





## KEY TO SYMBOLS



INDUSTRIAL



Drive technology



Frequency converters



Digital energy meters



Uninterruptible power supply



Solar



Wind



Power modules



AUTOMOTIVE (AEC-Q200 QUALIFIED)



Diesel and petrol direct injection systems



Electric power steering



Vehicle lighting systems



Climate control



Electric parking brake systems



HYBRID AND ELECTRIC VEHICLES



Batteries



Fuel cells



Electric vehicles



COMPUTERS



MEDICAL ENGINEERING



ELECTRICAL ENGINEERING



DOMESTIC APPLIANCES



MEASUREMENT SYSTEMS



LABORATORY



AEROSPACE

## GLOSSARY

### ISA-PLAN®

is a special manufacturing process in which resistance elements are etched from the precision resistance alloys MANGANIN® and ZERANIN® and then electrically insulated and mounted on a metal substrate with good heat-conducting properties. The planar structure and optimised current-density distribution enable low temperature coefficients (TCR), low-inductance designs, very low internal heat resistance and therefore a high load capacity.

### ISA-WELD®

is a patented process for the manufacture of advanced high-performance resistors. The resistors are made from solid electron-beam welded composite materials incorporating one of our resistance alloys, e.g. MANGANIN®, ZERANIN® or ISAOHM®. They can be stamped or bent to suit almost any shape or application. ISA-WELD® resistors are used in high-current applications in the automotive industry, battery charging technology, drive technology and electronic energy meters.

### MANGANIN®

is a resistance alloy developed by Isabellenhütte which is made from copper, manganese and nickel. MANGANIN® has been used in precision resistors worldwide for over 100 years; it has a moderate specific resistivity, a very low temperature coefficient (TCR) and a low thermal EMF against copper.

### ZERANIN®

was developed as a low-ohmic alternative to MANGANIN®. This copper-manganese-tin alloy has an even better temperature coefficient (TCR) but slightly lower specific resistivity. It is therefore ideal for very low-ohmic resistors with extremely high precision characteristics.

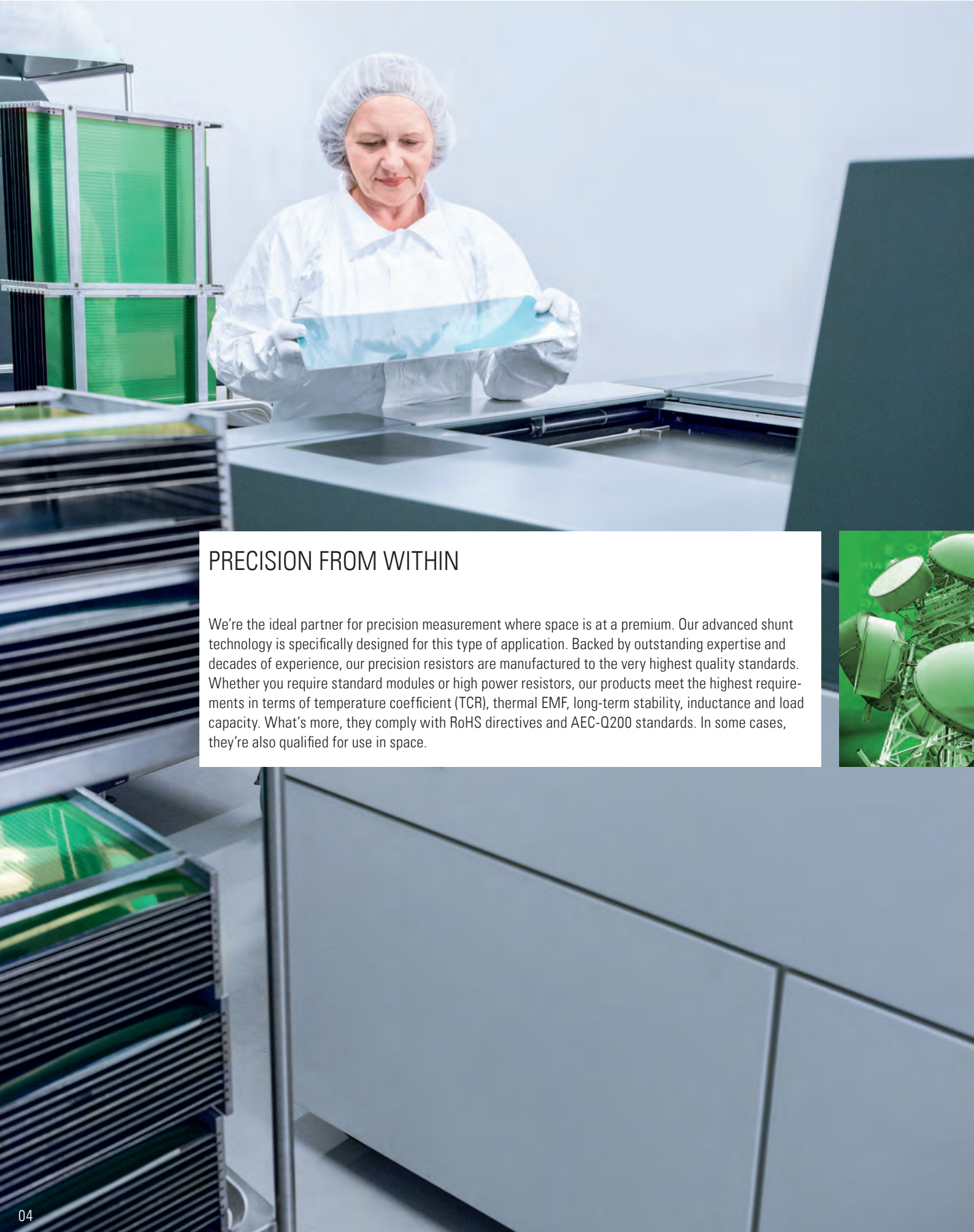
### ISAOHM®

is another resistance alloy developed by Isabellenhütte, this time made from nickel and chrome with traces of aluminium, silicon, manganese and iron. ISAOHM® is a very versatile material thanks to its particularly high specific resistivity, low temperature coefficient (TCR) and low thermal EMF against copper. It is mainly used in wire form for the production of high-ohmic, ultra-stable resistors and potentiometers as used in the automotive and consumer electronics industries as well as testing and automatic control equipment.

### NOVENTIN®

With its high specific electrical resistance, the newly developed NOVENTIN® closes the gap between MANGANIN® and ISAOHM®. NOVENTIN® stands out particularly due to a small temperature coefficient of the electrical resistance with a parabolic behaviour of the R(T) curve, a high long-term stability of the electrical resistance, an extremely low thermoelectric power against copper and a good workability. Due to these features, NOVENTIN® is excellently suitable for the production of precision, standard and shunt resistors.





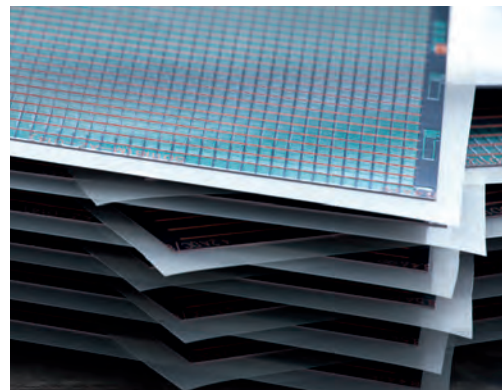
## PRECISION FROM WITHIN

We're the ideal partner for precision measurement where space is at a premium. Our advanced shunt technology is specifically designed for this type of application. Backed by outstanding expertise and decades of experience, our precision resistors are manufactured to the very highest quality standards. Whether you require standard modules or high power resistors, our products meet the highest requirements in terms of temperature coefficient (TCR), thermal EMF, long-term stability, inductance and load capacity. What's more, they comply with RoHS directives and AEC-Q200 standards. In some cases, they're also qualified for use in space.

“Our modular design system enables us to create customised solutions for current, voltage and temperature measurement applications in time and affordably.”

## THE BASICS OF CURRENT SENSING

When we introduced our ISA-PLAN® and ISA-WELD® technologies, Isabellenhütte set totally new standards for low-ohmic resistors and became the global benchmark in this field. Our physically optimised current sensors (“shunts”) provide a range of unique benefits. In contrast to competing products, ISA-PLAN® and ISA-WELD® retain their specified tolerances under all conditions, i.e. over the entire temperature range, under full power load and throughout the entire operating life cycle.



*Production panels made from pressed and laminated substrate and resistance material*

The following equation generally applies to the voltage measured on a resistor:

$$U = R \cdot I + U_{th} + U_{ind} + U_{iext} + \dots$$

Since the voltage drop in low-ohmic resistors is correspondingly small, error voltages not produced by a current flow can completely distort the measured result. For this reason, it is essential that the product developer and layout designer understand the causes and minimise their influence through careful layout design and, in particular, by selecting appropriate components and materials.

$U_{th}$	<i>Thermal EMF</i>
$U_{ind}$	<i>Induced voltage</i>
$U_{iext}$	<i>Voltage drop on leads</i>

The real resistance value is typically dependent on parameters such as temperature, time, voltage, frequency, etc.

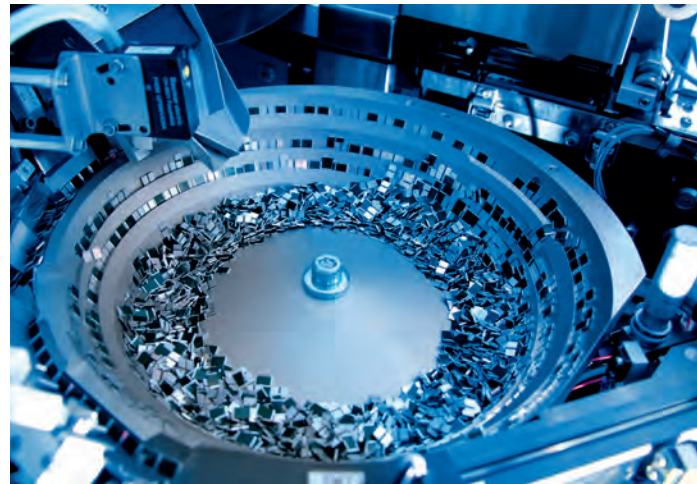
$$R = R(T, t, P, Hz, U, A, \mu, \rho \dots)$$

Some of these characteristics are influenced not only by the choice of material but also by the design of the component and the production process. Isabellenhütte products are physically optimised to ensure the effects described above are reduced as far as possible. Our resistors are made using one of two basic production technologies: ISA-PLAN® (etched-foil resistors) and ISA-WELD® (resistors made from electron-beam welded composites, e.g. Cu-MANGANIN®-Cu).





*Etching technology process of ISA-PLAN® resistors*



*Components are comprehensively tested, measured and calibrated before packing in standard tapes and reels*

## WE'RE PIONEERS FOR A GOOD REASON

### LONG-TERM STABILITY

Long-term stability is an extremely important characteristic for a sensor. Even after many years of service, it is essential that users can rely on the original calibration. Resistance materials must therefore be stable against corrosion and invulnerable to any metallurgical change in structure or state.

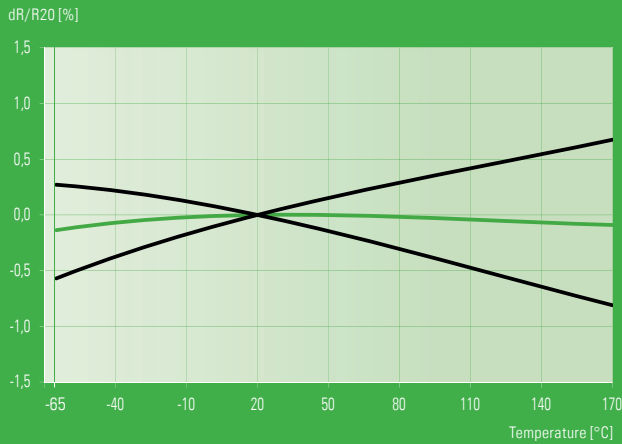
Our MANGANIN®, NOVENTIN®, ISAOHM® and ZERANIN® alloys have a homogenous mixed crystal structure, which makes them the ideal material for these applications. The alloys are carefully annealed and stabilised and are therefore supplied in their thermodynamic ground state. As a result, they all have resistance stability ratings in the range of ppm per annum. Which is why our alloys have proved themselves for over 100 years in reference resistors worldwide.

### TEMPERATURE DEPENDENCE

The temperature dependence of our resistors is mainly determined by the precision resistance alloys MANGANIN®, NOVENTIN®, ISAOHM® and ZERANIN®. In many cases, however, low-ohmic resistors suffer from significant influences of the termination, which is why the sense voltage should be measured via two additional contacts located directly on the resistance material. The examples (right) show that poor layout and/or construction can result in major inaccuracies in both resistance value and temperature coefficients (TCR).

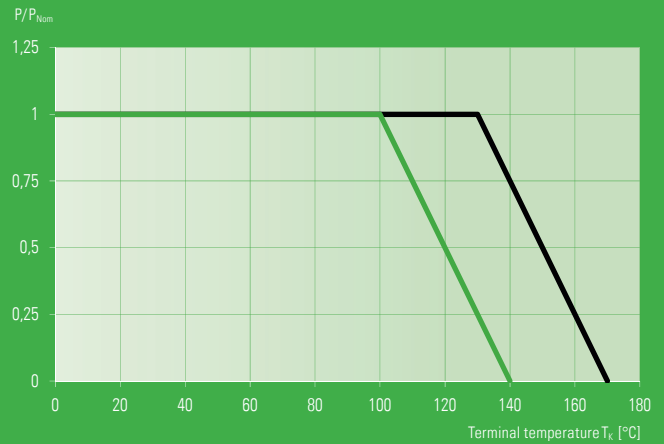
The 10 mm copper leads on a 10 mOhm conventional 2-terminal resistor already create 24 % of the total resistance while increasing the temperature coefficient from 10 ppm/K to almost 1000 ppm/K. The additional resistance on the leads could be offset by calibration, but the effect on the temperature coefficient would still remain the same. It is therefore incorrect to specify the temperature coefficient of the resistance material, a practice that is common on many data sheets.

The second example shows that poor layout design for the sense voltage connection can distort both the resistance value and the temperature coefficient by more than 100 %. In our resistors made from electron-beam welded composites (Cu-MANGANIN®-Cu), the lead resistance is extremely low. The same applies to our SMx, VMx and VLx series, thanks to the copper substrates used in these products. With the right combination of layout, soldering and resistor, it is possible to implement an optimum four-terminal configuration in which the rated resistance and temperature coefficient of the component remains valid in the application.



**Temperature dependence: MANGANIN® // 50 ppm/K**

— Upper/lower limit  
 — Typical temperature dependence of a resistor



**Power derating curve (0.5 mOhm)**

— Stability 1.0 %  
 — Stability 0.5 %

## HIGH LOAD CAPACITY

Due to the fact that the thermal conductivity of resistance materials is relatively low compared with copper and the resistor foil thickness is low, in the region of 20 to 150  $\mu\text{m}$ , it is not possible to conduct the heat out of the resistor via the resistance material into the terminals.

For this reason, the resistance foil on our ISA-PLAN® resistors is bonded to a metal substrate with good thermal conductivity (copper or aluminium) using a thin adhesive that is also thermally conductive. This enables effective discharge of dissipated heat via the substrate and terminals. The result is a relatively very low internal heat resistance, typically in the region of 10 to 30 K/W.

Our resistors can therefore be used at their full rated power up to a very high terminal temperature, i.e. the derating point on the power derating curve is very high compared with other products. At the same time, the maximum temperature in the resistance material is kept low, thereby significantly improving long-term stability under load and the TCR-dependent reversible resistance change.

## LOWER INDUCTANCE

Since in many applications it is necessary to not only measure but also control switch-mode currents, the inductance of the shunt or measurement circuit is of great importance.

To reduce inductance, our SMD resistors have a flat design, with or without closely adjacent meanders. Performance is further improved by the diamagnetic characteristics of all our precision alloys mentioned above, as well as the metal substrate and four-terminal connection.

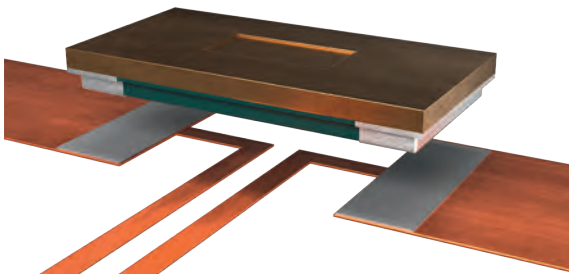
However, since the sensing leads and the resistor form an antenna structure in which voltages are induced by the magnetic field generated by the current flow as well as other external magnetic fields, it is especially important to ensure that the area enclosed by the leads is as small as possible. We therefore recommend the use of closely adjacent leads or even a strip-line arrangement, i.e. where the two lines are routed to the amplifier on two separate layers congruently one above the other.



## SURFACE MOUNT ASSEMBLY (ISA-PLAN®)

**Product series: FMx**

Sizes: 1206/2010/2512



### Features

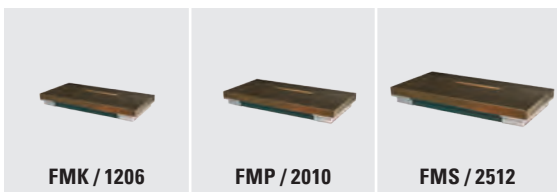
- Up to 3.5 watts permanent power at 70 °C
- Very high pulse power rating
- Small design
- Very good long-term stability
- Standard solder pad size
- Mounting: reflow and infrared soldering
- AEC-Q200 qualified
- RoHS 2011/65/EU compliant

### Technical data

Resistance values	2 to 6 mOhm
Tolerance	1 %, 5 %
Temperature coefficient	<50 ppm/K (20 °C to 60 °C)
Applicable temperature range	-65 °C to +170 °C
Power rating	up to 3.5W
Internal heat resistance	from 25 K/W
Insulation voltage	200 V
Inductance	from 0.5 nH
Stability (nominal load) deviation	<0.5 % after 2000 h ( $T_K = 80\text{ °C}$ )
$T_K =$ Terminal temperature	<1.0 % after 2000 h ( $T_K = 110\text{ °C}$ )

### Advantages/user benefits

- 4-terminal connection on pc-board
- Tin/copper plated terminals for optimum soldering points
- Extremely low Rthi
- Extremely low TC for the entire resistance value range
- High load capacity at high temperature



FMK / 1206

FMP / 2010

FMS / 2512

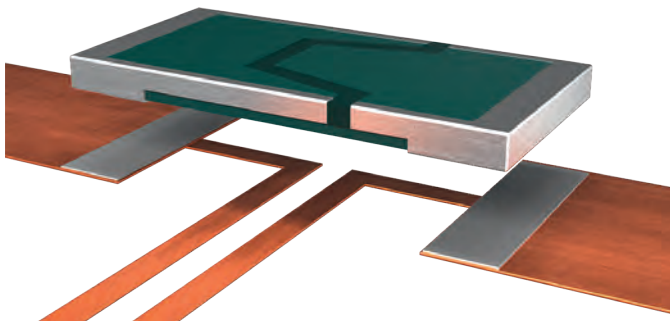




## SURFACE MOUNT ASSEMBLY (ISA-PLAN®)

**Product series: VMx**

Sizes: 0805 / 1206 / 2010 / 2512



### Features

- Up to 4 watts permanent power at 70 °C
- Very high pulse power rating
- Very good long-term stability
- Standard solder pad size
- Mounting: reflow and infrared soldering
- AEC-Q200 qualified

### Technical data

Resistance values	5 mOhm to 1 Ohm
Tolerance	1 %, 5 %
Temperature coefficient	<20 ppm/K (20 °C to 60 °C)
Applicable temperature range	-65 °C to +170 °C
Power rating	up to 4 W
Internal heat resistance	<25 K/W
Insulation voltage	200 V
Inductance	<2 nH
Stability (nominal load) deviation	<0.5 % after 2000 h ( $T_K = 65\text{ °C}$ )
$T_K$ = Terminal temperature	<0.7 % after 2000 h ( $T_K = 95\text{ °C}$ )

### Advantages/user benefits

- 4-terminal connection on pc-board
- Tin/copper plated terminals for optimum soldering points
- Extremely low internal heat resistance
- Extremely low TCR for all resistance values
- Negligible thermal EMF against copper (< 1  $\mu\text{V/K}$ )
- Very good long-term stability under full load



VMI / 0805

VMK / 1206

VMK-NA / 1206

VMP / 2010

VMP-NA / 2010

VMS / 2512

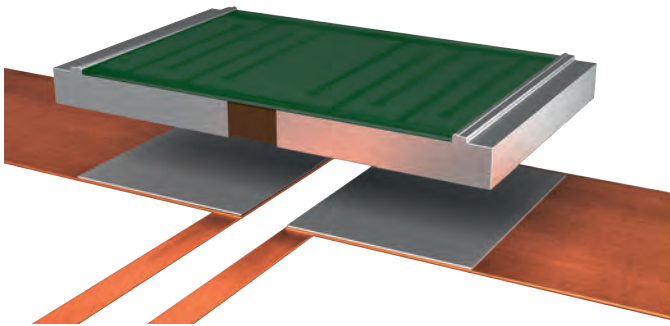
GMP / 2010



## SURFACE MOUNT ASSEMBLY (ISA-PLAN®)

### Product series: **SMx**

Sizes: 1206/2010/2512/2817



### Features

- Up to 7 watts permanent power at 70 °C
- Very high pulse power rating
- Very good long-term stability under full load
- Mounting: reflow and infrared soldering
- AEC-Q200 qualified

### Technical data

Resistance values	4 mOhm to 4.7 Ohm
Tolerance	0.5 %, 1 %, 5 %
Temperature coefficient	<50 ppm/K (20 °C to 60 °C)
Applicable temperature range	-65 °C to +170 °C
Power rating	up to 7 W
Internal heat resistance	from 13 K/W
Insulation voltage	200 V
Inductance	<3 nH
Stability (nominal load) deviation	<0.5 % after 2000 h ( $T_K = 75\text{ °C}$ )
$T_K$ = Terminal temperature	<1.0 % after 2000 h ( $T_K = 105\text{ °C}$ )

### Advantages/user benefits

- 4-terminal connection on pc-board
- Tin/copper plated terminals for optimum soldering points
- Extremely low internal heat resistance
- Extremely low TCR for all resistance values
- Nominal power at high temperature



SMK / 1206

SMP / 2010

SMS / 2512

SMT / 2817

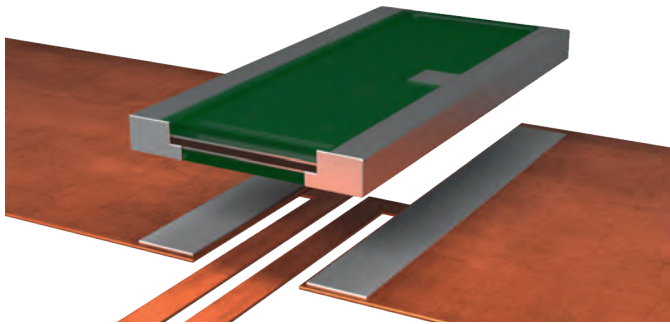
SMT-V / 2817



## SURFACE MOUNT ASSEMBLY (ISA-PLAN®)

Product series: **VLx**

Sizes: 0612/1020



### Features

- Up to 2 watts permanent power at 130 °C
- High pulse power rating
- Good long-term stability under full load
- Mounting: reflow and infrared soldering
- AEC-Q200 qualified

### Technical data

Resistance values	1 to 6 mΩ
Tolerance	1 %, 5 %
Temperature coefficient	<50 ppm/K (20 °C to 60 °C)
Applicable temperature range	-65 °C to +170 °C
Power rating	up to 2 W
Internal heat resistance	<20 K/W
Insulation voltage	200 V
Inductance	<1 nH
Stability (nominal load) deviation	<0.5 % after 2000 h ( $T_K = 100\text{ °C}$ )
$T_K$ = Terminal temperature	<0.7 % after 2000 h ( $T_K = 130\text{ °C}$ )

### Advantages/user benefits

- 4-terminal connection on pc-board
- Tin/copper plated terminals for optimum soldering points
- Extremely low internal heat resistance
- Virtually unaffected by ambient temperature in range -65 to +170 °C due to low TCR
- Negligible thermal EMF against copper (< 1 μV/K)
- Large soldering and terminal surface
- High mechanical strength of solder joint



VLK / 0612

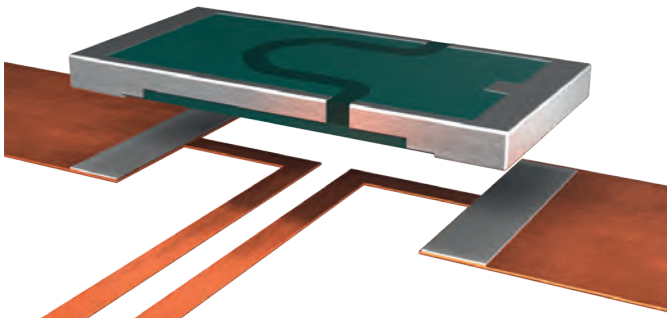
VLP / 1020



## SURFACE MOUNT ASSEMBLY (ISA-PLAN®)

**Product series: CMx**

Sizes: 1206 / 2010 / 2512



### Features

- Up to 2.5 watts permanent power at 70 °C
- High pulse power rating
- Good long-term stability
- Standard solder pads
- Mounting: reflow and infrared soldering
- AEC-Q200 qualified

### Technical data

Resistance values	10 to 500 mOhm
Tolerance	1 %, 5 %
Temperature coefficient	<75 ppm/K (20 °C to 60 °C)
Applicable temperature range	-65 °C to +170 °C
Power rating	up to 2.5 W
Internal heat resistance	<35 K/W
Insulation voltage	200 V
Inductance	<3 nH
Stability (nominal load) deviation	<1.0 % after 2000 h ( $T_K = 100 °C$ )
$T_K$ = Terminal temperature	

### Advantages/user benefits

- 4-terminal connection on pc-board
- Tin/copper plated terminals for optimum soldering points
- Extremely low internal heat resistance
- Virtually unaffected by ambient temperature in range -65 to +170 °C due to low TCR
- Negligible thermal EMF against copper (< 1  $\mu$ V/K)
- Very good long-term stability under full load



CMK / 1206

CMP / 2010

CMS / 2512



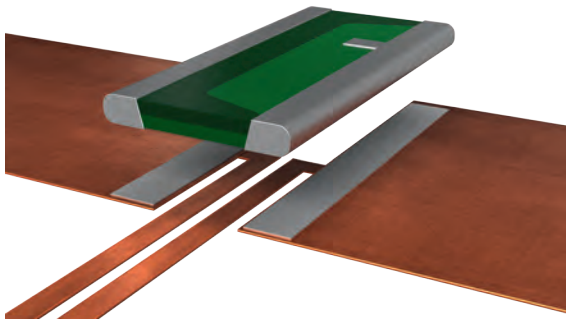


## SURFACE MOUNT ASSEMBLY (ISA-PLAN®)

Wide terminal resistor

**Product series: CLx**

Sizes: 0612 / 1020



### Features

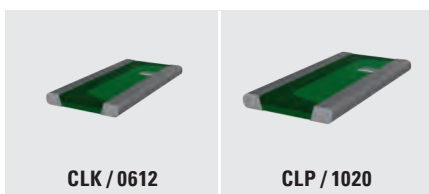
- Up to 5 W power rating at 70 °C
- Constant current up to 26 A (3 mOhm)
- Excellent good long-term stability
- High pulse power rating
- Mounting: Reflow- and IR-soldering
- AEC-Q200 qualification in preparation

### Technical data

Resistance values	3 / 5 mOhm
Tolerance	1 %, 5 %
Temperature coefficient	<50 ppm/K (20 °C to 60 °C)
Applicable temperature range	-65 °C to +170 °C
Power rating	up to 5 W
Internal heat resistance	<20 K/W
Dielectric withstanding voltage	200 V AC/DC
Inductance	<1 nH
Stability (nominal load) deviation	<0.5 % after 2000 h ( $T_K = 100\text{ °C}$ )
$T_K$ = Terminal temperature	<0.7 % after 2000 h ( $T_K = 130\text{ °C}$ )

### Advantages/user benefits

- 4-terminal connection on pc-board
- Tin/copper plated terminals for optimum soldering points
- Extremely low internal heat resistance
- Low TCR
- Negligible thermal EMF against copper (< 1  $\mu\text{V/K}$ )
- Large soldering and terminal surface
- High mechanical strength of solder joint



CLK / 0612

CLP / 1020

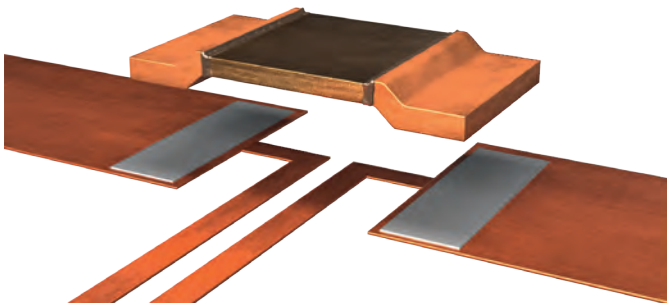


## SURFACE MOUNT ASSEMBLY (ISA-WELD®)

SMD resistors for high current applications

**Product series: BVx**

Sizes: 2512 / 3920 / 5930



### Features

- Up to 15 watts permanent power at 70 °C
- Very low resistance values
- Very good long-term stability
- Standard solder pad size
- Made from electron-beam welded composite material
- AEC-Q200 qualified

### Technical data

Resistance values	0.1 to 6.8 mOhm
Tolerance	1 %, 5 %
Temperature coefficient	<50 ppm/K (20 °C to 60 °C)
Applicable temperature range	-65 °C to +170 °C
Power rating	up to 15 W
Internal heat resistance	from 3 K/W
Insulation voltage	100 V
Inductance	<0.5 nH
Stability (nominal load) deviation	<0.5 % after 2000 h ( $T_K = 90\text{ °C}$ )
$T_K$ = Terminal temperature	<1.0 % after 2000 h ( $T_K = 120\text{ °C}$ )

### Advantages/user benefits

- 4-terminal connection on pc-board
- Suitable for soldering temperatures up to +350 °C/30 secs
- High power rating



BVT / 2512

BVS / 3920

BVE / 5930

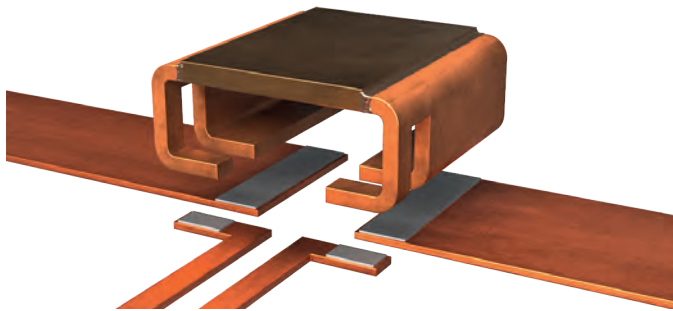


## SURFACE MOUNT ASSEMBLY (ISA-WELD®)

SMD resistors for high current applications

**Product series: BVx**

Sizes: 1216 / 2725 / 3812 / 3820 / 4026



### Features

- Up to 12 watts permanent power at 70 °C
- Very low resistance values
- Very good long-term stability
- Made from electron-beam welded composite material
- AEC-Q200 qualified

### Technical data

Resistance values	0.2 to 25 mOhm
Tolerance	1 %, 2 %, 3 %, 5 %
Temperature coefficient	from 20 ppm/K (20 °C to 60 °C)
Applicable temperature range	-65 °C to +170 °C
Power rating	up to 12 W
Internal heat resistance	from 3 K/W
Insulation voltage	100 V
Inductance	<3 nH
Stability (nominal load) deviation	<0.5 % after 2000 h ( $T_K = 90\text{ °C}$ )
$T_K$ = Terminal temperature	<1.0 % after 2000 h ( $T_K = 120\text{ °C}$ )

### Advantages/user benefits

- 4-terminal design
- Suitable for soldering temperatures up to +350 °C/30 secs
- High power rating
- Ideal for mounting on DCB/IMS substrate



BVN / 1216



BVB / 2725



BRS / 3812



BVH / 3820



BVR / 4026



BVZ / 4026



## SMD-MONTAGE (ISA-WELD®)

**Product series: WAx**

Sizes: 1206/ 1213



### Features

- Up to 7 watts permanent power at 70 °C
- Very low resistance values
- Very good long-term stability
- Standard solder pad size
- Made from electron-beam welded composite material
- AEC-Q200 qualified

### Technical data

Resistance values	0.5 to 1 mOhm
Tolerance	1 %, 5 %
Temperature coefficient	<70 ppm/K (20 °C to 60 °C)
Applicable temperature range	-65 °C to +170 °C
Power rating	up to 12 W
Internal heat resistance	6 and 12 K/W
Insulation voltage	100 V
Inductance	<0.5 nH, <3 nH
Stability (nominal load) deviation	<0.5 % after 2000 h ( $T_K = 110\text{ °C}$ )
$T_K =$ Terminal temperature	<1 % after 2000 h ( $T_K = 150\text{ °C}$ )

### Advantages/user benefits

- Current sensor for power hybrid applications
- Suitable for soldering temperatures up to +350 °C/30 secs
- High power rating with small design



WAF / 1213

WAK / 1206



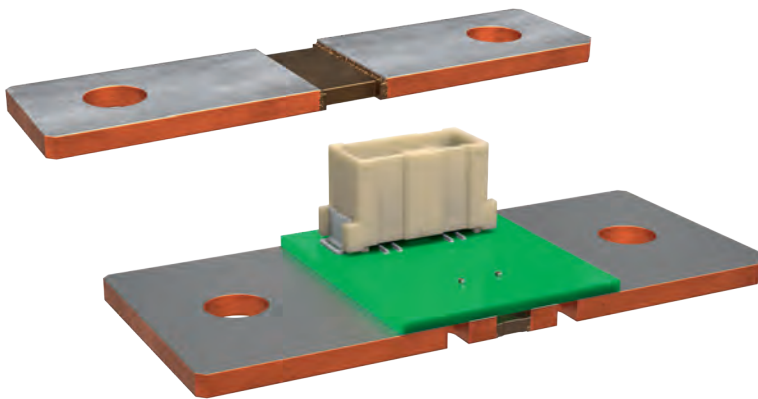


## BUS BAR MOUNTING

Bus bar components in composite material for high current applications

**Product types: *BAS / BAC / BSN / BAV / BAX / BAN / KVM / BAL***

Sizes: 8420 / 8436 / 3516 / 5216



### Features

- Up to 30 watts permanent power
- Low resistance current sensors
- Very good long-term stability
- Bus bar mounting
- Available with pins or PCB, tinned or untinned terminals
- AEC-Q.200 qualified

### Technical data

Resistance values	<i>0.005 to 0.1 mOhm</i>
Tolerance	<i>5%</i>
Temperature coefficient	<i>from 20 ppm/K (20 °C to 60 °C)</i>
Applicable temperature range	<i>-55 °C to +170 °C</i>
Power rating	<i>up to 50W</i>
Continuous current	<i>up to 1500 A</i>
Internal heat resistance	<i>from 0.6 K/W</i>
Inductance	<i>from 1 nH</i>
Stability (nominal load) deviation	<i>&lt;0.5 % after 2000 h (T<sub>K</sub> = 110 °C)</i>
T <sub>K</sub> = Terminal temperature	<i>&lt;1 % after 2000 h (T<sub>K</sub> = 140 °C)</i>

### Advantages/user benefits

- Current sensing in bus bars
- High permanent and pulse power rating
- High accuracy over lifetime
- Solderable and weldable



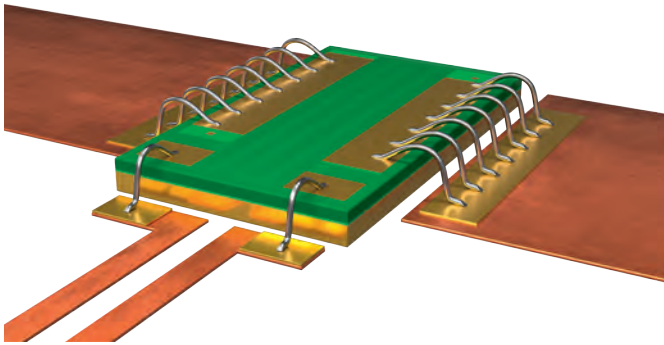


## HYBRID MOUNTING

Bondable resistors for high power applications

**Product series: PMH / PMH-D / PLU**

Sizes: 2512 / 2439



### Features

- Up to 5 watts permanent power
- Very good heat dissipation
- Mounting: soldering or adhesive bonding on substrate
- Bondable contacts
- AEC-Q200 qualified (PMH-D, PLU)

### Technical data

Resistance values	1 to 50 mOhm
Tolerance	0.5 %, 1 %, 5 %
Temperature coefficient	<30 ppm/K (20 °C to 60 °C)
Applicable temperature range	-65 °C to +170 °C
Power rating	up to 5 W
Internal heat resistance	from 4 K/W
Insulation voltage	100 V
Inductance	<2 nH
Stability (nominal load) deviation	<0.5 % after 2000 h ( $T_K = 120\text{ °C}$ )
$T_K =$ Terminal temperature	<1 % after 2000 h ( $T_K = 150\text{ °C}$ )

### Advantages/user benefits

- 4-terminal connection
- Direct DBC/IMS solder mounting
- Ni-plated/Au-plated bond pads
- High load capacity
- Extremely low internal heat resistance
- Bondable resistor



PMH-D / 2512

PMH / 2512

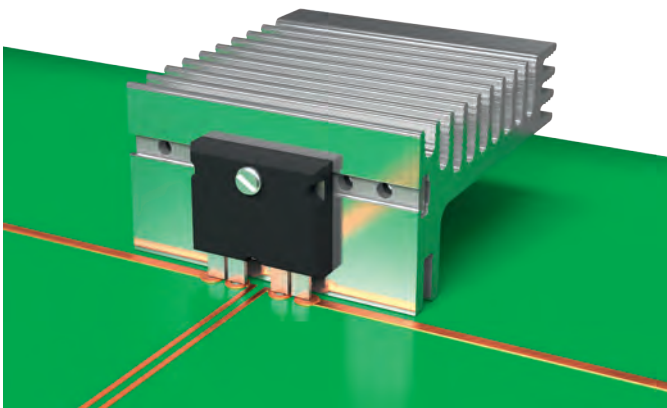
PLU / 2439



## PCB AND HEAT SINK MOUNTING

**Product types: PBH/PBV**

Sizes: TO-247 / 2317 (metric)



### Features

- Up to 10 watts permanent power
- Very low resistance values
- Very good long-term stability
- Very high pulse power rating
- Low self-heating

### Technical data

Resistance values	0.5 mOhm to 100 Ohm
Tolerance	0.5 %, 1 %, 5 %
Temperature coefficient	<30 ppm/K (20 °C to 60 °C)
Applicable temperature range	-55 °C to +125 °C
Power rating	up to 10 W
Internal heat resistance	from 3 K/W
Insulation voltage	<500 V
Inductance	from 10 nH
Stability (nominal load) deviation	<0.5 % after 2000 h ( $T_K = 70\text{ °C}$ )*
$T_K$ = Terminal temperature	
*with heat sink	

### Advantages/user benefits

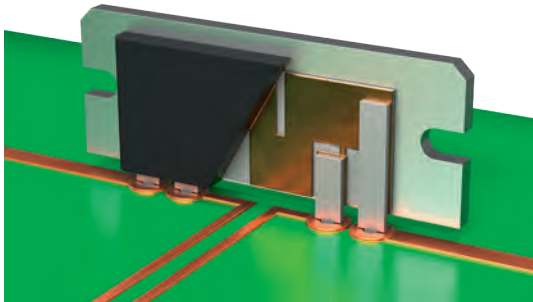
- 4-terminal connection (PBV)
- Suitable for soldering temperatures up to 350 °C/30 secs
- Heat sink mounting possible





## PCB AND HEAT SINK MOUNTING

**Product types: A-H/AZ-H**



### Features

- Up to 10 watts permanent power
- Very low resistance values
- Very good long-term stability
- Very high pulse power rating
- Low self-heating

### Advantages/user benefits

- 4-terminal connection
- Suitable for soldering temperatures up to 350 °C/30 secs
- Heat sink mounting possible
- Available from 3 ppm/K (AZ-H)

### Technical data

Resistance values	1 mOhm to 100 Ohm
Tolerance	0.1 %, 1 %
Temperature coefficient	from 3 ppm/K (20 °C to 60 °C)
Applicable temperature range	-55 °C to +140 °C
Power rating	up to 10 W
Internal heat resistance	<3 K/W / 15 K/W
Insulation voltage	500 V AC/DC
Inductance	<10 nH
Stability (nominal load) deviation	<0.1 % after 2000 h ( $T_K = 80 °C$ )*
$T_K =$ base plate	<0.2 % after 2000 h ( $T_K = 95 °C$ )*

\*with heat sink

**Product type: RUG-Z**



### Features

- Up to 250 watts permanent power (RUG-Z)
- Insulation voltage 500 V AC
- For highest currents and precision
- High pulse power rating up to 50 J (RUG-Z)
- Extremely low TCR

### Advantages/user benefits

- 4-terminal connection
- Optimised heat dissipation
- DAkkS calibration possible

### Technical data

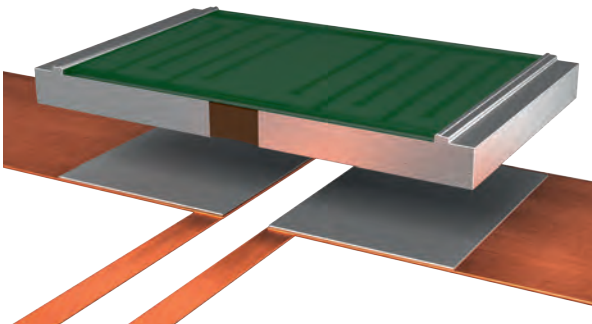
Resistance values	0.5 mOhm to 100 Ohm
Tolerance	0.1 %, 1 %
Temperature coefficient	from 1 ppm/K
Applicable temperature range	-55 °C to +110 °C
Power rating	up to 250 W
Internal heat resistance	<0.1 K/W
Insulation voltage	500 V AC
Inductance	<10 nH
Stability (nominal load) deviation	<0.2 % after 2000 h
$T_K =$ Terminal temperature	( $T_K = 85 °C$ )



## AVIATION & AEROSPACE

**Product types: SMP/SMS/SMT/SMV**

Sizes: 2010 / 2512 / 2817 / 4723



### Features

- ESCC 4001/027 for aerospace applications
- ESCC 4001/028 for aerospace applications
- Customer-specific qualification

### Quality

- SnPb tinning of the contacts
- Certificate according to TS 16949 / ISO 9001
- 100 % control
- Clearly retraceable due to gapless documentation
- Date code labeling

### Solderability

- Processable in all common soldering processes (Reflow-, IR-soldering)
- ISA-WELD® processable up to +350 °C (1 min.)
- ISA-PLAN® processable up to +260 °C (peak)

### Value range

- E6/E12/decadic values, depending on the type
- Further values on demand

### Technical data SMP / SMS / SMT

Resistance values	3 mOhm to 2 Ohm
Tolerance	0.5 %, 1 %
Temperature coefficient	<50 ppm/K
Applicable temperature range	-55 °C to +170 °C
Power rating	1 / 2 / 3 W
Internal heat resistance	from 13 K/W
Insulation voltage	200 V
Inductance	<3 nH
Stability (nominal load) deviation	<0.2 % after 2000 h
T <sub>K</sub> = Terminal temperature	(T <sub>K</sub> = 120 °C)

### Technical data SMV

Resistance values	3.3 mOhm to 1 Ohm
Tolerance	0.5 %, 1 %
Temperature coefficient	<30 ppm/K
Applicable temperature range	-55 °C to +140 °C
Power rating	3 W
Internal heat resistance	<20 K/W
Insulation voltage	1,000 V
Inductance	<10 nH
Stability (nominal load) deviation	<0.2 % after 2000 h
T <sub>K</sub> = Terminal temperature	(T <sub>K</sub> = 80 °C)



























SMP / 2010

SMS / 2512

SMT / 2817

















SMV / 4723

# PRODUCT OVERVIEW ISA-PLAN®

Type	Mounting method	Series	Size	Parts per reel	Resistance value [mΩ]								Rated power at 70°C			
					0.01	0.1	1	10	100	1 000	5 000	100 000				
ISA-PLAN®	SMD	FMK		1206	12 500			2	6							1 – 3.5 W
		FMP		2010	12 500			2	6							2 – 3.5 W
		FMS*		2512	9 000			2	6							1.5 – 4 W
		SMK		1206	12 500				8	500						1 W
		SMP		2010	10 000				5	1 000						3 W
		SMS		2512	5 000				5	1 000						5 W
		SMT		2817	5 000				4	4 700						5 – 7 W
		CLK*		0612	10 000				3	5						3 W
		CLP*		1020	10 000				3	5						5 W
		VLK		0612	10 000				1	5						3 W
		VLP		1020	10 000				3	6						5 W
		VMI		0805	15 000					10	100					0.65 – 1.1 W
		VMK		1206	12 500					10	470					1.5 W
		VMP		2010	12 500					5	1 000					3 W
		VMS		2512	9 000					5	1 000					4 W
		GMP		2010	12 500					10	80					1 W
		CMK		1206	12 500					10	100					1.25 W
		CMP		2010	12 500					10	500					2 W
		CMS		2512	9 000					10	500					2.5 W
		THT & Heat sink		PBV		2317 (metric)				0.5	1 000					
RUG-Z				7056 (metric)				0.5	100 000						250 W	
A-H				4618/3825 (metric)					1	5 000					3 – 10 W	
AZ-H				4618/3825 (metric)						2	5 000				3 – 10 W	
PBH				TO-247						2	100 000				3 – 10 W	

\*Preliminary version

# PRODUCT OVERVIEW ISA-WELD®

Type	Mounting method	Series	Size	Parts per reel	Resistance value [mΩ]								Rated power at 70°C			
					0.01	0.1	1	10	100	1 000	5 000	100 000				
ISA-WELD®	Bus-Bar	BAX 	8436 (metric)	2 000	0.005	0.02									40 – 50 W	
		BAN 	8436 (metric)		0.025											36 W
		BAS 	8420 (metric)		0.035	0.5										10 – 36 W
		BAV* 	8420 (metric)		0.035	0.1										36 W
		BAC 	8420 (metric)		0.05	0.1										10 – 36 W
		KVM 	3516 (metric)		0.05	0.1										7 W
		BAL 	5216 (metric)			0.1										12 W
	SMD	BVE 	5930	2 000	0.1	3									4 – 15 W	
		BVS 	3920	3 000	0.2	5									5 – 12 W	
		BVT 	2512	5 000	0.3	6.8									2 – 6 W	
		BVR 	4026	1 400	0.2	3									5 – 12 W	
		BVB 	2725	1 400	0.2	5									3 – 12 W	
		BVN 	1216	3 000	0.3	3									3 – 10 W	
		BVZ 	4026	1 400	0.5	3									5 – 13 W	
		WAF 	1213	5 000	0.487	1									6 – 7 W	
		WAK 	1206	12 500	0.5	1									6 W	

\*Preliminary version

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PROVIDED BY



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Innovation by Tradition

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