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ISOTEK

CORPORATION



Precision



Current Sensing



and



Power Resistors



Product Catalog



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Founded in 1989, ISOTEK has built a solid reputation for quality products, engineering support and superior customer service. In this catalog you will find data sheets for a broad range of standard products. However, ISOTEK welcomes all inquiries for technically demanding custom product development. With more than 30 years of engineering experience, ISOTEK has the resources to provide you with your design solution.

ISOTEK's newly designed web site provides faster access for technical information and on-line purchasing. Order using Visa or MasterCard and receive your confirmation via email in minutes.

WELCOME TO ISOTEK.....We Deliver Solutions.

High Performance Through Advanced Technology...

ISA-PLAN® precision resistors are ideal for sensing and controlling current. ISA-PLAN® resistor elements are etched from rolled Manganin or Zeranin® foil. The foil is laminated to a heat-sinking substrate resulting in a planar geometry ideal for high power dissipation and low inductance. Special annealing and manufacturing processes guarantee low temperature coefficient of resistance and excellent long-term stability.

ISA-PLAN® resistors are manufactured by ISABELLENHÜTTE of Dillenburg, Germany. ISABELLENHÜTTE is a vertically integrated manufacturer of resistance alloys and therefore controls all stages of the manufacturing process from smelting the alloys to testing the finished resistors.

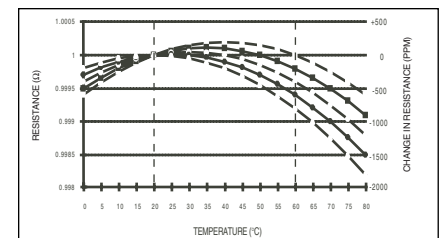
ISABELLENHÜTTE is certified ISO 9002 and manages a calibration lab under the guidelines of the German Calibration Service (DKD - Deutscher Kalibrierdienst) which is subject to supervision by the national bureau of standards (Physikalisch-Technische Bundesanstalt — PTB).

Manganin, Zeranin® and Temperature Coefficient of Resistance...

All conducting materials change resistance in response to temperature. This is typically non-linear but is usually expressed as a straight line between two temperatures. The slope of the line is known as the temperature coefficient of resistance or "TCR."

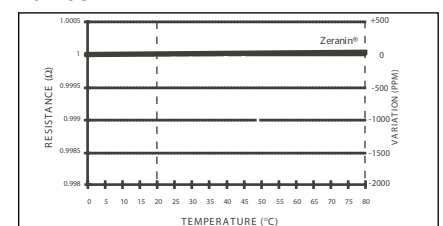
Manganin was first developed by

ISABELLENHÜTTE about 100 years ago and is the standard resistance material in the ISA-PLAN® product-line. Its resistance response to temperature is given in the chart below. From 20 to 60°C the tcr is 10 ppm/°C. From 60 to 100°C it is 25 ppm/°C. Unless otherwise noted, tcr values for resistors are for Manganin alloys.



Manganin's resistive response to temperature. Curves indicate DIN 46460 allowable tolerance.

Zeranin® was first produced in 1965 by ISABELLENHÜTTE and is available on selected ISA-PLAN® products. Its resistance response to temperature is shown below. It is approximately one order of magnitude less responsive to temperature than Manganin. It offers a tcr of <10 ppm/°C from 20 to 100°C. Resistors offered with Zeranin® are indicated by the 'Z' in the model number.



Zeranin's® resistive response to temperature.

Power Rating...

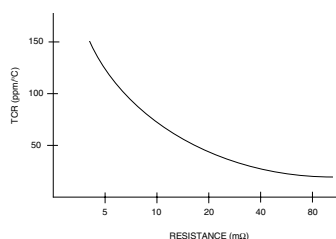
Thermal equilibrium in a resistor is achieved when the heat generated is equal to the heat disposed and a stable internal temperature results. For ISA-PLAN® technology, the maximum recommended continuous foil temperature is 125°C. The resistors are burned in at 140°C during manufacturing to assure stable long-term resistance when operating at 125°C.

Pulse Power...

The unique laminated construction makes ISA-PLAN® particularly adept at handling pulsed power by increasing the effective thermal mass of the resistance element. A factor of 10 times the continuous power rating is generally acceptable for pulses up to one second in duration. This varies somewhat with the specific resistor package and with the duty cycle of the pulse.

Kelvin Connection...

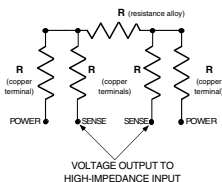
Kelvin or four-terminal connection is recommended for precision low-ohmic current sensing resistors. The lower in ohmic value, the more strongly it is advised. This is because the copper terminals become an ever increasing part of the overall resistance as the value decreases. The tcr of copper is around 4000 ppm/°C and produces large variation in effective resistance as the temperature of the resistor changes. This influence is illustrated by the graph below showing how the benefit of 10 ppm/°C Manganin is diminished by the copper when the resistance drops below about 80 mΩ in a two terminal resistor.



Rising TCR due to effect of copper with decreasing resistance.

This problem is eliminated with Kelvin connections where the voltage drop is measured on the resistor itself and directed to a high-impedance source. The TCR is only a function of

the Manganin or Zeranin® resistance material. ISA-PLAN® four-terminal resistors have the Kelvin connections etched directly to the resistive element.



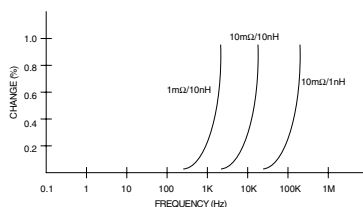
Kelvin measurement.

Reactance, Impedance & Inductance...

The presence of capacitance or inductance in an AC circuit produces a phase shift between the current and voltage known as reactance. Impedance is the ratio of effective voltage divided by effective current in an AC circuit. In low ohmic resistors, the effect of inductive reactance dominates. While the inductance of the resistors described in this literature is typically less than 10 nH, mounting and wiring or trace layout can increase the effective inductance. The total impedance (which determines resulting measured voltage drop) is given by:

$$Z = [R^2 + (2\pi fL)^2]^{0.5}$$

A 1 mΩ resistor with a net inductance of 10 nH produces an error in measurement of 1 % at a frequency of 2.23 kHz. The figure below illustrates the relationship between frequency, inductance and resistance. The error increases with increasing frequency and decreasing resistance.



Change of Impedance versus Frequency

Thermal EMF...

Thermal emf must be considered in low value resistors in DC circuits. The copper terminal is used as the reference metal. Manganin and Zeranin® have a low thermal emfs of <2 μV/°C

with copper. One side of the resistor is a +2 μV/°C generator and the other side is a -2 μV/°C generator. Ideally, both ends of the resistor are at the same temperature and the thermal emfs cancel. The low thermal emfs of Manganin and Zeranin® minimize this influence on the measurement, but it is up to the user to assure that the resistor is not being non-uniformly heated by other components in the application. Since measurements are generally above 50 mV, a few degrees of differential temperature will not materially affect the accuracy.

Noise...

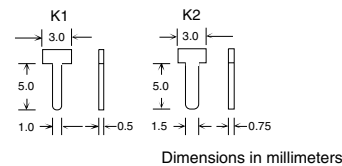
Noise is any undesired signal from the resistor. Noise in ISA-PLAN® metal foil resistors is primarily due to thermal effects. Thermal noise comes from random electron motion in the resistive material resulting in a small and fluctuating potential difference across the terminals. This is given by the equation:

$$E = [4KTR(f_2 - f_1)]^{0.5}$$

where K is Boltzmann's constant, T is the absolute temperature in Kelvin, R is the resistance and (f₂-f₁) is the bandwidth in Hertz. Typically, this noise is less than a few μV and can be ignored in most applications.

Terminals and Current Limits...

For through-hole resistors, the standard terminal is shown as K1 below. For applications over 35 amps, and up to 80 amps the optional K2 is recommended. (PBH and PBV have K2 power terminals as standard.) For over 80 amps, the high-power packages with screw terminals or bus bar mounting are recommended. Type F2 terminals are available for horizontal mounting.



Type of Terminals

Precision Current Sensing Resistors

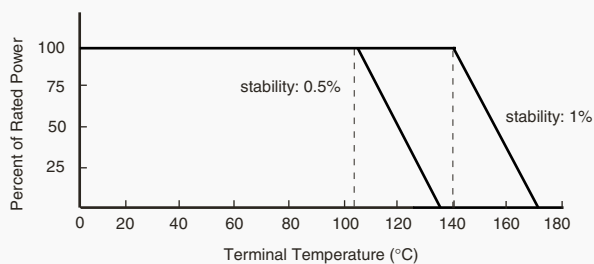


The BVS is a low cost, extremely low ohmic current sensing resistor designed for high volume applications.

The BVS is formed from a continuous band of electron-beam welded (EBW) copper / resistance alloy / copper. This unique structure results in a low-ohmic surface mount resistor with rugged copper terminals that guarantee good solderability and an extremely low ohmic connection to the circuit. The heavy resistor element has excellent heat conductivity through the copper terminals to the printed circuit board (or DCB) thus enabling the high power rating of 3 Watts.

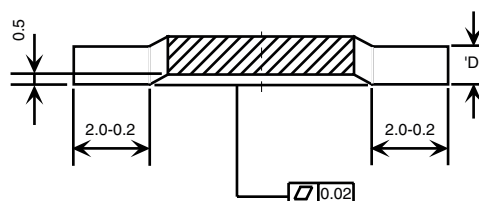
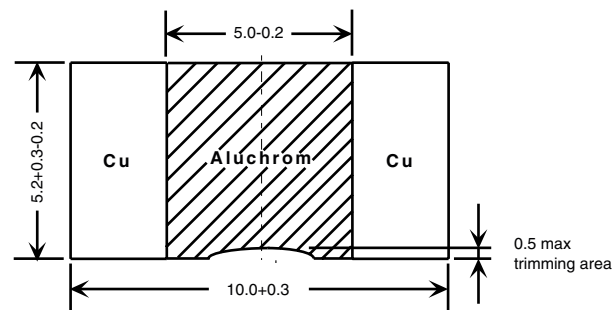
Various alloys are used based on the resistance value. The use of precision resistance alloys is responsible for the low inductance which makes the BVS ideal for switch-mode applications such as motor drive control circuits.

BVS is packaged 3,000 pieces per 16 mm tape and reel in accordance with IEC 286-3.



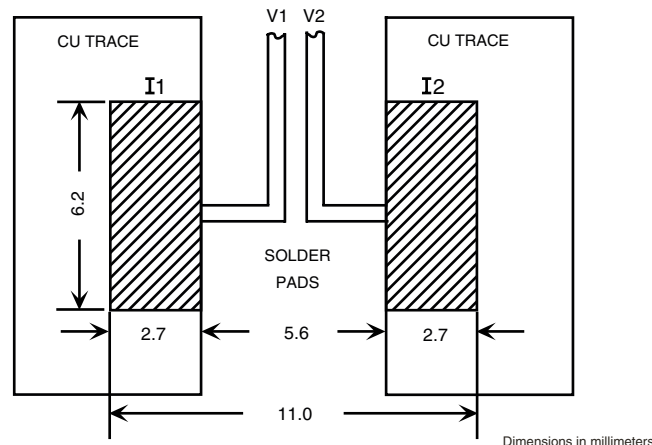
BVS-A-R001-1.0

- Model
- M=Manganin, A=Aluchrom
- Resistance value
- Tolerance



Type	Resistance Value (mΩ)	Resistance Material	Thickness D (mm)
BVS-Z-R0002	0.2	Zeranin	1.42
BVS-M-R0003	0.3	Manganin	1.42
BVS-M-R0005	0.5	Manganin	0.86
BVS-M-R001	1.0	Manganin	0.42
BVS-A-R001	1.0	Aluchrom	1.30
BVS-A-R002	2.0	Aluchrom	0.64
BVS-A-R003	3.0	Aluchrom	0.43
BVS-A-R004	4.0	Aluchrom	0.32

SUGGESTED PCB PAD DESIGN



Technical Data

Parameters

Resistance Values	BVS
Tolerance	0.2, 0.3, 0.5, 1, 2, 3, 4 mΩ
Temperature Coefficient of Resistance (20°C to 60°C)	1%, 5%
Power Rating (Watts)	< 50 ppm/°C
Maximum Current	3
Inductance	100A
Internal Heat Resistance	< 3 nH
Operating Temperature Range	Rth < 10°C/W
Stability (Nominal Load at 105°C)	-55°C to +170°C
	< 0.5% after 2000 hours

Precision Current Sensing Resistors



The BVE is ideal for sensing current in power supplies, motor drives, power modules and for use in automotive power electronic applications. It can be soldered to a PCB or welded to a bus bar.

Measuring 8 x 15 x 1.6 mm thick, the BVE is available in resistance values of 0.2, 0.5 and 1 milliohm with tolerances of 1, 2 and 5%. The BVE is rated for 5 watts continuous power at up to 120°C. Resistance change after 2000 hours at 95°C and full rated load is less than 0.5%.

Heat is dissipated through the large copper terminals. The unique integration of copper/resistance/copper alloys results in a thermal resistance of less than 10°C/W and inductance of less than 3 nH.

Mounting can be reflow soldering (350°C for 30 sec. or 250°C for 10 min.), or welded to copper bus bar. The BVE is supplied in 24 mm tape, 2000 pieces per reel.

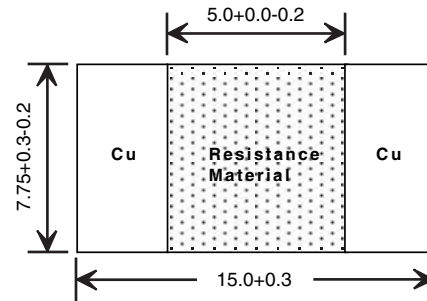
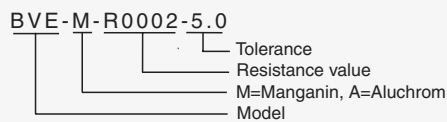
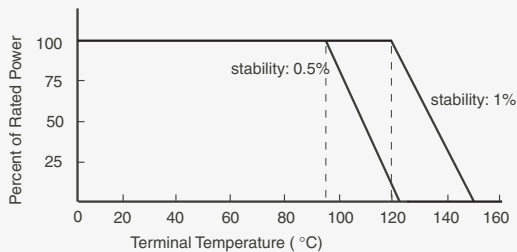
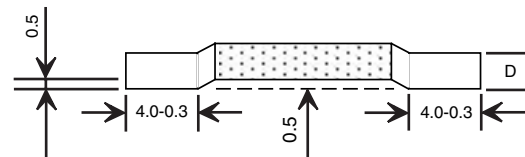
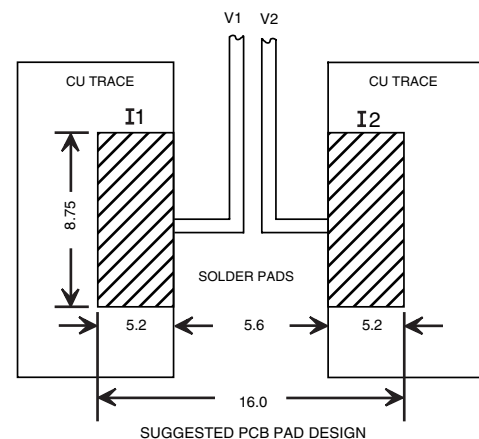


Table: typical material thickness vs. resistance value.
Dimensions without tolerances acc. to DIN ISO 2768-1 "medium"



Type	Value	Material	Thickness (D)
BVE-M-R0002	0.2 mOhm	Manganin	1.42 mm
BVE-M-R0003	0.3 mOhm	Manganin	0.94 mm
BVE-M-R0005	0.5 mOhm	Manganin	0.56 mm
BVE-A-R0005	0.5 mOhm	Alu-Chrom	1.63 mm
BVE-A-R001	1.0 mOhm	Alu-Chrom	0.91 mm



Dimensions in millimeters

Technical Data

Parameters	MANGANIN	ALUCHROM
Resistance Values	0.2 mΩ, 0.3, 0.5mΩ	0.5, 1 mΩ
Tolerance	1.0%, 5.0%	1.0%, 5.0%
Temperature Coefficient of Resistance (20°C to 60°C)	< 50 ppm/°C	< 50 ppm/°C
Power Rating (Watts)	5	5
Maximum Current	160 A	160 A
Inductance	< 3 nH	< 3 nH
Thermal Resistance to Ambient	Rth < 10°C/W	Rth < 10°C/W
Operating Temperature Range	-55°C to +125°C	-55°C to +125°C
Stability (Nominal Load at 95°C)	< 0.5% after 2000 hours	< 0.5% after 2000 hours

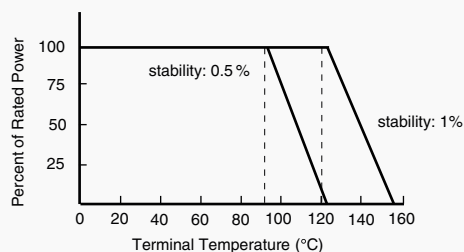
Precision Current Sensing Resistors



The BVR current sensing resistor is designed specifically to overcome the mechanical stresses to solder joints caused by the differences in temperature coefficients of expansion (tce) of traditional surface mount resistors when soldered to a DCB or IMS substrate.

Due to its special U-shape, four terminal (Kelvin) design, the BVR can withstand the rigors of extreme load and temperature cycling requirements (-40°C to 150°C) of many automotive applications while maintaining solder junction integrity. It's also ideal for current sensing in power hybrids, frequency converters, power modules, or any high current application.

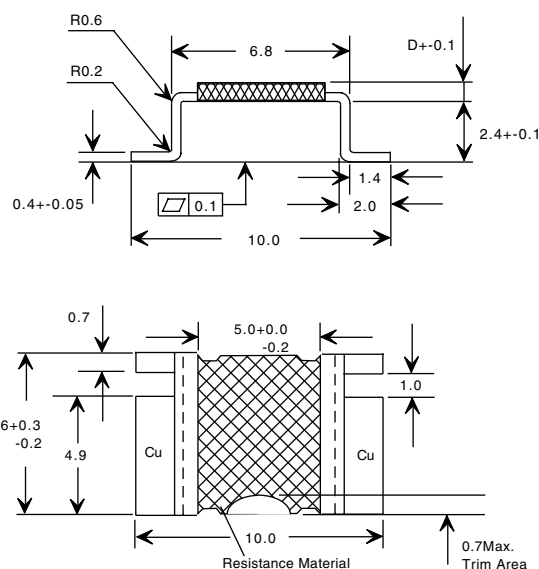
The BVR measures 10 mm x 6 mm and is less than 3.6 mm high. It is available in resistance values of 200 $\mu\Omega$, 300 $\mu\Omega$, 500 $\mu\Omega$, 700 $\mu\Omega$, 1 m Ω and 2 m Ω . Rated at 3W, the BVR can operate at up to 150°C.



BVR-Z-R0005-5.0

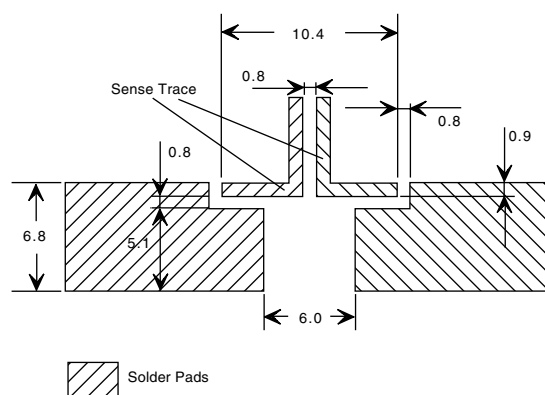
- Model
- Resistance Material
- Resistance value
- Tolerance

Type BVR



Type	Resistance Value (m Ω)	Resistance Material	Thickness D (mm)
BVR-Z-R0002	0.2	Zeratin	1.20
BVR-Z-R0003	0.3	Zeratin	0.85
BVR-Z-R0005	0.5	Zeratin	0.42
BVR-M-R0007	0.7	Manganin	0.42
BVR-M-R001	1.0	Manganin	0.35
BVR-I-R002	2.0	Isa-Ohm	0.49

SUGGESTED PCB LAYOUT



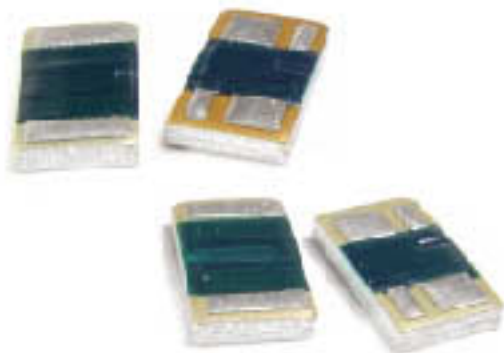
Dimensions in millimeters

Technical Data

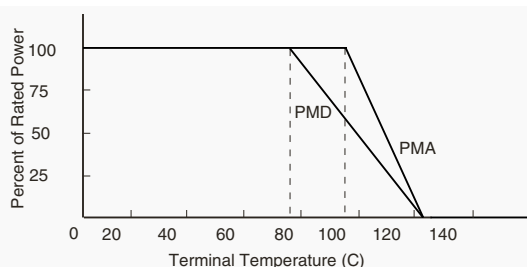
Parameters

Resistance Values	BVR
Tolerance	*0.2, *0.3, 0.5, 0.7, 1, 2m Ω
Temperature Coefficient of Resistance (20°C to 60°C)	1%, 5%
Power Rating (Watts)	< 50 ppm/°C
Maximum Current	3
Inductance	120A
Internal Heat Resistance	< 3 nH
Operating Temperature Range	Rth < 10°C/W
Stability (Nominal Load at 95°C)	-55°C to +150°C
*under development	< 0.5% after 2000 hours

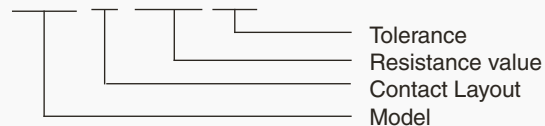
Precision Current Sensing Resistors



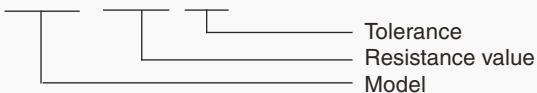
The PMA and PMD resistors are designed for current sensing applications in SMD power modules and hybrid circuits. They are designed for flip-chip mounting on a pc board or ceramic substrate and will withstand standard soldering and surface mount processes. The PMA is a four-terminal (Kelvin) resistor for use where the highest precision is required.



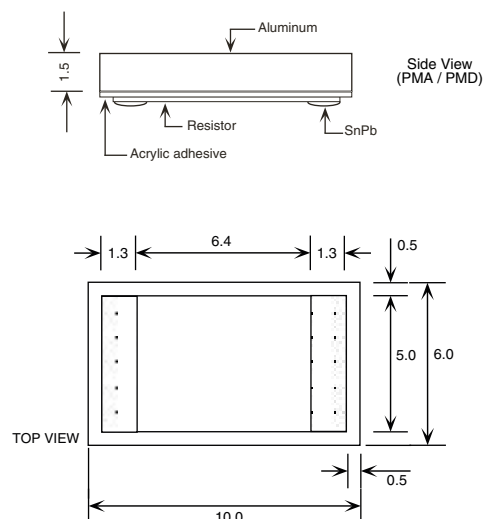
PMA-C-R005-1.0



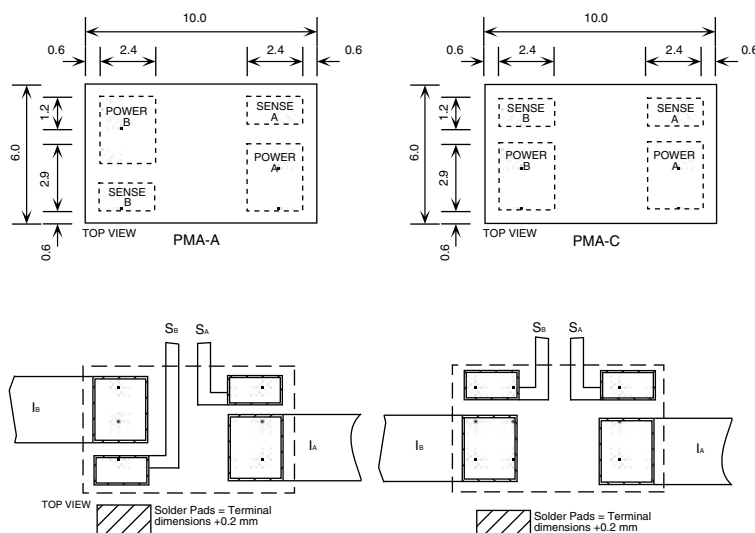
PMD-R100-1.0



PMD



PMA



Dimensions in millimeters

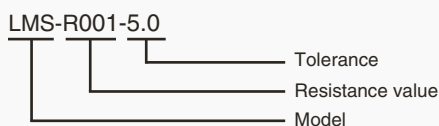
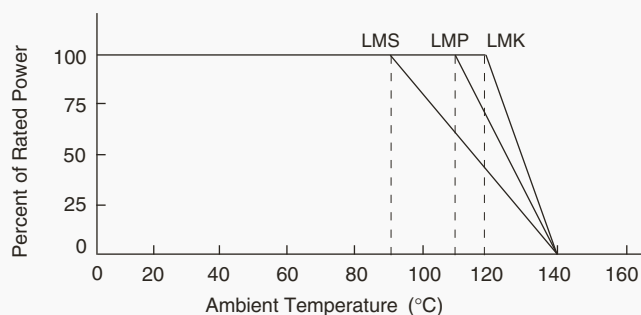
Technical Data

Parameters	PMA	PMD
Resistance Range	2 mΩ to 500 mΩ	10 mΩ to 2Ω
Tolerance	1.0%, 5.0%	1.0%, 5.0%
Temperature Coefficient of Resistance (20°C to 60°C)	< 30 ppm/°C	< 50 ppm/°C
Power Rating (Watts)	3	2
Dielectric Withstanding Voltage	100 VAC	100 VAC
Inductance	< 10 nH	< 10 nH
Internal Thermal Resistance	Rth < 10°C/W	Rth < 15°C/W
Operating Temperature Range	-55°C to +125°C	-55°C to +125°C
Stability (Nominal Load at 70°C)	< 0.5% after 2000 hours	< 0.5% after 2000 hours

Precision Current Sensing Resistors

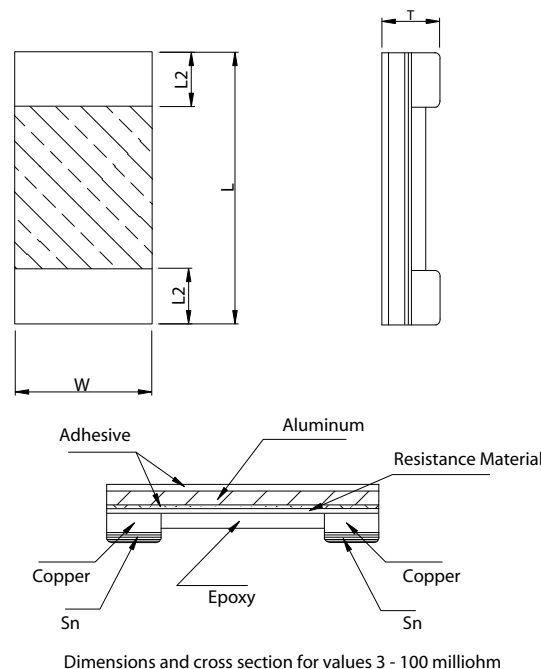
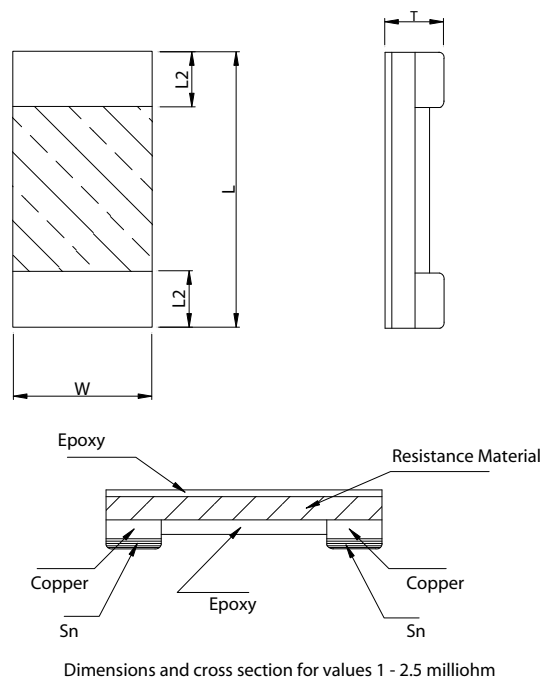


The LM series of current sensing resistors have been designed for use in high volume, cost sensitive applications where extremely low resistance and high performance are required. With power ratings between 0.5W (1206) and 2W (2512), the LM series offers resistance values down to 1 mΩ. The LM series carries the highest power ratings in the industry with full load capability up to 120°C. Their high pulse power ratings and excellent long term stability make this series ideal for use in control systems for the automotive market, power modules, frequency converters and switch mode power supplies. The LM series is available in standard EIA package sizes (1206, 2010 and 2512) with industry standard pad layouts. These resistors can be mounted using infrared and reflow soldering techniques.



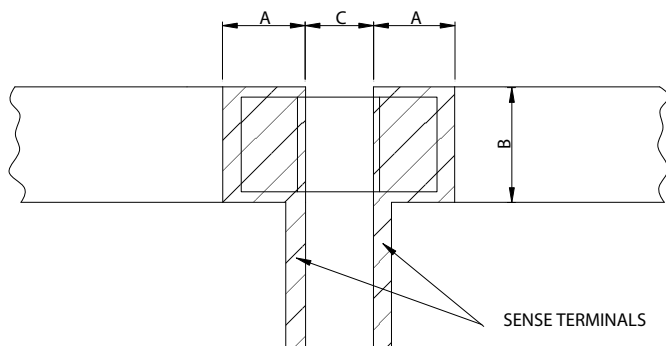
Technical Data

Parameters	LMK	LMP	LMS
Resistance Values	1mΩ to 100mΩ	1mΩ to 100mΩ	1mΩ to 100mΩ
Tolerance	5%	5%	1% (≥20 mΩ), 5%
Temperature Coefficient of Resistance (20°C to 60°C)	< 50 ppm/°C	< 50 ppm/°C	< 50 ppm/°C
Power Rating (Watts)	0.5	1	2
Dielectric Withstanding Voltage	50 V	50 V	50 V
Inductance	< 10 nH	< 10 nH	< 10 nH
Thermal Resistance to terminals	R _{th} < 40°C/W	R _{th} < 30°C/W	R _{th} < 25°C/W
Operating Temperature Range	-55°C to +140°C	-55°C to +140°C	-55°C to +140°C
Stability (Nominal Load)	< 1% after 2000 hours (@120°C)	< 1% after 2000 hours (@110°C)	< 1% after 2000 hours (@90°C)

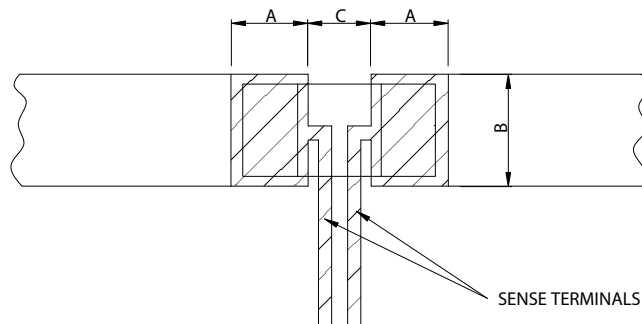


Precision Current Sensing Resistors

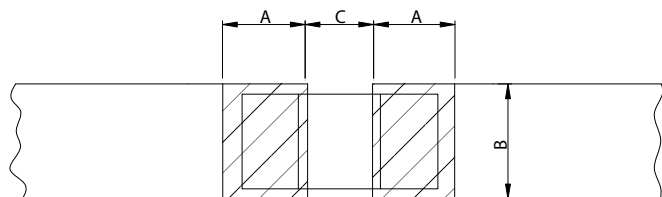
FOUR TERMINAL LAYOUT - LMK



FOUR TERMINAL LAYOUT - LMP, LMS

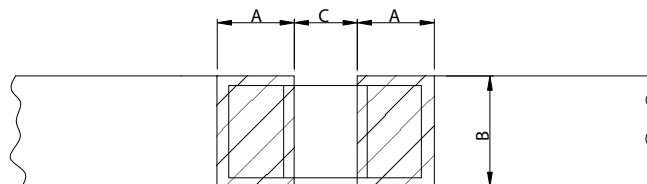


TWO TERMINAL LAYOUT - LMK



RECOMMENDED PCB-LAYOUT (REFLOW SOLDERING)

TWO TERMINAL LAYOUT - LMP, LMS



RECOMMENDED PCB-LAYOUT (REFLOW SOLDERING)

Model	REFLOW SOLDERING		
	A	B	C
LMK	1.6	1.8	1.8
LMP	2.0	3.0	3.5
LMS	1.2	2.6	3.8

LM SERIES MECHANICAL LAYOUT

Model	EIA Package	W	L1	T	L2
LMK	1206	1.52	3.05	0.5	0.68
LMP	2010	2.54	5.08	0.5	0.82
LMS	2512	3.05	6.35	0.5	0.9

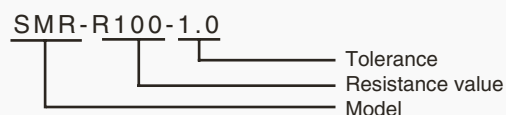
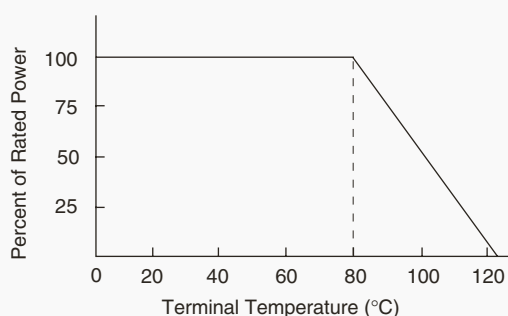
Precision Current Sensing Resistors



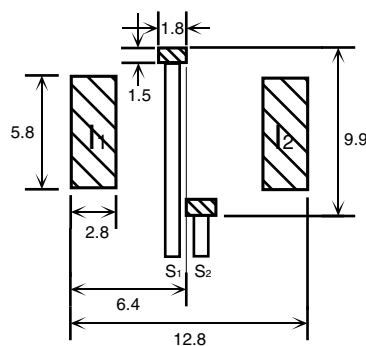
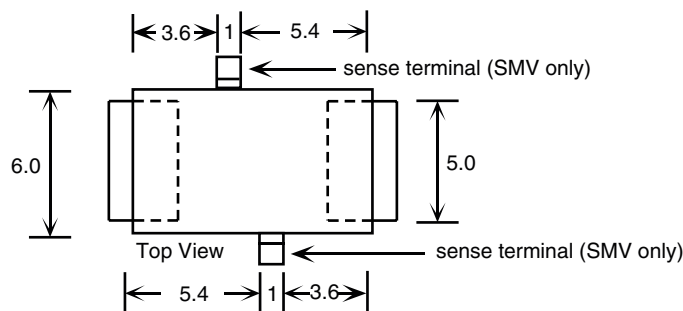
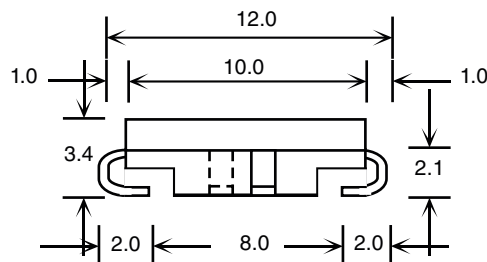
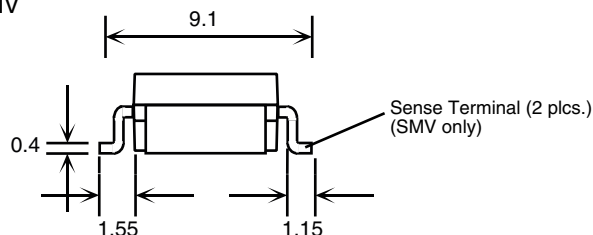
The SMR and SMV resistors are designed for precision current sensing in harsh environments. The molded package make them ideal for use in automotive applications. The SMV is a true Kelvin (four terminal) connection for the highest precision low-Ohmic current sensing.

Both models use etched manganin foil laminated to a copper lead frame which serves as an efficient heat sink. The manganin provides for low tcr and long term stability under load.

The SMR and SMV resistors are packaged in 24mm tape (EIA-481) and are compatible with all surface mount processes.



SMR / SMV



Proposed pcb layout for kelvin (SMV) connection

Dimensions in millimeters

Technical Data

Parameters	SMR	SMV
Resistance Range	0 Ω , 10 m Ω to 4.7 Ω	1 m Ω to 1 Ω
Tolerance	0.5%, (> 50m Ω), 1.0%, 5.0%	0.5%, 1.0%, 5.0%
Temperature Coefficient of Resistance (20°C to 60°C)	< 50 ppm/°C	< 30 ppm/°C
Power Rating (Watts)	3 W	3 W
Dielectric Withstanding Voltage	1000 VAC	1000 VAC
Inductance	< 10 nH	< 10 nH
Thermal Resistance (foil/terminals)	Rth < 15°C/W	Rth < 15°C/W
Operating Temperature Range	-55°C to +140°C	-55°C to +140°C
Stability (Nominal Load at 80°C)	< 0.5% after 2000 hours	< 0.5% after 2000 hours

Precision Current Sensing Resistors

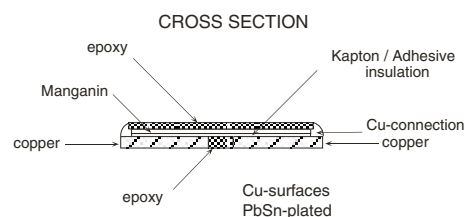
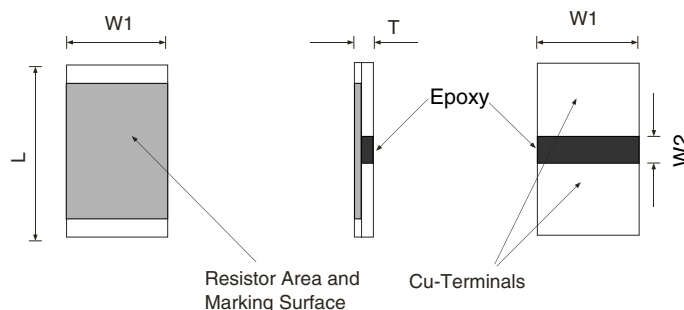
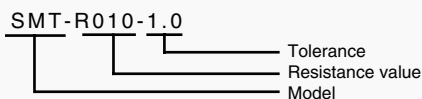
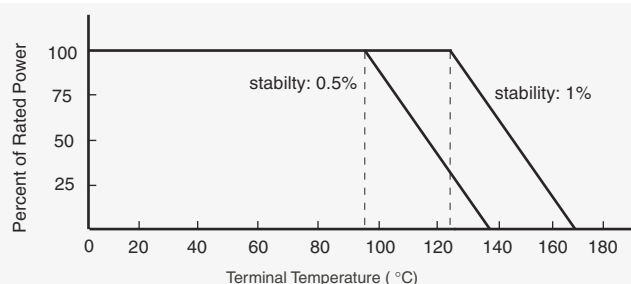


The SMK, SMP, SMS and SMT low-ohmic current sense resistors offer state-of-the-art in miniaturization and automated manufacturing process. This patented design combines excellent electrical properties with extremely small size, a high power rating and an effective, reliable mounting technology.

The use of the unique ISA-PLAN® etched-Manganin foil technology results in the SMK-T series' long-term stability and high pulse power ratings. In addition to providing high mechanical stability, the large copper terminals serve as both efficient heat conductors and extremely low-ohmic current terminals. Due to the low internal heat resistance, the temperature rise under power is very low, resulting in high stability and minimal power derating.

The TCR influence of the solid copper terminals on the overall resistance value is negligible. For precision measurements, the four terminal trace layout is recommended.

Due to the SMK-T series' very low profile, they can be mounted to either side of the pcb. The SMK-T series is compatible with all standard soldering and surface mount processes. The SMP, SMS and SMT are packaged in 12mm and the SMK in 8mm carrier tape for use in automatic pick and place equipment.

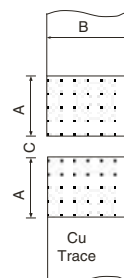


SM SERIES MECHANICAL LAYOUT

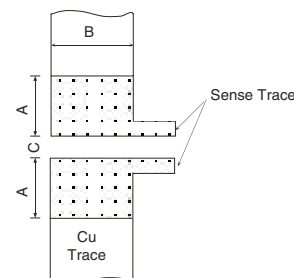
Model	EIA PACKAGE	W1	L	T	W2
SMK	1206	1.52	3.05	0.6	0.5
SMP	2010	2.54	5.08	0.7	0.8
SMS	2512	3.05	6.35	0.8	0.9
SMT	2817	4.2	7.1	0.8	0.9

SUGGESTED PCB LAYOUT

TWO TERMINAL CONNECTION



FOUR TERMINAL CONNECTION



Model	REFLOW SOLDERING			WAVE SOLDERING		
	A	B	C	A	B	C
SMK	2.5	2	0.5	2.5	2.0	0.5
SMP	2.4	2.8	0.6	2.1	3.0	1.4
SMS	3.1	3.5	0.6	2.8	3.7	1.4
SMT	3.4	4.6	0.6	3.2	5.0	1.5

Dimensions in millimeters

Technical Data

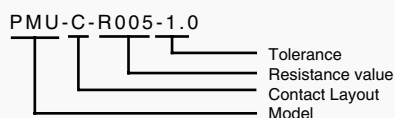
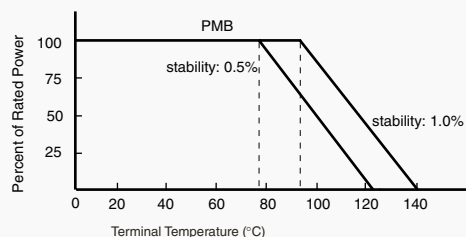
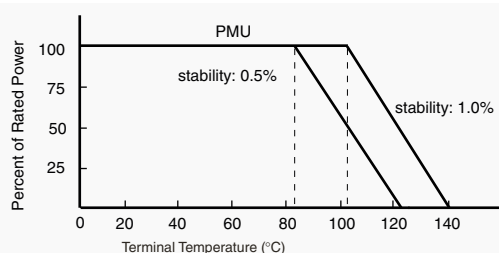
Parameters	SMK	SMP	SMS	SMT
Resistance Values	0 Ω, 10 mΩ to 500mΩ	5 mΩ to 1Ω	0 Ω, 5 mΩ to 1Ω	0 Ω, 5 mΩ to 2Ω
Tolerance	1%(> 25mΩ), 5.0%	1.0%, 5.0%	1.0%, 5.0%	1.0%, 5.0%
Temperature Coefficient of Resistance (20°C to 60°C)	< 50 ppm/°C	< 50 ppm/°C	< 50 ppm/°C	< 50 ppm/°C
Power Rating (Watts)	0.5	1	2	3
Dielectric Withstanding Voltage	200 V	200 V	200 V	200 V
Inductance	< 10 nH	< 10 nH	< 10 nH	< 10 nH
Thermal Resistance to terminals	Rth < 80°C/W	Rth < 40°C/W	Rth < 25°C/W	Rth < 13°C/W
Operating Temperature Range	-55°C to +170°C	-55°C to +170°C	-55°C to +170°C	-55°C to +170°C
Stability (Nominal Load at 130°C)	< 1.0% after 2000 hours	< 1.0% after 2000 hours	< 1.0% after 2000 hours	< 1.0% after 2000 hours
Stability (Nominal Load at 95°C)	< 0.5% after 2000 hours	< 0.5% after 2000 hours	< 0.5% after 2000 hours	< 0.5% after 2000 hours

Precision Current Sensing Resistors

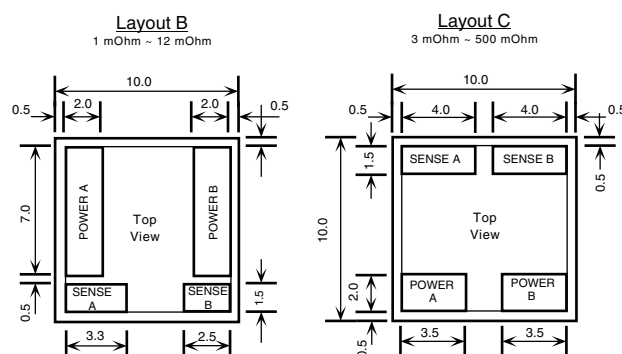


The PMB/PMU resistors have been designed for wire bonding in hybrid circuits. They can be soft soldered or epoxy bonded onto heat conductive ceramic or steel substrates.

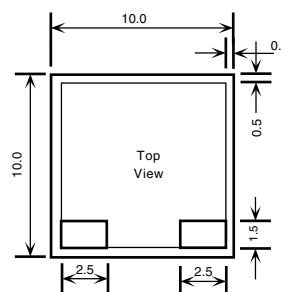
The use of etched Manganin foil laminated to a copper substrate allows a high pulse rating while providing long term stability. Both PMB and PMU are four terminal (Kelvin) resistors.



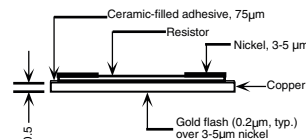
PMB



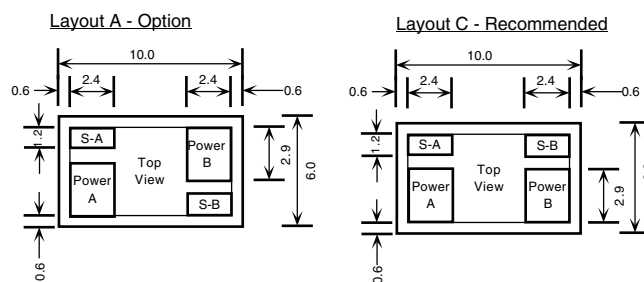
Layout D
500 mOhm ~ 20 Ohm



PMB/PMU Construction:



PMU



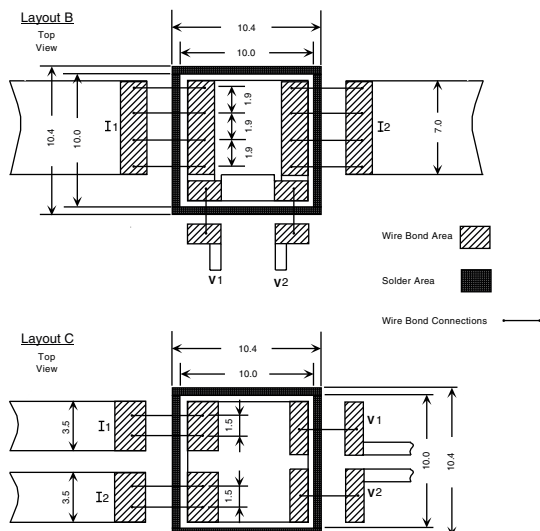
Dimensions in millimeters

Technical Data

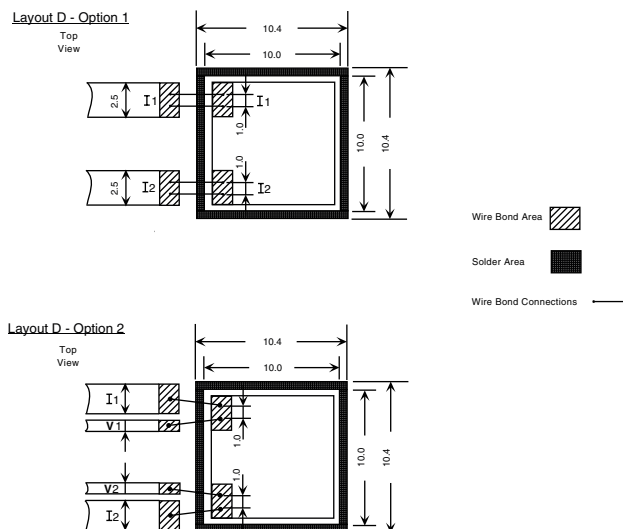
Parameters	PMB	PMU
Resistance Values	1 mΩ to 20 Ω	2 mΩ to 500 mΩ
Tolerance	1%, 5%	1%, 5%
Temperature Coefficient of Resistance (20°C to 60°C)	< 30 ppm/°C	< 50 ppm/°C
Power Rating (Watts)	20	3
Dielectric Withstanding Voltage	100 VAC	100 VAC
Inductance	< 10 nH	< 3 nH
Internal Thermal Resistance	Rth < 2.5°C/W	Rth < 8°C/W
Operating Temperature Range	-55°C to +140°C	-55°C to +140°C
Stability (Nominal Load at 75°C)	< 0.5% after 2000 hours	< 0.5% after 2000 hours

Precision Current Sensing Resistors

PMB

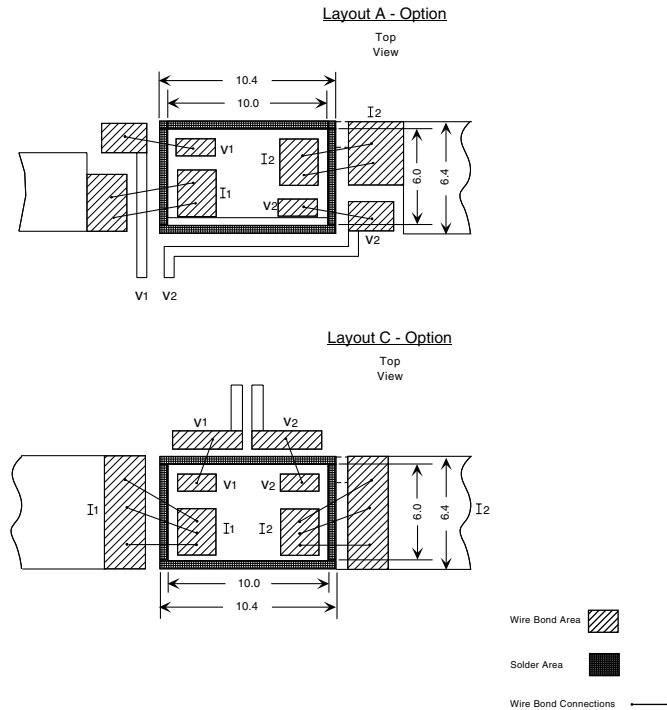


PMB



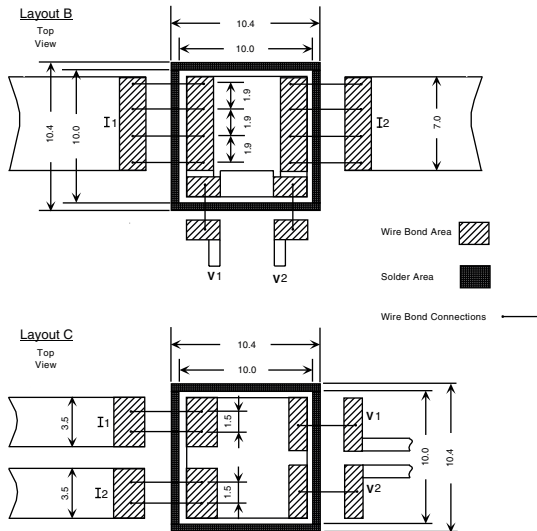
Dimensions in millimeters

PMU

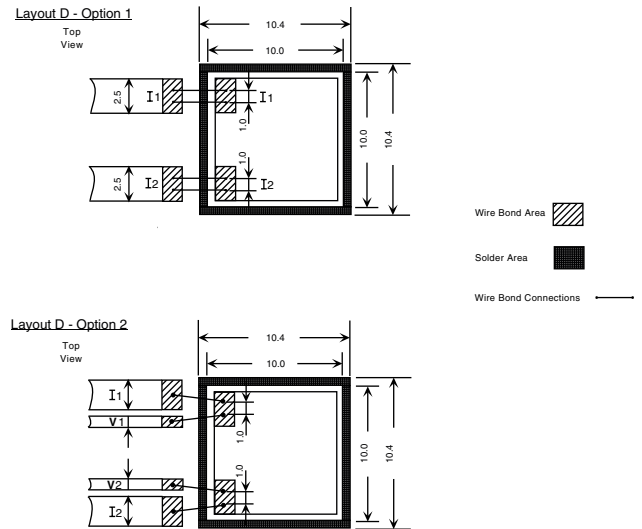


Precision Current Sensing Resistors

PMB

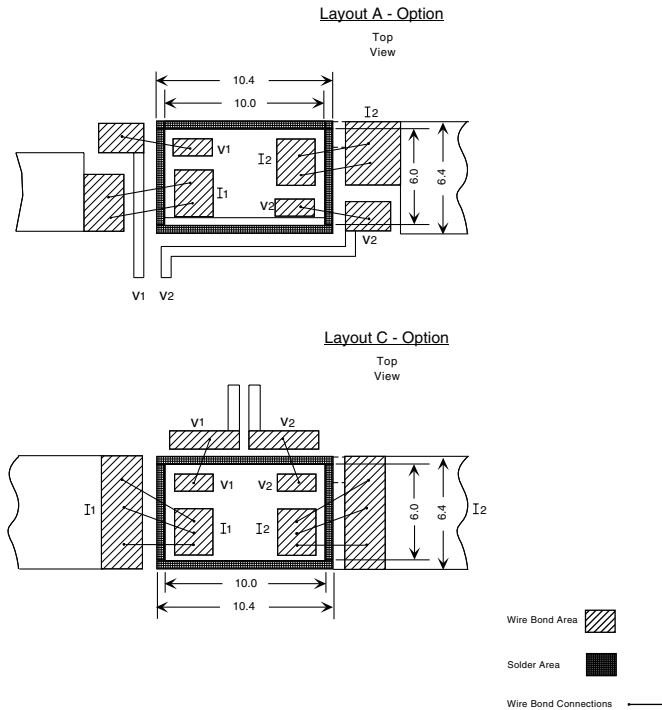


PMB



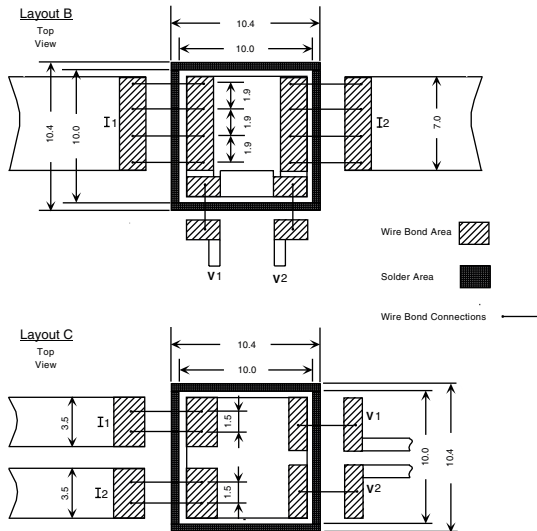
Dimensions in millimeters

PMU

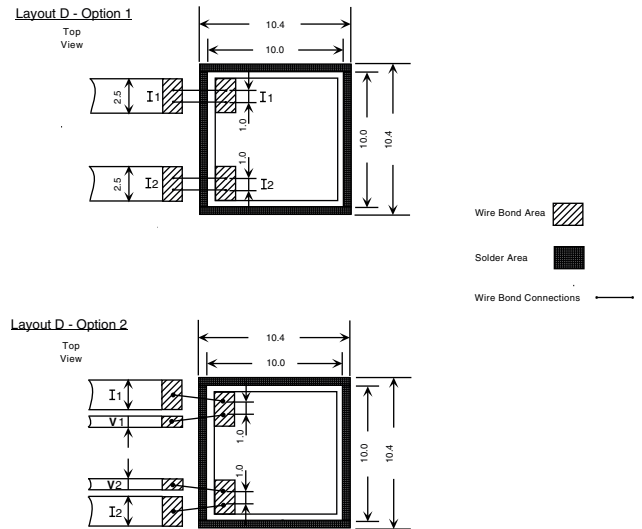


Precision Current Sensing Resistors

PMB

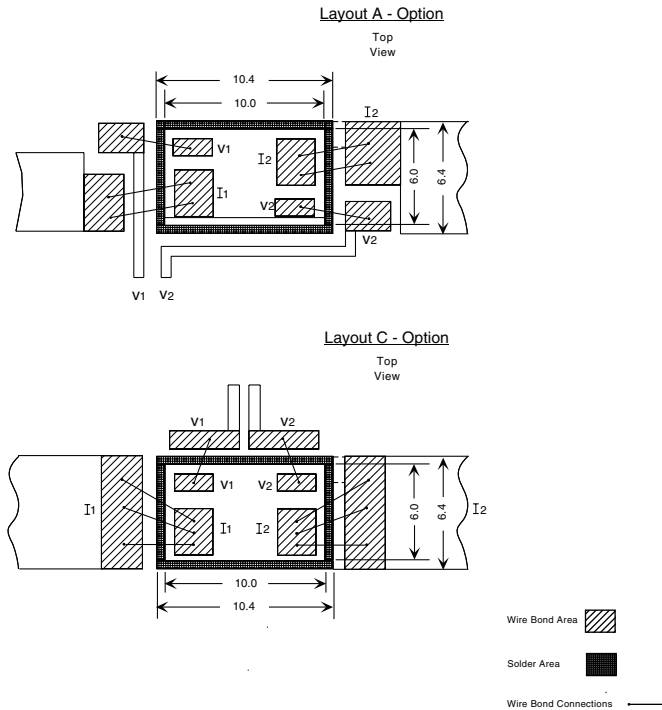


PMB



Dimensions in millimeters

PMU



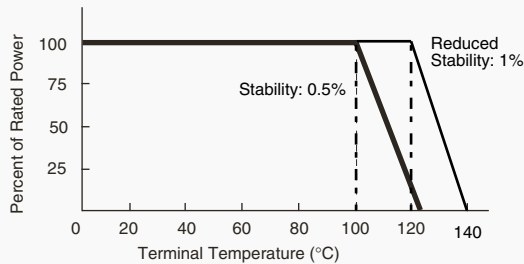
Precision Current Sensing Resistors



SMH is a precision power resistor designed for applications in power hybrids. Its copper base plate can be soldered (up to 300°C) or epoxy bonded onto a metallized ceramic, DBC or IMS® substrate. This allows for a highly efficient heat transfer to a heat sink via the thermally conductive adhesive and the copper base plate which results in the 3 Watt rating, 0°C to +95°C. The application of ISA-PLAN's unique etched-Manganin foil technology is responsible for the SMH's long-term stability and high pulse power.

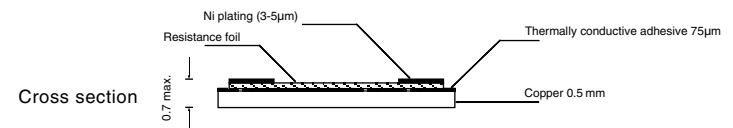
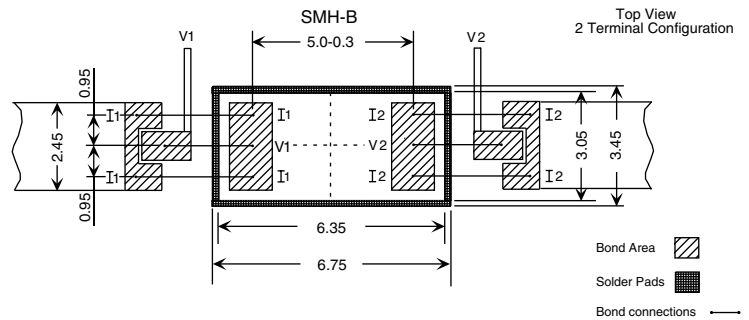
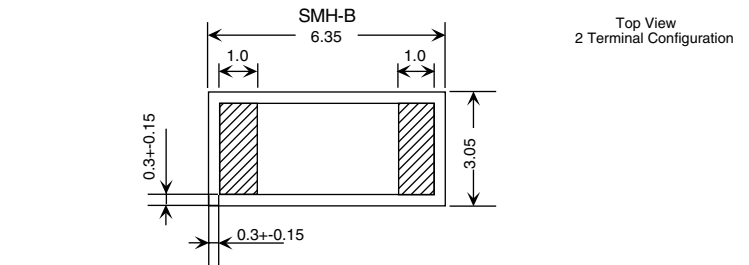
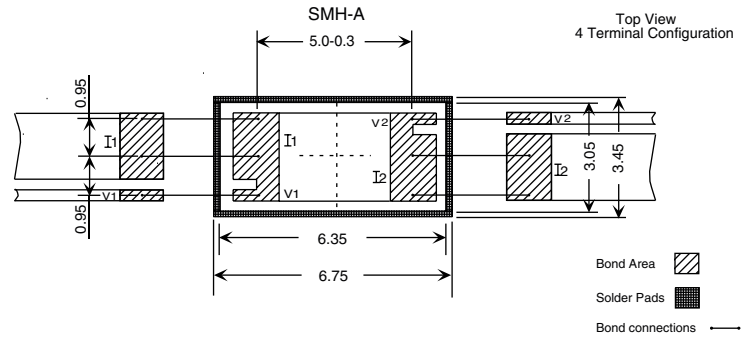
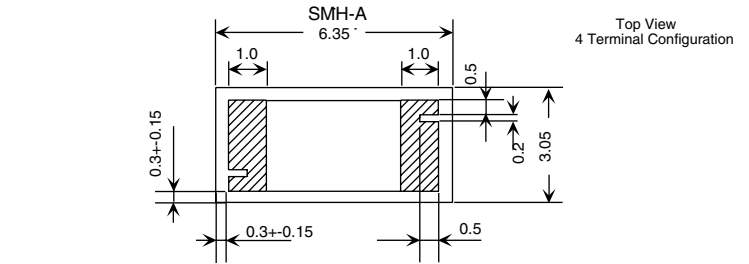
SMH is designed for wire bond attachment. The terminal areas are plated nickel over copper. The EIA 2512 size is ideal for application as a current sensor in intelligent semiconductors such as IGBTs. It is available in four (Kelvin) and two terminal configurations.

The SMH is delivered in 12mm (EIA-481) carrier tape for dispensing in automatic pick and place equipment.



SMH-B-R005-1.0

Tolerance
Resistance value
Model



Dimensions in millimeters

Technical Data

Parameters

Resistance Range	5mΩ to 500 mΩ
Tolerance	1.0%, 5.0%
Temperature Coefficient of Resistance (20°C to 60°C)	< 30 ppm/°C
Power Rating (Watts)	3
Dielectric Withstanding Voltage	100 VAC
Inductance	< 30 nH
Thermal Resistance to Base Plate	Rth < 10°C/W
Operating Temperature Range	-55°C to +125°C
Stability (Nominal Load at 70°C)	< 0.5% after 2000 hours

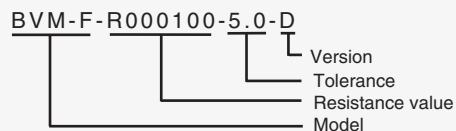
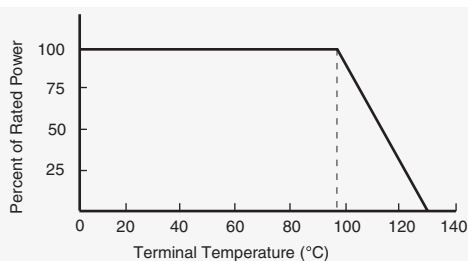
Precision Current Sensing Resistors



The BVD-A and BVM-F precision resistors are designed for use in energy metering, battery management, and high current automotive and welding applications.

The BVD-A is available in 500 micro-ohms and the BVM-F is available with resistances of 100, 200 and 500 micro-ohms. All have a tolerance of 5%. The rugged electron beam welded construction provides for continuous current up to 200A at up to 95°C. Resistance change after 2000 hours at 80°C and full rated load is less than 0.5%.

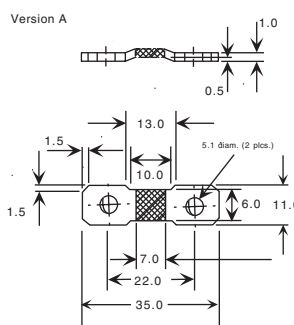
Heat is dissipated through the large copper terminals. The unique integration of copper/resistance/copper alloys results in a thermal resistance of less than 10°C/W and inductance of less than 1 nH. Mounting can be reflow soldering (350°C for 30 sec., or 250°C for 10 min.), welded or bolted to copper bus bar.



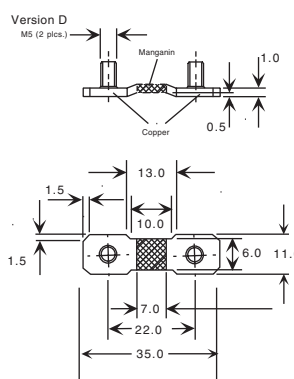
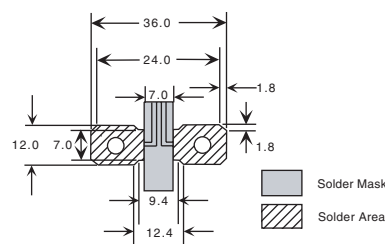
Technical Data

Parameters	BVD-A	BVM-F
Resistance Values	0.5 mΩ	0.1mΩ, 0.2mΩ, 0.5mΩ
Tolerance	5.0%	5.0%
Temperature Coefficient of Resistance (20°C to 60°C)	< 10 ppm/°C	< 10 ppm/°C
Power Rating (Watts)	3	5
Maximum Pulse Power	100W / 0.1s	100W / 0.1s
Inductance	< 1nH	< 1nH
Internal Heat Resistance	Rth < 10°C/W	Rth < 10°C/W
Operating Temperature Range	-55°C to +140°C	-55°C to +140°C
Stability (Nominal Load at 80°C)	< 0.5% after 2000 hours	< 0.5% after 2000 hours

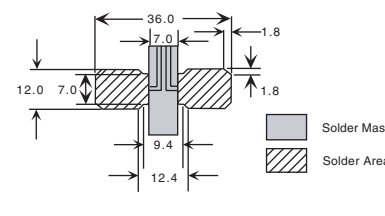
BVD-A



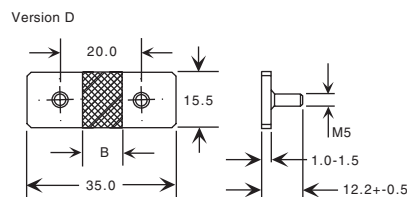
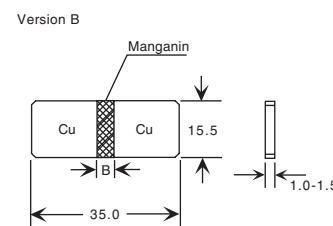
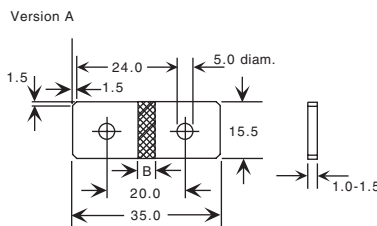
Proposed PCB Layout - Version A



Proposed PCB Layout - Version D



BVM-F



R	B
0.1mΩ	5.0+/-0.3mm
0.2mΩ	10.0+/-0.3mm
0.5mΩ	8.0+/-0.3mm

Dimensions in millimeters

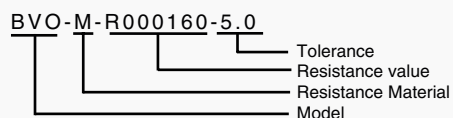
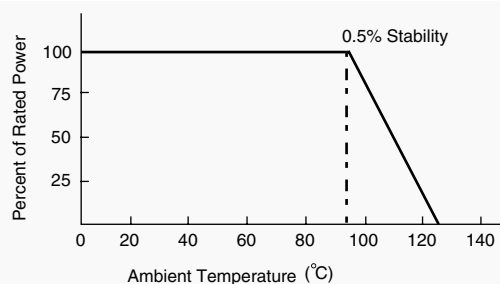
Precision Current Sensing Resistors



The BVO current sensing resistor is designed for use in kWh meters. The rugged electron beam welded construction is punched in a four terminal (Kelvin) configuration, which allows for accurate measurements at high currents.

The BVO is available in resistance values of 160 and 200 micro ohms. The power connections can be made with cables and ring terminals or the BVO can be soldered to a PCB. There are formed tabs in the shunt to connect sense and ground leads. The BVO is rated for 3Watts continuous power at up to 95°C. Resistance change after 2000 hours at 80°C and full rated load is less than 0.5%.

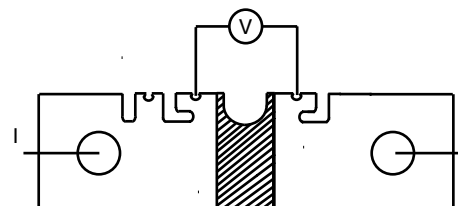
Heat is dissipated through the large copper terminals. The unique integration of copper/resistance/copper alloys results in a thermal resistance of less than 10°C/W and tcr less than 20 ppm/°C. Custom configurations of the BVO are available to meet exact mechanical requirements.



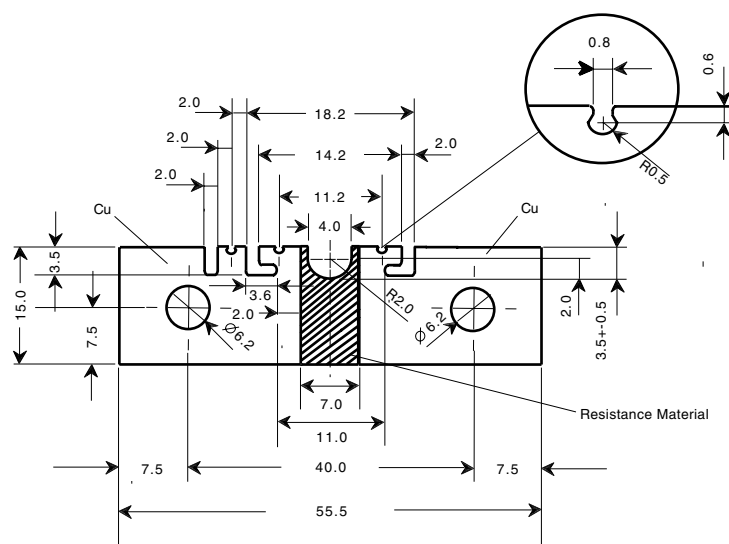
Technical Data

Parameters	BVO
Resistance Values	0.160 mΩ, 0.2mΩ
Tolerance	5.0%
Temperature Coefficient of Resistance (20°C to 60°C)	< 20 ppm/°C
Power Rating (Watts)	3
Maximum Pulse Power	3 kW / 0.1 s
Internal Heat Resistance	< 1 nH
Operating Temperature Range	Rth < 10°C/W
Stability (Nominal Load at 80°C)	-55°C to +125°C
	< 0.5% after 2000 hours

BVO



Connection Diagram



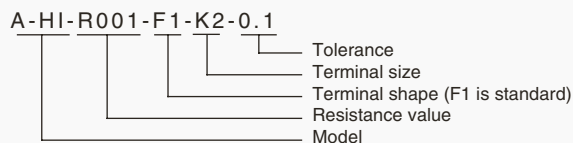
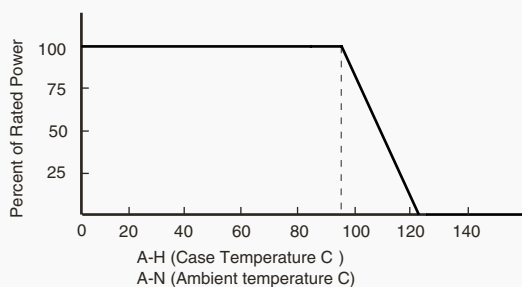
Dimensions in millimeters

Precision Current Sensing Resistors

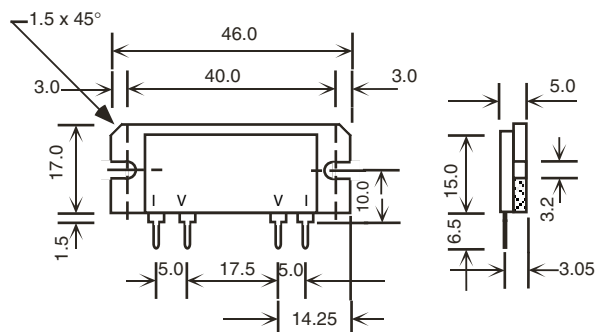


The A series utilizes etched manganin foil as the resistor element for precision and long term stability. The A-H models are constructed for high power and low inductance. The low thermal resistance to the aluminum base plate is $<3^{\circ}\text{C/W}$ for a continuous power rating of 10W.

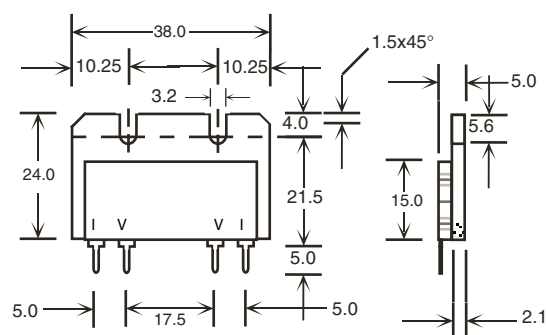
The four terminal (Kelvin) design of the A series makes it ideal for precision current measurement, limiting or regulation in power supplies, current sources and electronic loads, including pulse width modulated (PWM) control circuits for inductive loads such as servo and stepper motors and solenoid drive circuits.



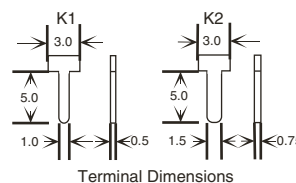
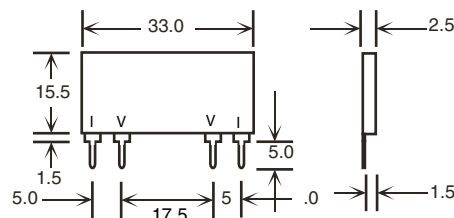
A-H1



A-H2



A-N



Dimensions in millimeters

Technical Data

Parameters	A-H	A-N
Resistance Values	1 m Ω to 100 Ω	1 m Ω to 100 Ω
Tolerance	0.1%, 0.5%, 1.0%	0.1%, 0.5%, 1.0%
Temperature Coefficient of Resistance (20°C to 60°C)	$< 10 \text{ ppm}/^{\circ}\text{C}$	$< 10 \text{ ppm}/^{\circ}\text{C}$
Power Rating (Watts)	10	1
Dielectric Withstanding Voltage	500 VAC	1000 VAC
Inductance	$< 10 \text{ nH}$	$< 10 \text{ nH}$
Thermal Resistance to Base Plate	$R_{th} < 3^{\circ}\text{C/W}$	n/a
Thermal Resistance to Ambient	$R_{th} < 15^{\circ}\text{C/W}$	$R_{th} < 30^{\circ}\text{C/W}$
Operating Temperature Range	-55°C to +125°C	-55°C to +125°C
Stability (Nominal Load at 70°C)	$< 0.1\%$ after 2000 hours	$< 0.05\%$ after 2000 hours

PBV, PBH, PSB



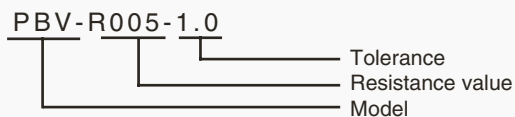
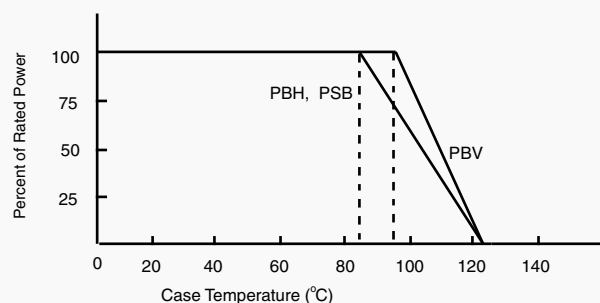
Precision Current Sensing Resistors



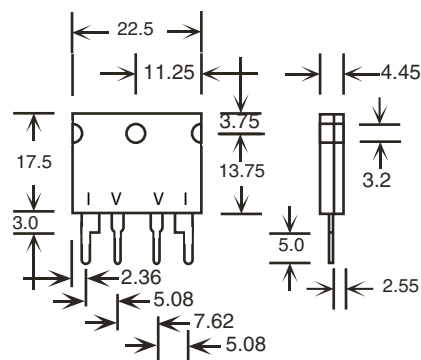
The PBV, PBH and PSB resistors are designed for mounting to a heat sink.

The PSB utilizes a spring clip. Both the PBV and PBH have one screw mounting capability. Etched Manganin foil and copper terminals provide for low temperature coefficient of resistance, long term stability and low inductance. The internal thermal resistance, <4K/W, assures low self-heating at the 10W rating.

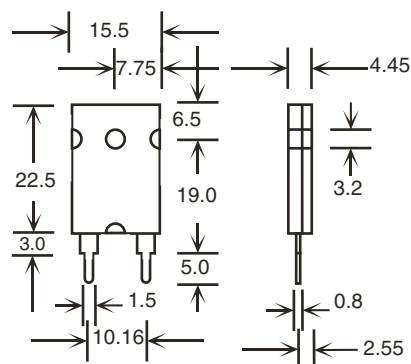
The PBV is a four terminal (Kelvin) version which provides a lower resistance range (0.0005 Ω to 1 Ω) where precision measurement of current is necessary. All are ideal for power electronics and control applications.



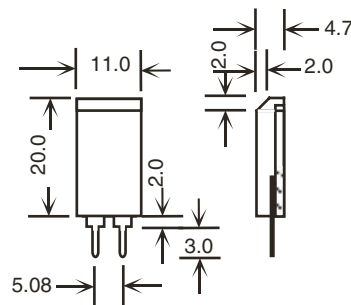
PBV



PBH



PSB



Dimensions in millimeters

Technical Data

Parameters	PBH	PBV	PSB
Resistance Values	2 m Ω to 100 Ω	0.5 m Ω to 1 Ω	5 m Ω to 1 Ω
Tolerance	1.0%, 5.0%	0.5%, 1.0%, 5.0%	1.0%, 5.0%
Temperature Coefficient of Resistance (20°C to 60°C)	< 50 ppm/°C	< 30 ppm/°C	< 50 ppm/°C
Power Rating (Watts)	3/10 on heatsink	3/10 on heatsink	3/10 on heatsink
Dielectric Withstanding Voltage	500 VAC	500 VAC	100 VAC
Inductance	< 20 nH	< 50 nH	< 10 nH
Thermal Resistance to Base Plate	Rth < 4°C/W	Rth < 3°C/W	Rth < 4°C/W
Thermal Resistance to Ambient	Rth < 20°C/W	Rth < 15°C/W	Rth < 20°C/W
Operating Temperature Range	-55°C to +125°C	-55°C to +125°C	-55°C to +125°C
Stability (Nominal Load at 70°C)	< 0.5% after 2000 hours	< 0.5% after 2000 hours	< 0.5% after 2000 hours

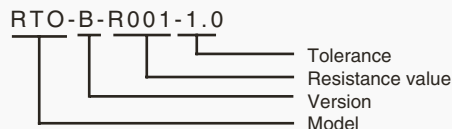
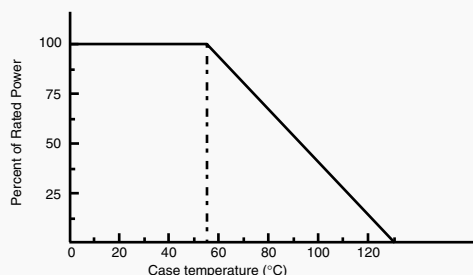
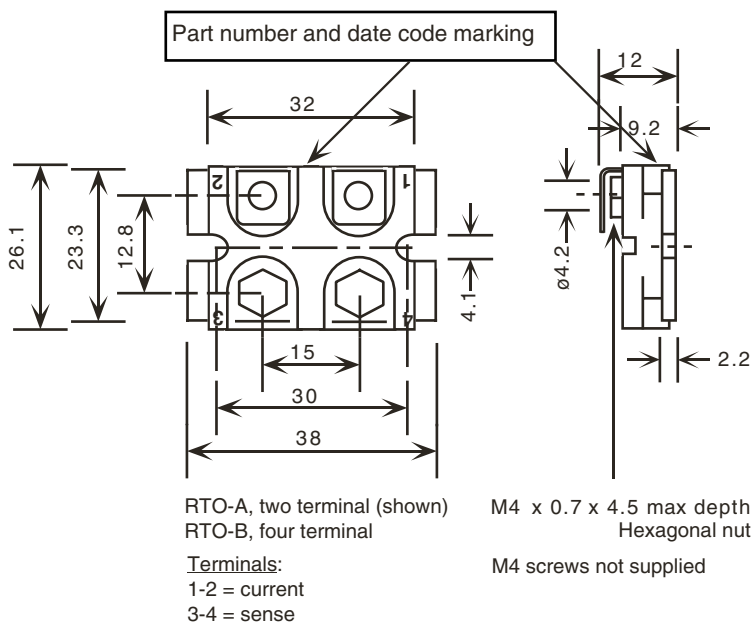
Precision Current Sensing Resistors



The RTO is available in both two-terminal (A) and four-terminal, Kelvin (B) configurations. Both types utilize the popular ISOTOP (SOT 227B) package commonly used for active components such as diodes, transistors and thyristors.

Mounting the RTO directly on a heat sink with other components provides an economic assembly for high power current supplies and electrical drives. Wiring is via screw connection to the resistor. These low impedance current connections permit continuous current up to 150A. The RTO will easily handle pulse currents equal to 10 times the rated current.

The RTO may be used in series with a three-phase supply due to its high dielectric strength to the aluminum base plate. It may serve as a measuring resistor for actual current measurement, or as a damping resistor in snubber circuits.



Technical Data

Parameters	RTO-A	RTO-B
Resistance Range	500 m Ω to 100 Ω	1 m Ω to 470 m Ω
Tolerance	1.0%, 5.0%	1.0%, 5.0%
Temperature Coefficient of Resistance (20°C to 60°C)	< 50 ppm/°C	< 50 ppm/°C
Power Rating (Watts)	50	50
Dielectric Withstanding Voltage	2500 VAC	2500 VAC
Inductance	< 2 nH	< 5 nH
Thermal Resistance to Base Plate	R _{th} < 2.5°C/W	R _{th} < 2.5°C/W
Operating Temperature Range	-55°C to +125°C	-55°C to +125°C
Stability (at 125°C foil temperature)	< 0.5% after 2000 hours	< 0.5% after 2000 hours

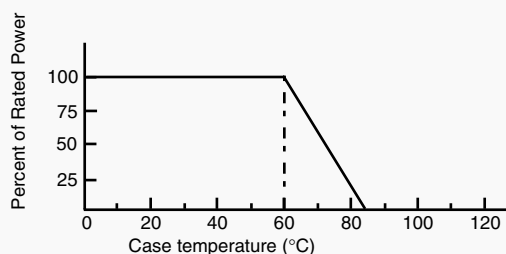
Dimensions in millimeters

Precision Current Sensing Resistors



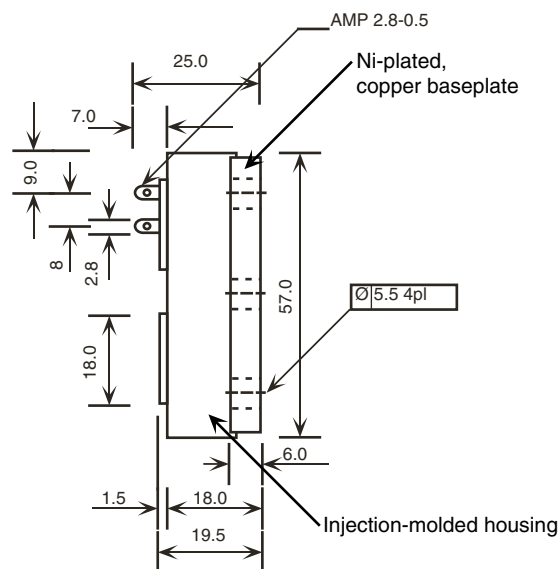
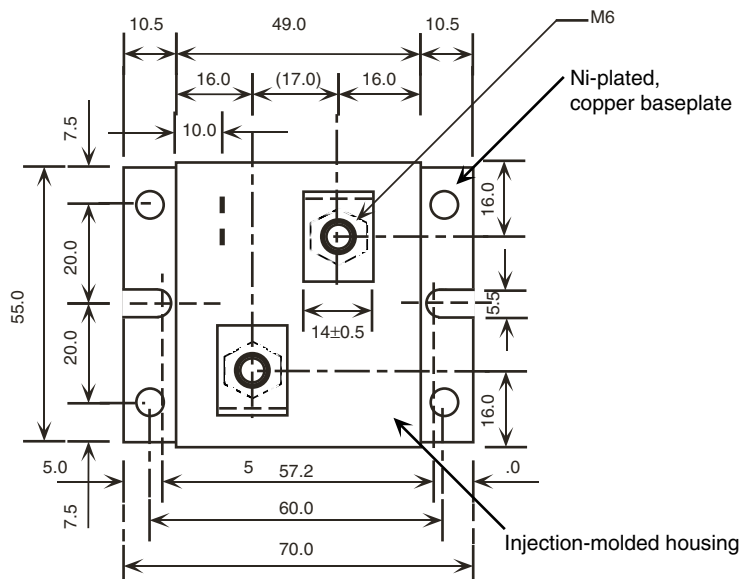
A high power resistor in four-terminal (Kelvin) configuration, the RUG-Z has been developed for applications requiring precision regulation of high DC or low frequency AC currents. The design and construction of RUG-Z allow it to withstand pulses of up to 1000 W without damage or degradation of performance.

The RUG-Z utilizes Zeranin® foil as the resistor element. Zeranin exhibits very low tcr over a wide temperature range, making it ideal for use in power amplifiers in MRI and for controlling super-conducting magnets.



RUG-Z-R010-0.1 TK3

- Model
- Resistance value
- Tolerance
- TCR



Dimensions in millimeters

Technical Data

Parameters

Parameters	RUG-Z
Resistance Range	1, 2, 5, 10, 20, 50, 100, 200, 500 mΩ, 1, 10, 100 Ω
Tolerance	0.1%, 1.0%
Temperature Coefficient of Resistance (20°C to 60°C)	1, 3, 5, 10 ppm/°C
Power Rating (Watts)	250
Single Pulse Power	50 J (t < 10 msec)
Maximum Continuous Current	250A
Dielectric Withstanding Voltage	500 VAC
Inductance (R < 10mΩ)	< 10 nH
Thermal Resistance to Base Plate	Rth < 0.1°C/W
Operating Temperature Range	-55°C to +85°C
Stability (Nominal Load at 70°C)	< 0.1% after 2000 hours

BRK, BRM, BRQ



Dynamic Braking Resistors

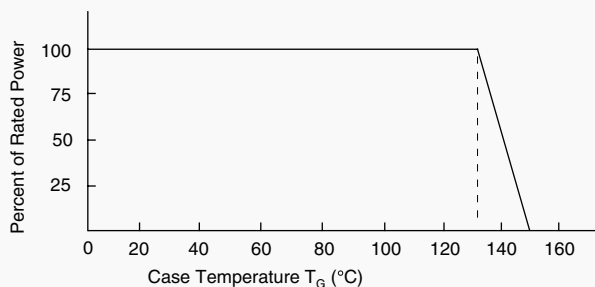


The BR series is ideal for use as a dynamic braking resistor, in a soft-start motor circuit or any application requiring high power and compact size. The primary advantage of the BR resistors is their small footprints compared to power dissipation capacity. For example, the BRQ dissipates up to 7W/cm².

All models are only 1.42 cm tall and are housed in an injection-molded case. Each resistor contains a 2 mm thick copper base plate that provides heatsinking and pulse power loads up to 1 kW, 2kW or 3 kW, depending on power rating.

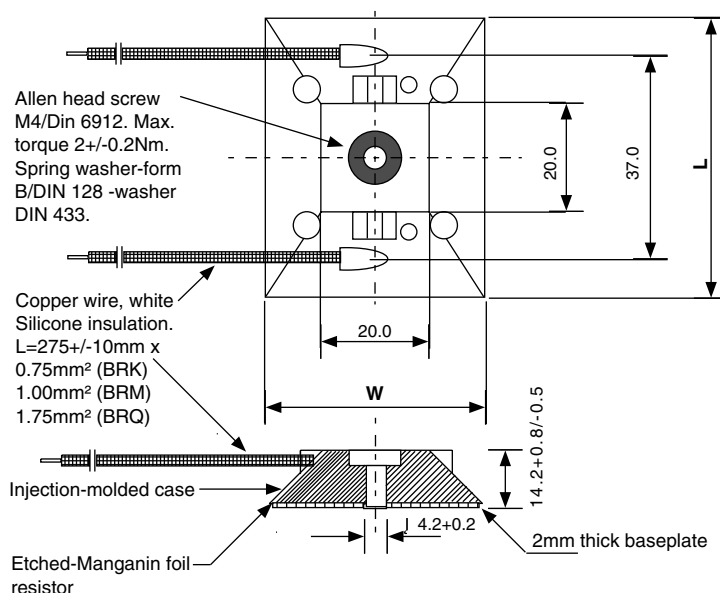
Mounting requires a single screw. The BR series is available with standard Silicone insulated lead wires or copper terminal pins.

Several standard resistance values are offered. Many more values are available as the list of standard values is expected to expand.



BRQ-100R -10 - L

'L' = Leads 'K' = Pins
Tolerance
Resistance Value
Model



Dimensions (+/-0.5)

	W	L
BRK	40.5	51.5
BRM	51.5	61.5
BRQ	61.5	69.5

Dimensions in millimeters

Technical Data

Parameters	BRK	BRM	BRQ
Resistance Values (others upon request)	4.7, 10, 33, 47, 68 100, 150, 200Ω	10, 22, 47, 100, 150Ω	1, 2.5, 10, 12, 22, 47, 68, 100, 125, 150, 180, 200Ω
Tolerance (others upon request)	10%	10%	10%
Temperature Coefficient of Resistance	< 50 ppm/°C	< 50 ppm/°C	< 50 ppm/°C
Applicable Temperature Range	-50°C to +150°C	-50°C to +150°C	-50°C to +150°C
Power Rating (heat sink mounting)	100	200	300
Max. Pulse Power @ 1s on >10s off (≤80°C case temperature)	1kW	2kW	3kW
Thermal Resistance to Base Plate	R _{th} < 0.15°C/W	R _{th} < 0.1°C/W	R _{th} < 0.05°C/W
Operating Voltage (max)	1000 VAC	1000 VAC	1000 VAC
Dielectric Withstanding Voltage	2500 VAC	2500 VAC	2500 VAC
Stability (Nominal Load)	< 1% after 2000 hours	< 1% after 2000 hours	< 1% after 2000 hours

Voltmeter Shunts & Milliohmmeters

CS



Increase the current measuring capability of your digital multimeter with Isotek's Voltmeter Current Shunts. Isotek's shunts cover the range of 0 to 30 amperes. The shunts utilize a precision, four-terminal (Kelvin) resistance technique to accurately measure the voltage drop while dissipating <2 watts of burden power. The shunts are packaged in a rugged, epoxy-filled, thermoplastic case. Polycarbonate insulated, gold-plated brass binding posts are used on all models.

Features

- Increased voltmeter range and accuracy
- Thermal coefficient of resistance <10 ppm/°C from -20°C to 60°C
- < 2 watt burden power loss when used below the recommended maximum current
- Polycarbonate insulated, gold-plated, brass binding posts
- Rugged, epoxy-filled, thermoplastic case

CS Specifications

MODEL	INPUT RANGE	MAX CURRENT 1 MINUTE	ACCURACY	SENSITIVITY	RESISTANCE Ω
CS-10	0-10A	20A	.1%DC/1%@5kHz	10mV/A	0.01 \pm 0.1%
CS-20	5A-20A	30A	.1%DC/1%@5kHz	5mV/A	0.005 \pm 0.1%
CS-30	10A-30A	40A	.1%DC/5%@5kHz	1mV/A	0.001 \pm 0.1%

M210



M210/9B



Isotek's M210 Milliohmmeter provides accurate low resistance measurement and the convenience of a portable handheld instrument.

The battery operated (9V) resistance meter utilizes a four-terminal (Kelvin) network which eliminates errors caused by test lead resistance. It can accurately measure from 0.001 Ω to 200 Ω . Small, lightweight and easy to use.

The M210/9A jaws are molded in rugged plastic and inset into each jaw face is a copper/silver inlay contact. One contact face on each clip is connected to the current generating circuit; the other face is connected to the voltage measuring circuit. In this way, two clips instantly connect the four wires.

Typical Applications

- Earth conductor continuity
- Weld integrity
- Transformer and motor windings
- PC-plated through holes and track resistance
- Relay, switch and connector contacts
- RFI shielding and coil resistance

Features

- Kelvin Connections
- Portable
- 0.1% accuracy
- 1m Ω to 200 Ω
- <5mA test current
- Optional clip and probe leads (M210/9B)

M210 Specifications

Ranges (selected automatically):	1.999 Ω , 19.99 Ω , 199.9 Ω
Increment:	0.001 Ω , 0.01 Ω , 0.1 Ω
Accuracy:	\pm 0.1% of range
Zero Offset:	\pm 0.001 Ω
Test Current:	5mA, max.
Test Power:	5mW, max.
Operating Range:	5°C - 35°C
Display:	3-1/2 digit LCD
Size:	Instrument - 5.7" H x 3.25" W x 1.43" D Carrying Case - 6.1" H x 5.65" W x 1.8" D
Weight:	1lb. 3oz.
Supplied Accessories:	Carrying case w/strap, M210/9A Kelvin clip leads



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