

## BUILDING ON INNER QUALITY



PRECISION MEASUREMENT // PRECISION AND POWER RESISTORS // PRECISION ALLOYS



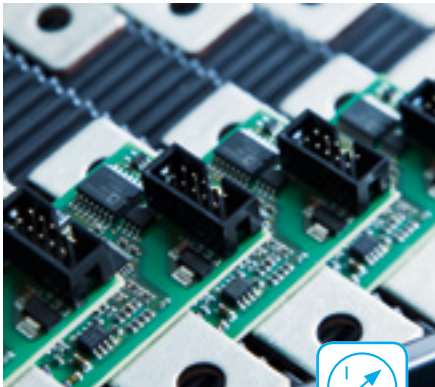
**ISABELLENHÜTTE**

Innovation by Tradition

Our company is one of the world's leading manufacturers of electrical resistance and thermoelectric alloys for temperature measurement and a well known manufacturer of passive components for the automotive, electrical and electronics industries. Precision measurement systems from Isabellenhütte set the industry benchmark for current, voltage and temperature measurement in cars and trucks, hybrid and electric vehicles, as well as in industrial and renewable energy generating systems.

As a globally renowned specialist and technology leader, our innovative products consistently redefine the state of the art while showcasing Isabellenhütte's technical and innovative capabilities. Our success is driven by the continuous development of innovative products, new technologies and sophisticated manufacturing processes. In addition, we concentrate on a wide range of production steps and proprietary technologies in-house. This ranges from the production of alloys as well as forming and separating to coating and stranding for both standard and customer-specific requirements.

### **Innovation by Tradition**

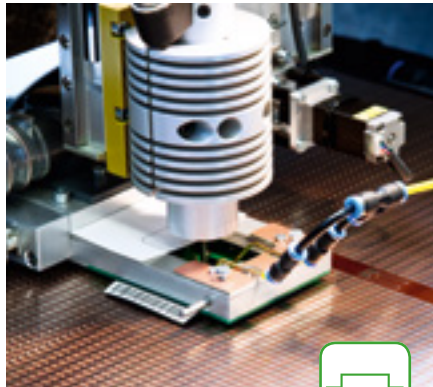


---

### Precision Measurement

The ultimate in precision – ISAscale® and ISA-ASIC technology // With our innovative products and technologies, we are one of the world's leading providers of advanced solutions in current, voltage and temperature measurement.

// 06



---

### Precision and power resistors

Appreciated and preferred everywhere – ISA-PLAN® and ISA-WELD® // Our resistors have a number of unique features that make them indispensable as current sensors in a wide range of automotive and industrial applications.

// 08



---

### Precision Alloys

A wealth of possibilities – precision alloys // Exceptional quality individually tailored to specific customer requirements.

// 12

---

### Research & development // 15

Pioneer and technology leader – the continuous improvement of existing products, technologies and production processes, combined with ongoing innovation, is an essential part of our day-to-day operations.

---

### Our people // 16

Innovation, quality, expertise – our employees are the basis of our success.

**Royal seal of approval**  
 Our logo honours our historic namesake:  
 Princess Isabella Charlotte of Nassau



## TRADITION IS ABOUT MORE THAN JUST EXPERIENCE

Our heritage is extremely important to us. Which is natural, given our long and eventful history. The first documented reference to the “Kupferhütte auf der Nanzenbach” (copper smelter in Nanzenbach) dates from 1482. In 1728 we acquired our current name, and have been in the ownership of the Heusler family since 1827. This extraordinary history makes us the oldest industrial concern in the state of Hesse – yet also one of the most modern.

From those early roots in copper smelting more than 500 years ago, we’ve grown into a high-tech manufacturer of global renown. Today, we’re one of the world’s leading producers of thermoelectric and resistance alloys, as well as low-ohmic precision and power resistors. In addition, Isabellenhütte sets the same high standards in precision measurement technology.

**Made in Germany.** Despite being a global technology leader, we have remained loyal to our roots in Dillenburg. Not just for reasons of tradition, though. For a company such as ours, with enormous expertise in both design and manufacturing, Germany remains a highly attractive location – not least when it comes to maintaining our competitive edge. Our headquarters in Dillenburg is home to possibly one of the most unique value chains anywhere in the world. Every stage of production is concentrated here, from the foundry, rolling mill and wire-drawing shop to the manufacturing of finished components and highly sophisticated measurement modules. With development, quality management and assurance, as well as technical expertise, all entirely in our own hands, we can ensure the highest quality standards.

### Locations

Dillenburg

### Subsidiaries

2013 China

2012 Japan

2010 USA



**1482**  
 First recorded reference to the “Kupferhütte auf der Nanzenbach”

**1728**  
 Name changed to “Isabelle Kupferhütte”

**1827**  
 Ownership of ISABELLENHÜTTE passes to the Heusler family



**1889**  
 MANGANIN® alloy developed

**1952**  
 Establishment of thermoelectric alloy division

**1955**  
 Establishment of separate resistance alloy and thermoelectric alloy divisions



## CONTINUOUS IMPROVEMENT IS OUR GOAL

To achieve that goal, we've developed a simple formula: traditional values combined with state-of-the-art production methods and a commitment to innovation. As part of the associated philosophy, we keep a high percentage of manufacturing processes in-house. This makes production more flexible and independent, enabling us to guarantee the best possible product quality.

Our products are developed and manufactured in compliance with mandatory quality objectives and value standards that are documented internally and externally. By consistently improving every aspect of our operations, we've successfully established and consolidated our position as a technological pioneer. An important factor in this respect is our continuous investment in research, development and production technologies.

Being proactive, not reactive, is crucial in what we do. It's also the reason why research and development have always been so central to our business. As a result, we're able to create innovative new products and remain a pioneering force and technology leader in each of our market segments. Naturally, our customers are always the focus of our R&D activity, with specific customer requirements often being the inspiration for new and innovative products.

In keeping with the value we place on tradition, we're committed to developing long-term relationships with our partners, our suppliers and, above all, our employees. Our strengths are innovation, superior technology, exceptional product quality, specialist expertise and solution capabilities – none of which would be possible without our employees.

### Quality standards

DIN EN ISO 9001:2008

DIN EN ISO TS 16949:2009

DIN EN ISO 14001/

DIN EN ISO 50001

RoHS 2011/65/EU

Authorised Economic Operator (AEO)

AEO-F certificate

(Customs simplifications/ security and safety)

European Space Agency (ESA)



Calibration Laboratory

Accredited by

DIN EN ISO/IEC 17025:2005



Deutsche  
Akkreditierungsstelle  
D-K-19500-01-00



**1978**  
Establishment of components division



**1987**  
Development and production of world's first SMD mOhm precision current-sensing shunt using ISA-PLAN® technology

**1992**  
Introduction of ISA-WELD® series

**2004**  
Series production deployment of ISA-ASIC in battery management systems

**2008**  
Establishment of ISAscale® precision measurement division



**2014**  
Opening calibration authority DAkkS, Set-up pilot plant for small-scale alloys orders



**Precision Measurement applications:**  
Automotive battery management systems  
Industrial drive systems  
Renewable energy  
Energy supply and distribution  
Uninterrupted power distribution

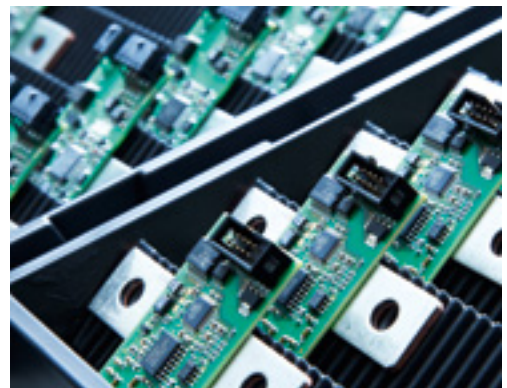


“Our modular design system enables us to create customised solutions for current, voltage and temperature measurement applications in time and affordably.”



## BEHIND THE SCENES WE PLAY A MAJOR ROLE

Renowned for our expertise in the field of precision measurement in high-current applications, Isabellenhütte has for many years been a leading global producer of state-of-the-art measuring systems. Our pioneering role is based on decades of experience, combined with a commitment to improving every aspect of our business in every project and task we undertake. This enables us to offer our customers the ultimate in precision, in keeping with our tradition of superior technology.



*Sensor module on ESD rack prior to calibration*

### **ISAscale®**

ISAscale® is our brand name for precision measurement systems offering ultra-high performance. Our commitment to exceptional precision is uniquely combined here with easy operation and a high degree of variability. As well as providing more accurate data, ISAscale® systems enable the use of more efficient control algorithms.

### **ISA-ASIC**

In 2002, we became the first company in the world to enable high-precision measurement of current, voltage and temperature in an automotive battery management system, with our ISA-ASIC product. The four-channel measuring system has 16-bit resolution and features zero offset, ultra-low noise and high linearity. Combined with our ISA-WELD® resistors made from MANGANIN® or ZERANIN® it is possible to determine key battery data such as state of charge (SOC) and state of health (SOH) with impressive accuracy.

### **Applications**

The unique metrological characteristics of our products make them ideal not only for automotive applications but also for many other measuring tasks, e.g. energy management or general current measurement. From control systems for all types of high-performance electric drives, custom configurations in measurement systems or components in solar and wind-power installations, our modules fulfil the highest expectations and consistently redefine the state of the art.





“We bring physics to the marketplace in the form of components that perform in the ppm range.”



## ULTIMATE PERFORMANCE WHERE IT'S LEAST EXPECTED – IN EVERY DETAIL

With our combination of specialist expertise and many decades of experience, we can offer our customers solutions with the highest quality standards. From SMD shunts and resistors made from electron-beam welded composite material to heavy-duty power resistors, our products meet even the toughest requirements with regard to temperature coefficient (TCR), long-term stability, inductance and power rating. These characteristics are influenced not only by the choice of resistance material, but also by resistor design. For this reason, we've created two very different manufacturing technologies: ISA-PLAN® and ISA-WELD®.



*Laminating resistor substrates in cleanroom*



*Plating process in new panel plating shop*

### ISA-PLAN®

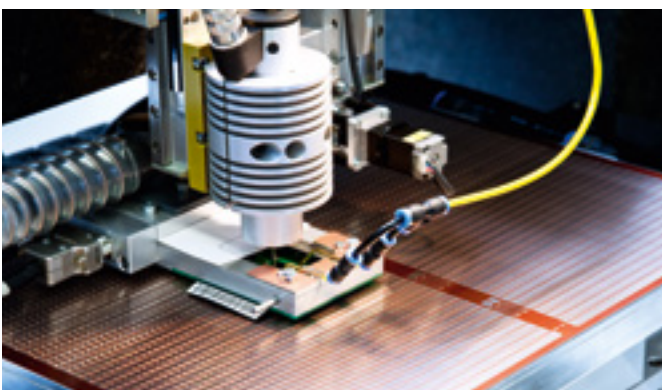
ISA-PLAN® resistors are manufactured from etched MANGANIN® or ZERANIN® foils, electrically insulated and mounted on a metal substrate with good thermal conductivity. The resistance materials have low temperature coefficients of less than 10 ppm/K and are thermoelectrically matched to the copper, thereby reducing the thermoelectric voltage to almost zero. In addition, the heat conduction into the substrate, together with its high thermal capacity, provides excellent pulse and continuous power rating.

### ISA-WELD®

ISA-WELD® resistors are stamped from solid electron-beam welded composite materials consisting of copper in combination with one of our resistance alloys, e.g. MANGANIN®, ZERANIN® or ISAOHM®. This process is very flexible and offers a wide range of options in terms of both design and production. The thickness and width of the bands are variable, as are the resistance materials. The resistors can be adapted by means of stamping and bending to suit almost any shape and application. Current density distribution within the components is optimised to prevent hot spots.

Other benefits include the relatively low termination resistance of the copper connections, their high thermal conductivity and thermal capacity, and the resulting uniformity of both current density and heat distribution in the resistor. The exceptionally high pulse and continuous load capacity is due to the high mass of the resistance material.

*Step-and-repeat trimming of resistors on manufacturing substrates*



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



“Every car produced in Europe has at least one of our resistors on board. AEC-Q200 qualified, of course.”

## Applications

Our precision and power resistors are always in demand wherever customers require quality that not only complies with industry standards but can also meet exceptional requirements.

Both ISA-PLAN® and ISA-WELD® offer low TCR values, low thermoelectric voltage, high long-term stability and high power rating.

They can therefore be used in a very wide range of applications. The automotive industry in particular utilises our products in many different vehicle systems. Other important sectors include industrial and power electronics, power drive engineering, energy measurement, telecommunications equipment and medical technology. In fact, wherever low-impedance resistors are required for precision current-sensing applications, Isabellenhütte is always the number one choice. Our resistors are crucial for numerous applications in industrial and power electronics, in domestic appliances and in telecommunications devices such as mobile phone base stations and power supplies.

In power drive engineering, our products can be found in devices such as frequency converters, high-current actuators, power modules and precharge resistors in power supply units.

In the automotive industry, many well-known systems and technologies have either been made possible or improved with the aid of our precision resistors and their accurate current-sensing properties. Examples include engine management, fuel injection, driver assistance and energy management systems. In addition, our products are virtually indispensable in many more fundamental vehicle systems, e.g. ignition, lights, water pump, transmissions and modern locking systems.



<b>Selected automotive applications:</b>	
<b>Automotive</b>	ABS (anti-lock braking system)
	ASR (anti-slip regulation)
	ACC (adaptive cruise control)
	EPS (electric power steering)
	Brake-by-wire
	BMS (battery management system)
	Cat control unit
<b>Diesel/petrol injection</b>	Diesel/petrol injection
<b>Electronic steering</b>	EPHS (electrically powered hydraulic steering)



“We cater to individual customer requirements and can supply our products in the form of regular wires, stranded wires, bands, flat wires, rods, tubes and more.”



## FROM HIDDEN DEPTHS COMES UNEXPECTED POWER

When competing with other products, it often comes down to the wire – which is where we excel. Our alloys rank among the finest in the world and are used in many areas of both electronics and electrical engineering. We are happy to cater to individual customer requirements and can supply our alloys in the form of regular wires, sheets, stranded wires, bands, flat wires, tubes, rods and foils.



*All our alloys are made from nonferrous metals, e.g. Cu, Ni, Mn, Si, Cr, Al, Sn and Co*



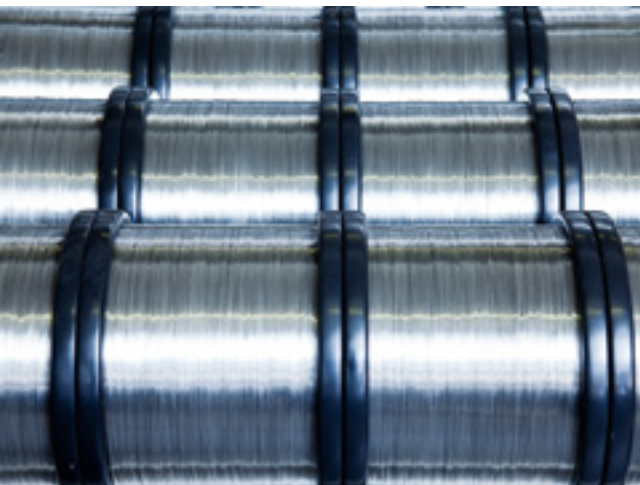
*Casting molten alloy*

### Precision alloys

Our precision alloys are made to the most exacting tolerances and in compliance with all national and international standards. The result is exceptionally high quality. What's more, the range of available alloys is very wide. We can also accommodate individual requirements, with the customer choosing the form in which each product is supplied. Here the possibilities are virtually unlimited and include soft annealed wires (bare or insulated), soft annealed flat wires and bands, and stranded wire with standard or customer-specific structure.

**Applications**

Our resistance materials and heating wires are used in many areas of electronics and electrical engineering. Our customers come from a range of industries, including automotive, aerospace, petrochemicals, instrumental analysis, process engineering, railways and control technology. All of them rely on our high-quality products and the security and reliability they provide. Our ultra-high performance heating components include wires, cables, bands, tubes and leads. In addition, you'll find our thermoelectric alloys in power generation as well as numerous metal-processing plants. They are used in the production of thermocouples, mineral-insulated thermocouples, dip sensors, quick cups for carbon testing in cast-iron melts, trailing thermocouples, pilot light fuses, plug connectors, metallic Peltier elements and many other applications.



*Bringing physics to the marketplace, e.g. precision fine wire down to 0.007 mm*

<b>Typical applications:</b>	
Compensation leads	Circuit breakers
Strain gauges	Signal lines
Level sensors	Seat heaters
Floor heating systems	Plug connectors
Coiled filaments	Tank container heating systems
Hard solders	Thermocouples
Heating cables	Thermoelectric leads
Heated hoses	Airfoil de-icers
Mineral-insulated wires	Resistors
Quick cups	Resistance thermometers
Rail heating systems	Ignition and lighting systems

**Calibration Laboratory for Germany's National Accreditation Body**

Our calibration laboratory is another important customer service and a further example of our commitment to quality. One of the first to be accredited by the German Calibration Service (Deutscher Kalibrierdienst [DKD]), our laboratory guarantees consistent quality standards. It is certified for electrical (resistance, voltage, current) and thermal (temperature) measurements by Germany's national metrology institute, the Physikalisch-Technische Bundesanstalt (PTB) in Berlin and Braunschweig. As such, it is subject to continuous monitoring by the PTB and the DAkkS.

1889

MANGANIN®

1967

ZERANIN®

1987

World's first low-impedance SMD resistor featuring ISA-PLAN® technology

1990

Resistor for overall current measurement in vehicles

1992

ISA-WELD® technology

1993

First 20-Watt SMD resistor for power hybrids

1994

SMx series – premium resistors in sizes 1206, 2010, 2512, 2817

1996

Production of first electrical kWh meter module with integrated shunt

1998

Battery current sensor consisting of 100- $\mu$ Ohm shunt with integrated electronics

2002

First fully integrated 16-bit measured value acquisition system for electronic battery management systems in cars and trucks

2004

2- $\mu$ Ohm coaxial resistor for measuring extremely high currents

2005

USB precision measuring device for temperature and resistance ( $\mu$ Ohm meter) based on ISA-ASIC

2007

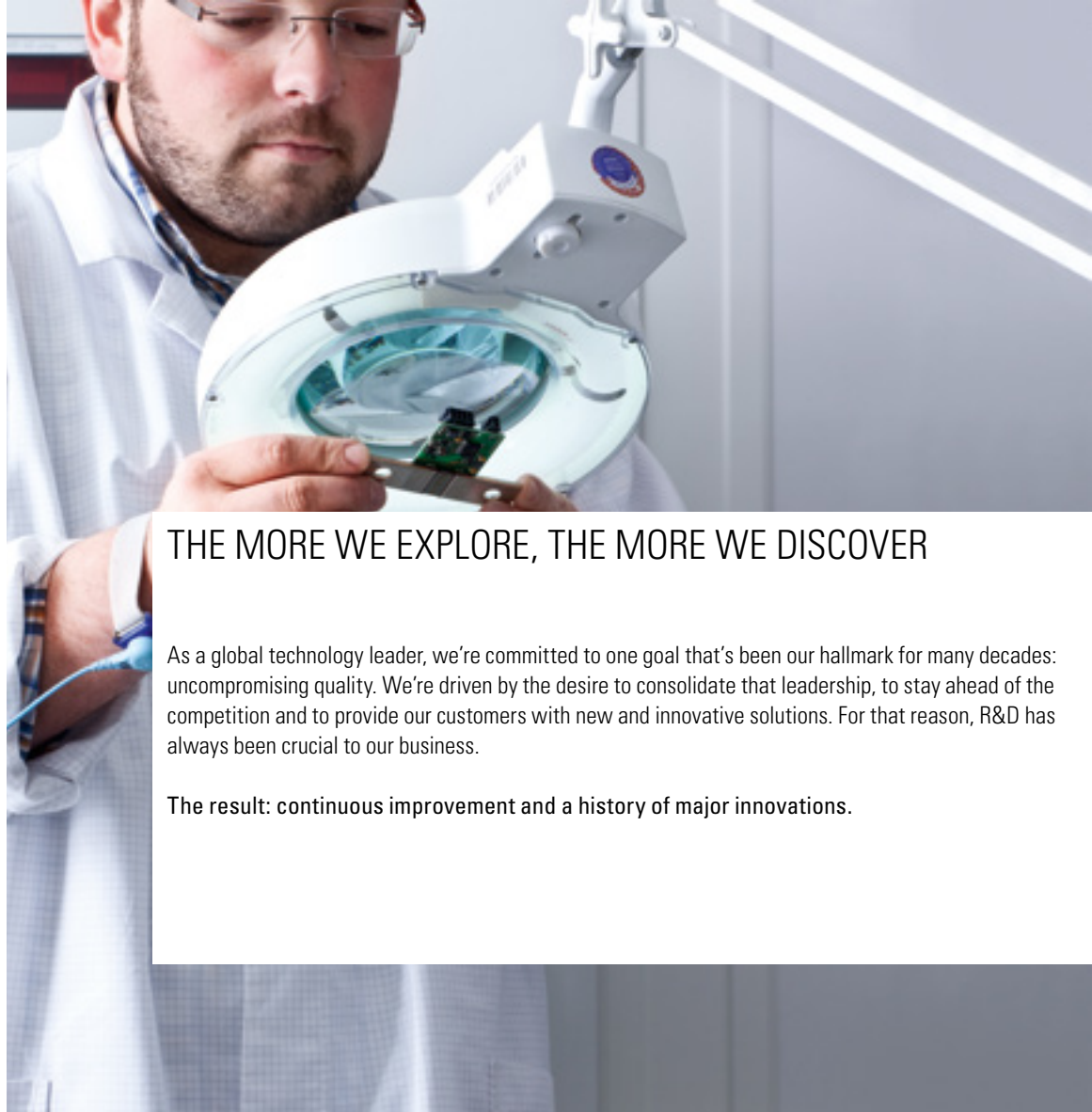
VMx series – cost-optimised premium resistors in sizes 0805, 1206, 2010, 2512

2008

ISAscale® series – precision measurement systems for current, voltage and temperature

2014

Set-up pilot plant for small-scale alloys. Product development ISA-CON® and NOVENTIN®



## THE MORE WE EXPLORE, THE MORE WE DISCOVER

As a global technology leader, we're committed to one goal that's been our hallmark for many decades: uncompromising quality. We're driven by the desire to consolidate that leadership, to stay ahead of the competition and to provide our customers with new and innovative solutions. For that reason, R&D has always been crucial to our business.

**The result: continuous improvement and a history of major innovations.**

*Progress makes us better every day.*



*Progress also stands for stability.*



*Progress means constantly developing further.*



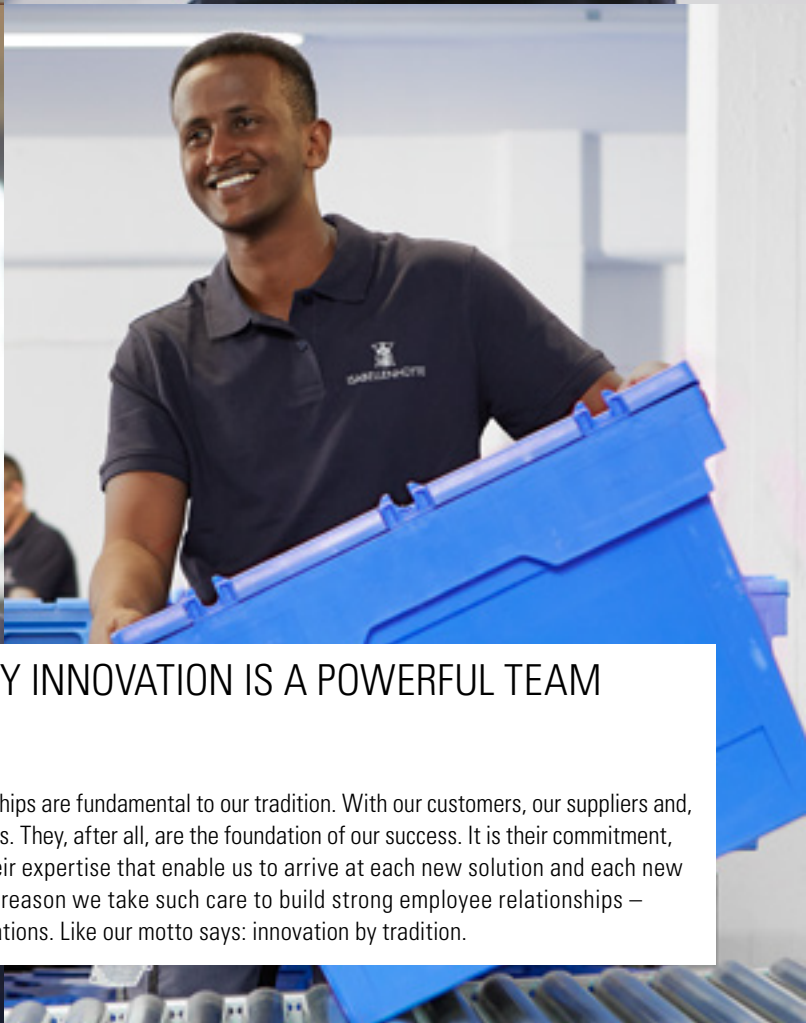
*Progress brings the world together.*



*Progress develops future perspectives.*



*Progress creates new paths.*



## BEHIND EVERY INNOVATION IS A POWERFUL TEAM

Long-standing relationships are fundamental to our tradition. With our customers, our suppliers and, above all, our employees. They, after all, are the foundation of our success. It is their commitment, their creativity and their expertise that enable us to arrive at each new solution and each new innovation. That's the reason we take such care to build strong employee relationships – sometimes over generations. Like our motto says: innovation by tradition.

*Progress produces unique opportunities.*

*Progress creates possibilities where none existed.*



# ISABELLENHÜTTE

Innovation by Tradition

Isabellenhütte Heusler GmbH & Co. KG  
Eibacher Weg 3-5 · 35683 Dillenburg · Germany  
P.O. Box 1453 · 35664 Dillenburg · Germany  
Tel +49 (0)2771 934-0 · Fax +49 (0)2771 23030  
info@isabellenhuetten.de · www.isabellenhuetten.de