetically sealed foil resistor	100 Ω to 100 kΩ	±0.005%	±0.6 ppm/°C (0°C to +50°C)	0.3 W	±0.01%
	HLS	Zero-TCR Hermetically sealed foil resistor	100 Ω to 100 kΩ	±0.005%	±0.6 ppm/°C (0°C to +50°C)	0.3 W	±0.01%










Voltage Dividers and Networks Resistors

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.

Product	Model	Description	Resistance Range	Best Tolerance	TCR (-55°C to +125°C, +25°C ref.)	Rated Power (@ +70°C)	Load Life Stability (2000 Hours, +125°C Rated Power, Typical)
	MU	Bulk Metal® Foil 1-2-3 network resistor	10 Ω to 20 kΩ	±0.02% (Absolute) ±0.01% (Matching)	±5 ppm/°C (Abs.) ±1 ppm/°C (Tracking)	0.05 W/element (@ +125°C)	±0.03% (Abs.) ±0.015% (Ratio)
	SM	Transfer molded resistor 1-2-3 network	50 Ω to 30 kΩ	±0.02% (Absolute) ±0.01% (Matching)	±2.5 ppm/°C (Abs.) ±0.5 ppm/°C (Tracking)	0.3 W (@ +125°C)	±0.015% (Abs.) ±0.005% (Ratio)
	SLD	Conformally coated resistor 1-2-3 network	50 Ω to 30 kΩ	±0.05% (Absolute) ±0.02% (Matching)	±2.5 ppm/°C (Abs.) ±0.5 ppm/°C (Tracking)	0.25 W (@ +125°C)	±0.01% (Abs.) ±0.005% (Ratio)
	SC	Case encapsulated resistor network	30 Ω to 120 kΩ	±0.01% (Absolute) ±0.01% (Matching)	±5 ppm/°C (Abs.) ±1 ppm/°C (Tracking) (-25°C to +125°C)	1.5 W	±0.01% (Abs.) ±0.005% (Ratio) (+70°C, Rated Power)
	SE	Conformally coated resistor network	30 Ω to 120 kΩ	±0.05% (Absolute) ±0.01% (Matching)	±5 ppm/°C (Abs.) ±1 ppm/°C (Tracking) (-25°C to +125°C)	1 W	±0.01% (Abs.) ±0.005% (Ratio) (+70°C, Rated Power)
	SF	Conformally coated resistor network	30 Ω to 120 kΩ	±0.05% (Absolute) ±0.01% (Matching)	±5 ppm/°C (Abs.) ±1 ppm/°C (Tracking) (-25°C to +125°C)	0.5 W	±0.01% (Abs.) ±0.005% (Ratio) (+70°C, Rated Power)
	SS	Conformally coated resistor network	30 Ω to 20 kΩ	±0.05% (Absolute) ±0.01% (Matching)	±5 ppm/°C (Abs.) ±1 ppm/°C (Tracking) (-25°C to +125°C)	0.5 W	±0.01% (Abs.) ±0.005% (Ratio) (+70°C, Rated Power)

Thermosensitive Resistors

Our ultra-precision thermosensitive resistors has a positive linear TCR and a tight TCR tolerance for temperature sensing applications and can be tailored to specific customer requirements.

Product	Model	Description	Resistance Range	Best Tolerance	TCR (ppm/°C)	Rated Power (@ +70°C)	Load Life Stability (1000 Hours, +70°C Rated Power, Typical)
	NMP	SMD Thermosensitive Resistor	5 Ω to 250 Ω	±0.5%	+6,060±2% (0 to 25°C) +6,260±2% (0 to 50°C) +6,660±2% (0 to 100°C)	0.1 W	±0.03%
	NMQ	SMD Thermosensitive Resistor	5 Ω to 500 Ω	±0.5%	+6,060±2% (0 to 25°C) +6,260±2% (0 to 50°C) +6,660±2% (0 to 100°C)	0.125 W	±0.03%
	CLA	Thermosensitive Resistor	5 Ω to 100 Ω	±0.5%	+4,250±1% (0 to 100°C)	0.125 W	±0.03%
	CLB	Thermosensitive Resistor	5 Ω to 200 Ω	±0.5%	+4,250±1% (0 to 100°C)	0.25 W	±0.03%
	NLA	Thermosensitive Resistor	5 Ω to 500 Ω	±0.5%	+6,060±1% (0 to 25°C) +6,260±1% (0 to 50°C) +6,660±1% (0 to 100°C)	0.125 W	±0.03%
	NLB	Thermosensitive Resistor	5 Ω to 1 k Ω	±0.5%	+6,060±1% (0 to 25°C) +6,260±1% (0 to 50°C) +6,660±1% (0 to 100°C)	0.25 W	±0.03%
	KLC	Thermosensitive Resistor	20 Ω to 40 kΩ	±0.5%	Any TCR from +100 to +6,060	0.25 W	±0.03%
	PTA	Pt Bulk Metal [®] Foil Temperature Sensor	100 Ω, 1 kΩ	CLASS A	+3,850 ±20 (0 to 100°C)	100 Ω: 1 mA Max. 1 kΩ: 0.5 mA Max.	N/A
	NBA, NBB, NBC	Ultra Precision Thermosensitive SMD Flip-Chip Resistor	100 Ω, 1 kΩ	± 0.5%	to +6,660 ppm/°C ±2% (0 to 100°C)	100 Ω, 1 kΩ (0.3 mA max.)	±0.03% (1000 hrs)

Thin Film Resistors

Our precision thin film resistors are available in a wide range of configurations with high resistance values and a low TCR for a diverse range of applications and can be tailored to specific customer requirements.

Product	Model	Description	Resistance Range	Best Tolerance	TCR	Rated Power (@ +70°C)	Load Life Stability (1000 Hours, +125°C Rated Power, Typical)
	TMP	SMD Thin Film Resistor	30 kΩ to 1 MΩ	±0.02%	±5 ppm/°C (-55°C to +125°C)	0.1 W	±0.01%
	MATF	Transfer molded thin film resistor	200 kΩ to 10 MΩ	±0.01%	±1 ppm/°C (0°C to +60°C)	0.2 W	±0.01%
	MCTF	Transfer molded thin film resistor	200 kΩ to 10 MΩ	±0.01%	±1 ppm/°C (0°C to +60°C)	0.2 W	±0.01%
	TLA	Conformally Coated thin film resistor	100 kΩ to 5 MΩ	±0.05%	±5 ppm/°C (-25°C to +125°C)	0.125 W	±0.01% (+70°C, Rated Power)
	TLC	Conformally Coated thin film resistor	200 kΩ to 10 MΩ	±0.02%	±5 ppm/°C (-25°C to +125°C)	0.25 W	±0.01% (+70°C, Rated Power)



 Alpha Electronics
A VPG Brand

Contact us at foil@vpgsensors.com | vpgfoilresistors.com

The document and the products described herein are subject to change from time to time without notice and are also subject to specific disclaimers.

Please visit <https://vpgsensors.com/disclaimer> for more information.