

Innovation in Motion



Miba Power Electronics Group

Your Partner for Resistors and Heat Sinks



Markets and Customers
Facts & Figures
Products & Technologies


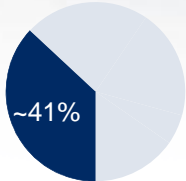

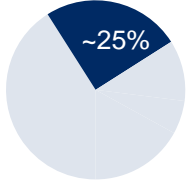

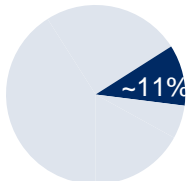

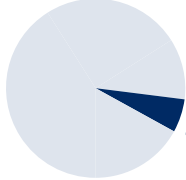

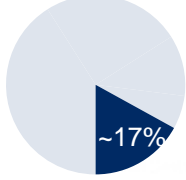
Markets and Customers

Miba Power Electronics Group

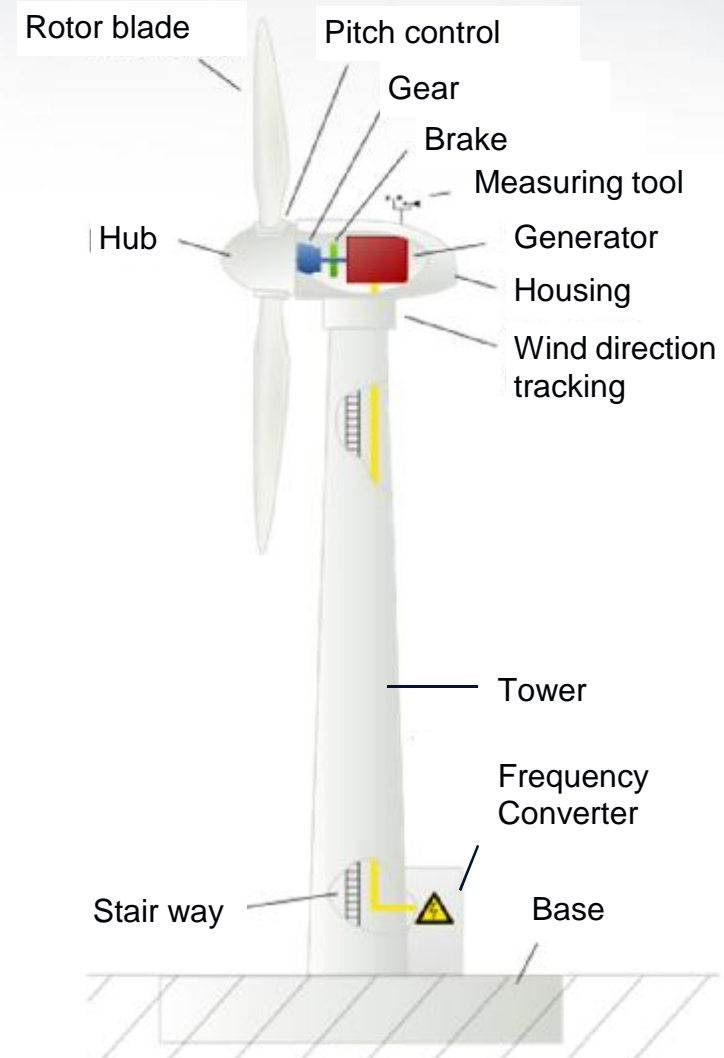
Market Segments Power Electronics Group

Innovation in Motion



| Market Segment | Applications | Share PEG |
|---|--|---|
|  Industrial | Motor drives Power supplies (welding, melting, laser) |  ~41% |
|  Energy | Power generation, UPS Renewables (wind, PV) Transmission/distribution (HVDC) Grid stability |  ~25% |
|  Mobility | Traction (urban, locomotives) Aerospace Electric vehicle Marine |  ~11% |
|  Medical | X-Ray, MRI, CT |  ~6% |
|  Others | HF/RF Power supplies Instrumentation Telecom networks |  ~17% |

Frequency Inverters for Wind Turbines



Frequency Inverters

For PV Applications and Solar Plants

Energy Transmission & Distribution



Energy Transmission & Distribution

(HGÜ / HVDC)



| Project | Yunnan - Guangdong |
|----------|---------------------------|
| Customer | China Southern Power Grid |
| Power | 5.000 MW |
| Voltage | 525kV 50Hz; 800kV DC |
| Distance | 1.418 km |



= 4 Nuclear Power plants @ 1.25 GW

= 1,000 Wind turbines @ 5 MW

Industrial Power Supplies



Welding

Large applications



Melting

Large Electrical Motors



Pumps



Paper mills



Steel mills

Electrical and Hybrid Vehicles

Resistors for Powertrain and Battery Management Systems

Innovation in Motion



Frequency Inverters for Traction



Aerospace Applications

(e.g. Emergency Power Supplies, Lightning Protection)

Innovation in Motion



Medical Applications



HF-/RF Power Supplies



Power Electronics Customers



Facts & Figures

Miba Power Electronics Group

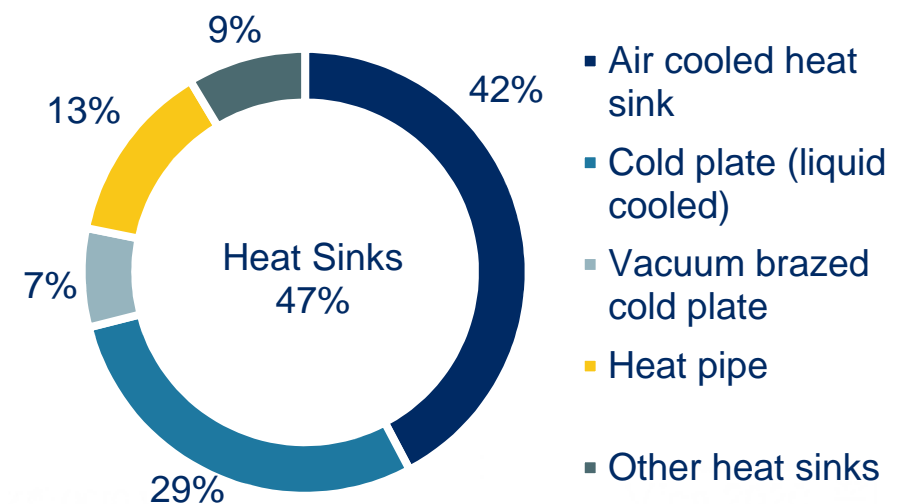
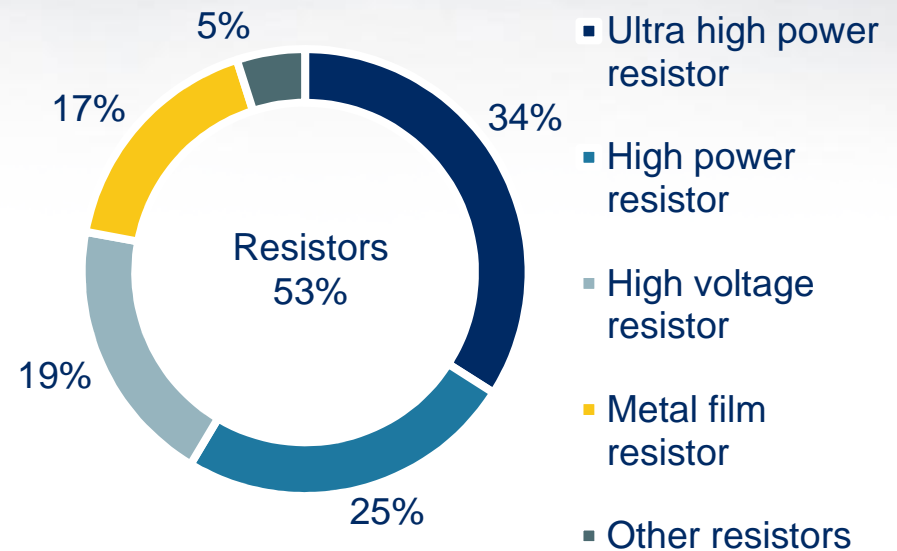
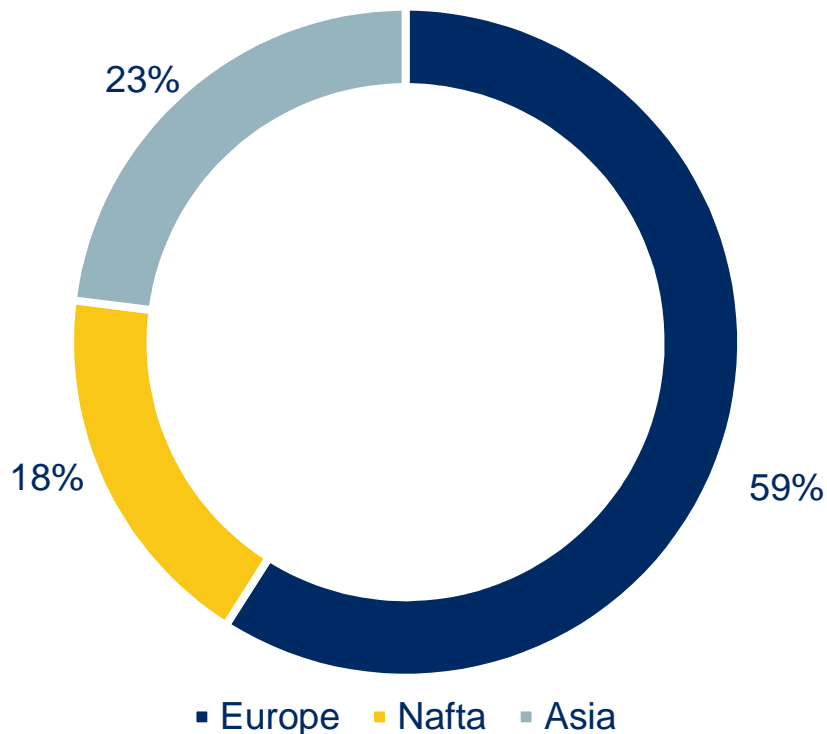
Sales Power Electronics

BY 2015/16 in %

Innovation in Motion



BY 2015-16: 52.7 Mio. € (+13%)



Organization & Brands



| Miba Power Electronics Group Miba Energy Holding (AT) | | |
|---|---|---|
| Michael Niedersuess (General Manager) Raimund Ratzi (Head of R&D) Sarah Trippacher (Group Controlling) Martina Dellarosa (Human Capital) | | |
| DAU (AT) Martin Reisner (Head of Operations DAU Group) | EBG (AT) Alois Klein | EDMS (SI) Radko Luzar |
| DAU Thermal Solutions North America (US) Kevin Kreger | EBG Resistors LLC (US) Sales & Engineering Office Tom Zimmerman | |
| | EBG Shenzhen (CN) Frank Wang (General Manager) Xiuying Yan (Deputy GM) | |
|  A Miba Group Company |  A Miba Group Company |  A Miba Group Company |

Global Network

Innovation in Motion



Close to our Customer

We Develop and Produce for our Customers Worldwide

Innovation in Motion



EBG Elektronische Bauelemente

Kirchbach and Production Site St. Stefan, Austria

Innovation in Motion



Employees: 97 (Sep16)

Founded in 1977, member of Miba Group since 2010

- Sales
- R&D
- Application engineering
- Full production of sophisticated resistors

Products

- High voltage resistors
- Power resistors (mounted to heat sink)
- Ultra high power resistors
- Voltage dividers
- Shunts
- Metal film

Quality Certificates

EN ISO 9001: 2008

ISO 14000 Certification in preparation

EBG Shenzhen

Shenzhen, Guangdong, China

Innovation in Motion



Employees: 224 (Sep16)

Founded in 1988, member of Miba Group since 2010

- Sales
- Application engineering

Products

- High precision metal films
- High voltage networks
- Power resistors

Quality Certificates

EN ISO 9001: 2008

EBG Shenzhen is a 55% joint venture of Miba

EBG Resistors LLC

Middletown, PA, USA

Innovation in Motion



Founded in 1992, member of Miba Group since 2011

- Sales
- Application engineering

Products

- High voltage resistors
- Power resistors (mounted to heat sink)
- Ultra high power resistors
- Voltage dividers
- Shunts
- Metal film

American sales office covering

- USA
- Canada and Mexico
- South America



www.ebg-us.com

A Miba Group Company

Miba Power Electronics Group



DAU

Ligist, Austria

Innovation in Motion



Employees: 78 (Sep16)

Founded in 1970, member of Miba Group since 2010

- Sales
- R&D
- Application engineering
- Full production of complex thermal products

Products

- Thermal solutions for power electronics
- Air cooled heat sinks, liquid cooled heat sinks, vacuum brazed heat sinks, heatpipes and systems for high thermals performance, high power LED applications, heat exchangers, bus bars, etc.

Certificates (Quality & Environment)

EN ISO 9001:2008

EN ISO 14001:2004

DAU Thermal Solutions North America

Macedon, NY, USA



Employees: 39 (Sep16)

Founded in 2011

- Sales
- R&D
- Application engineering
- Full production of complex thermal products
- Thermal modeling
- High speed in house machining capabilities

Products

- Thermal solutions for power electronics
- Air cooled heat sinks, liquid cooled heat sinks (bonded fin, hybrid, copper, extruded), heatpipes, bus bars

Quality Certificates

- ISO 9001: 2008
- AS9100: 2009
- ITAR (International traffic in arms regulations) registered



EDMS

Šentjernej, Slovenia

Innovation in Motion



Employees: 40 (Sep 16)

Founded in 1988, member of Miba Group since 2010

- Production of resistors
- Production of heat sinks, cold plates and heat pipes

Products

- Power resistors (mounted to heat sink)
- Ultra high power resistors
- Air cooled heat sinks
- Liquid cooled heat sinks
- Heat pipes
- Bus bars

Quality Certificates

EN ISO 9001: 2008

ISO 14001 – in preparation

EDMS is a 49 % joint venture of Miba

Products & Technologies

Miba Power Electronics Group

Specialist in High Performance Resistors



EBG develops and produces precision **high-voltage** and **high-power resistors**.

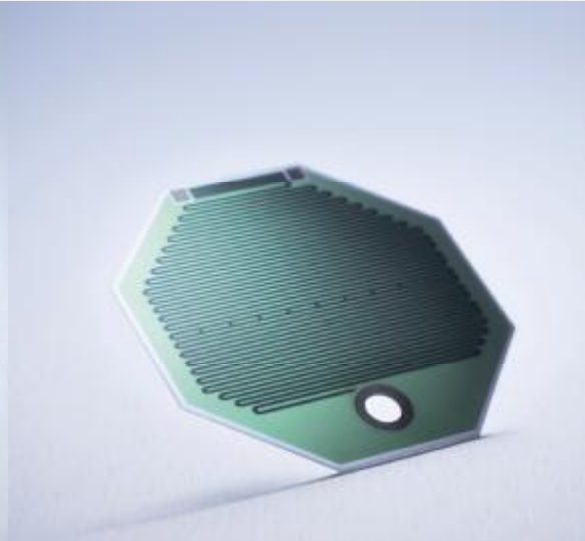
In development, EBG particularly focuses on **saving installation space** while at the same time **increasing performance**

EBG's Resistors offer

- Very low and controlled temperature and voltage coefficients
- High load capability
- High stability
- High temperature operations and
- Very tight tolerances
- Embedded intelligence



Specialist in High Performance Resistors



The product portfolio includes

- **High voltage** resistors, e.g. for medical devices (up to 100kV in air)
- **High power** resistors, e.g. for frequency converters (up to 1700W, direct cooled version)
- **High precision** resistors, e.g. for measurement devices (0.1%, 5 ppm stability)



Ultra High Power Resistors

Electric Protection of Semiconductors

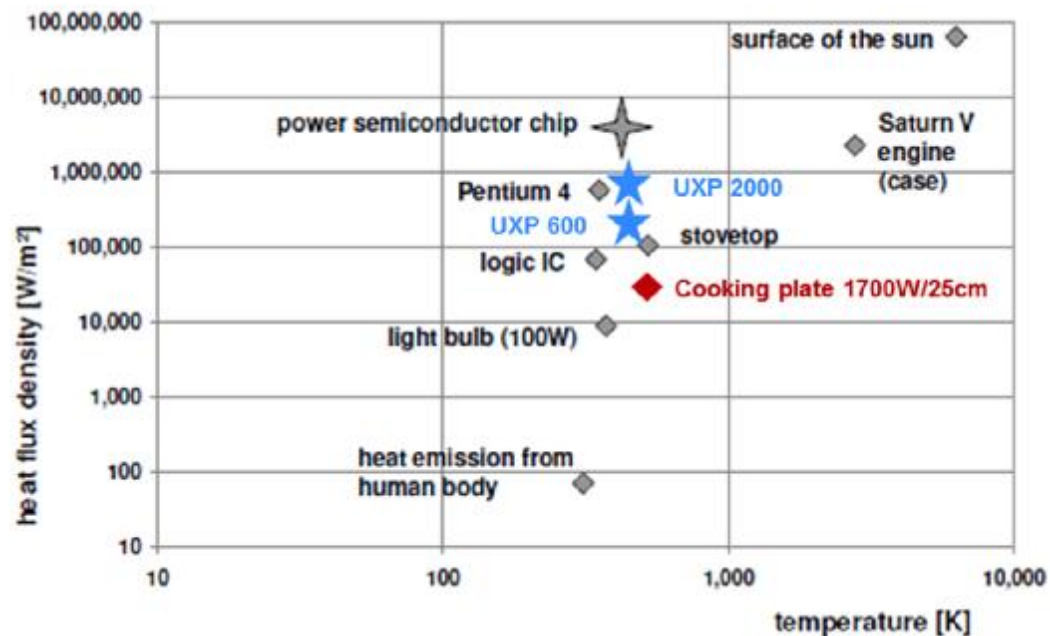
Innovation in Motion



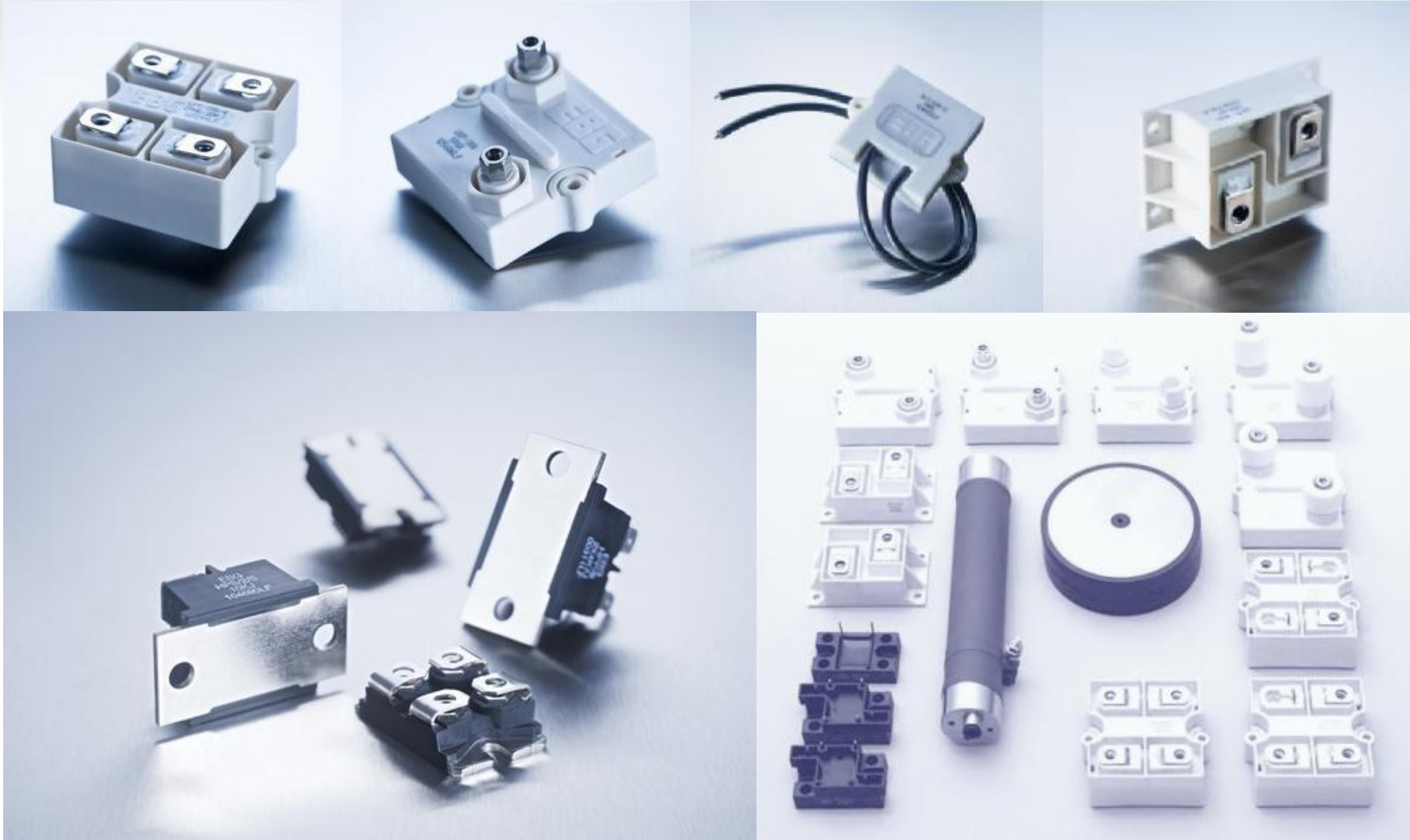
| | |
|-----------------------|---|
| Function | Snubber resistor for high power semiconductors; damps electric pulses |
| Possible applications | Industrial electric power supply |
| Benefit / advantage | Small footprint, induction free, good pulse capability, vibration resistant |



UXP 2000 – the power of 2,5 resistors in one



Resistors – High Power

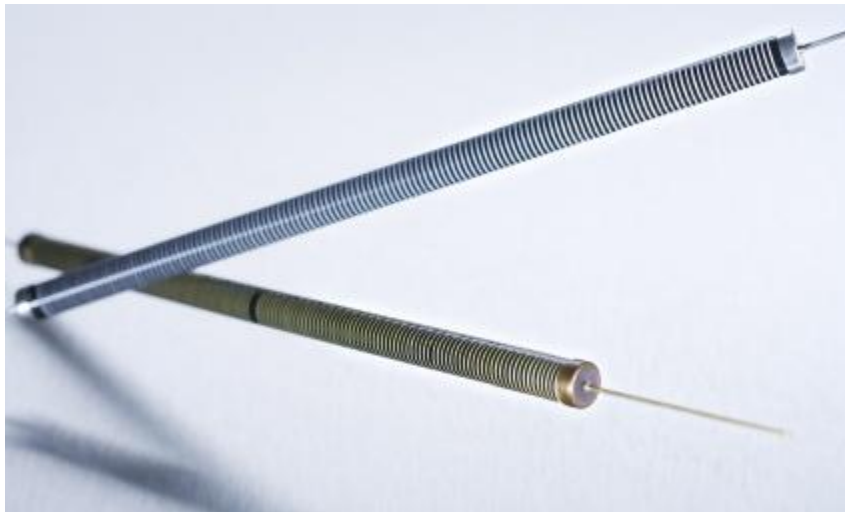


High Precision High Voltage Resistors

Precise Voltage Sensing and Control



| | |
|-----------------------|---|
| Function | Highly precise thick film resistors for high voltage power supplies; Temperature coefficient down to 5ppm/°C, Voltage range up to 100 kV |
| Possible applications | HV electric power supply, battery management, HF/RF power supplies, etc |
| Benefit / advantage | Extreme low temperature coefficient of resistance Precise control of power voltage levels in a wide temperature range |

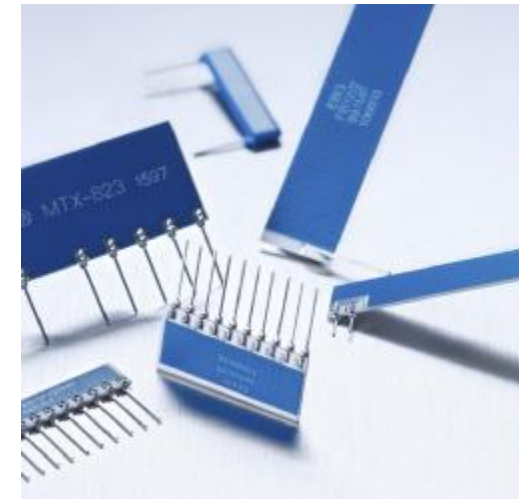


High Voltage, High Precision Resistors

Resistance change
per °C temperature

20 times less

than standard



High Voltage, High Precision
Dividers and Networks

Resistor Application Range for E-Vehicles

Electric Protection or Voltage Sensing



- Converter for charging systems (AC and DC charging)
- Power control unit (DC-AC)
- Charging converter (AC-DC)
- Power distribution unit (PDU)
- Motor control unit
- Battery pack



Charging system



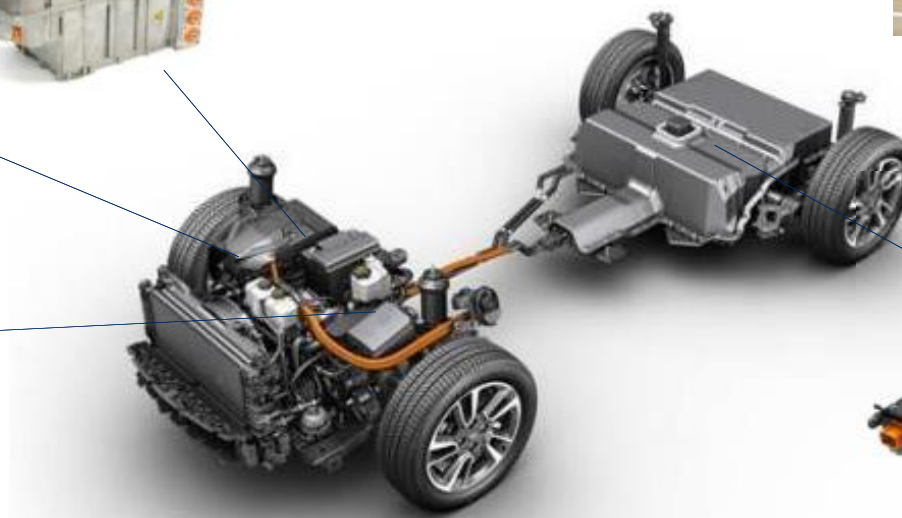
Battery charger



Motor control unit



PCU



Battery packs

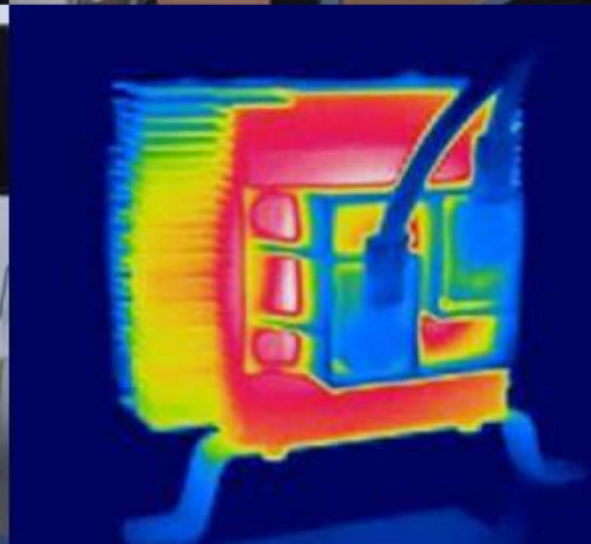


Center of Excellence (I)



EBG is focused on **metal-oxide thick film** resistors.

EBG is the **technology leader for sophisticated resistors.**



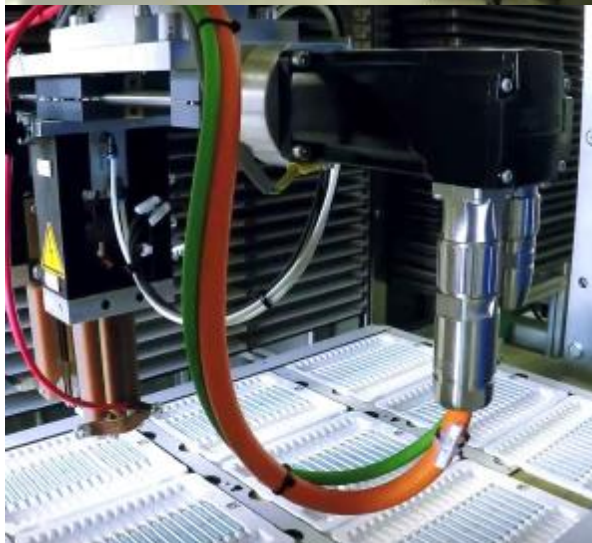
Kirchbach is EBG's R&D center. A **wide range of testing equipment** makes EBG an **attractive development partner.**

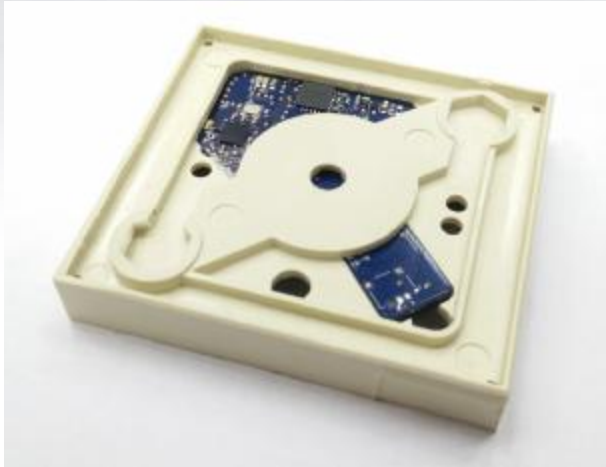
Center of Excellence (II)



We place **great value** on the **high end quality** of our products and on outstanding service and client support with our

- Screen printing installation
- Vacuum soldering system
- HV test equipment
- Pulse load tester





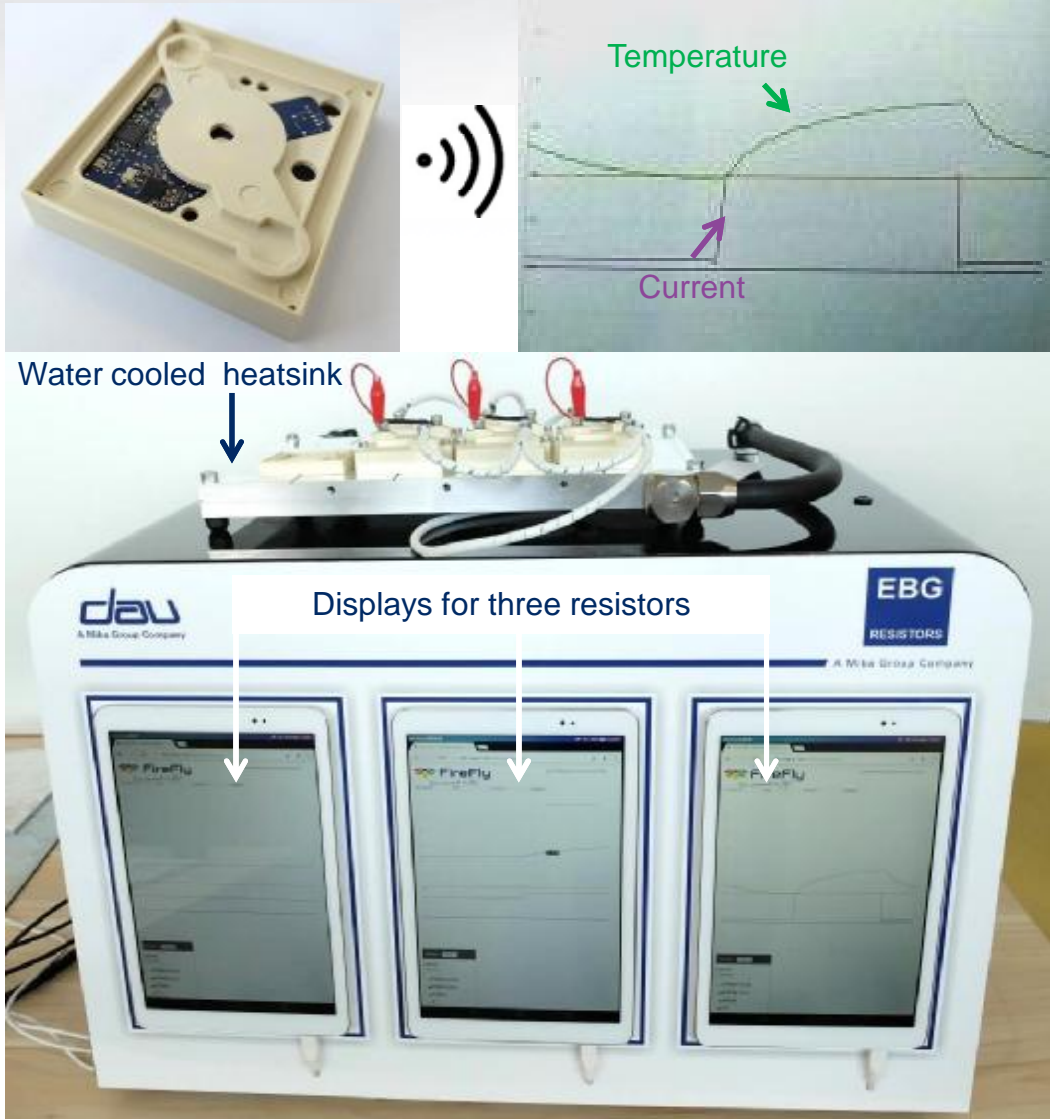
iResistor by EBG

- contribute to Industry 4.0 applications.
- monitor operational state in real time and send data.
- offer seamless integration of electronics, wireless communication and smart user interfaces.
- brings new possibilities to monitor, control and actively respond.

Intelligence in High Performance Resistors

Intelligence inside Resistors

Innovation in Motion



Customer added value

- Logging of operational conditions in real time voltage, current resp. temperature inside component
- Real time data analysis and user notification
- IoT connectivity to private/public clouds
- Easy data visualization on handhelds
- Suited for existing infrastructure

Applications

- High end test benches
- Continuous overload control
- Adaptation of existing equipment possible

Key Supplier for Thermal Products

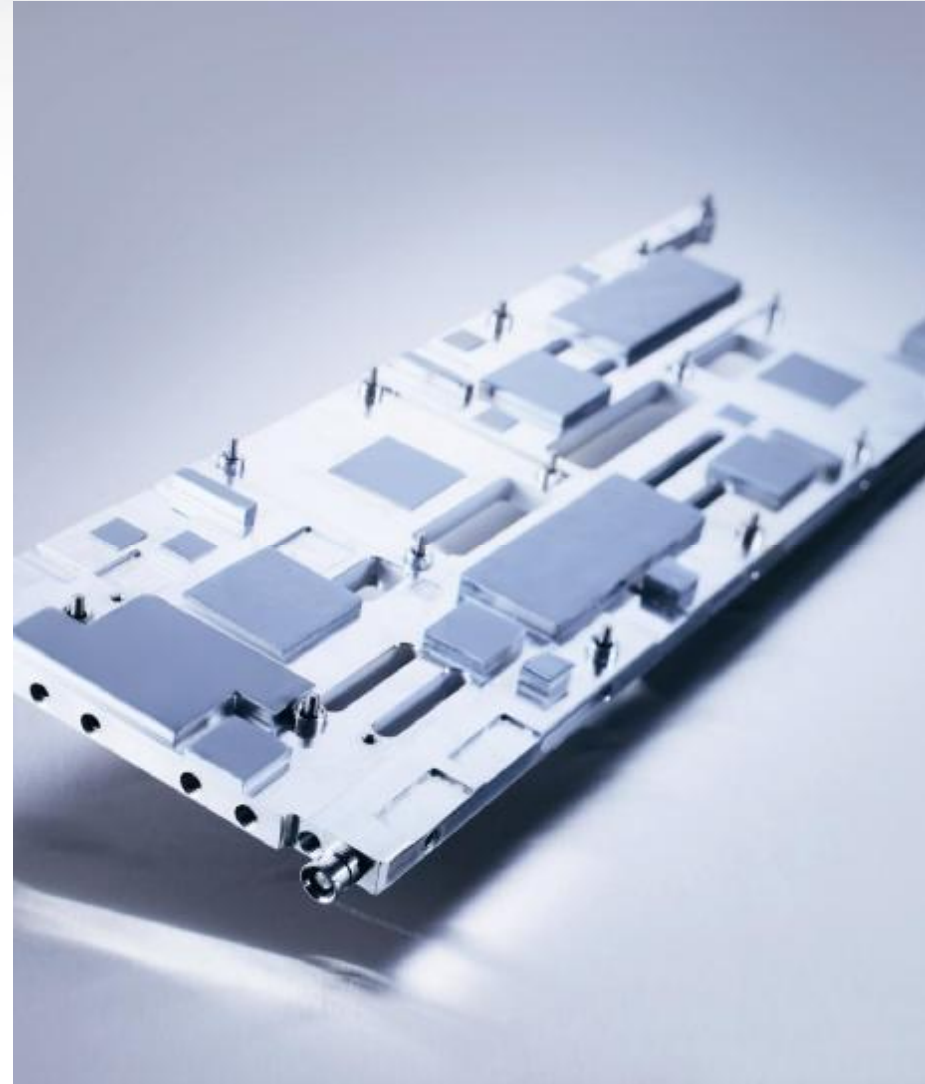
DAU

We are **Thermal Engineers**.

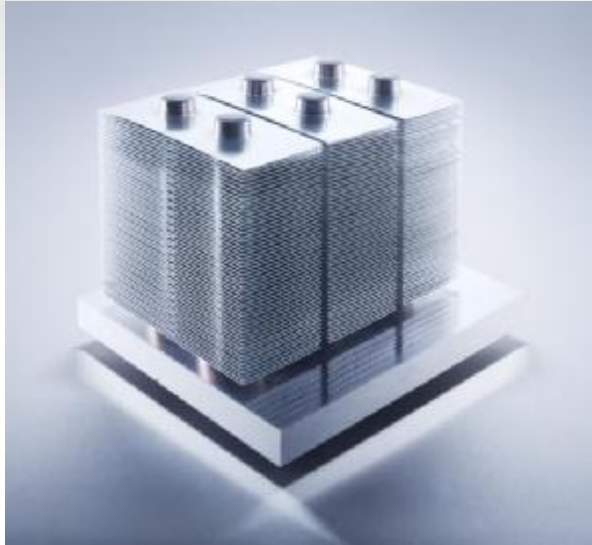
We develop **Thermal Solutions**
together with you.

We **optimize cooling performance**
and **reduce required installation**
space.

Efficiency increase is the guiding
principle.



Key Supplier for Thermal Products

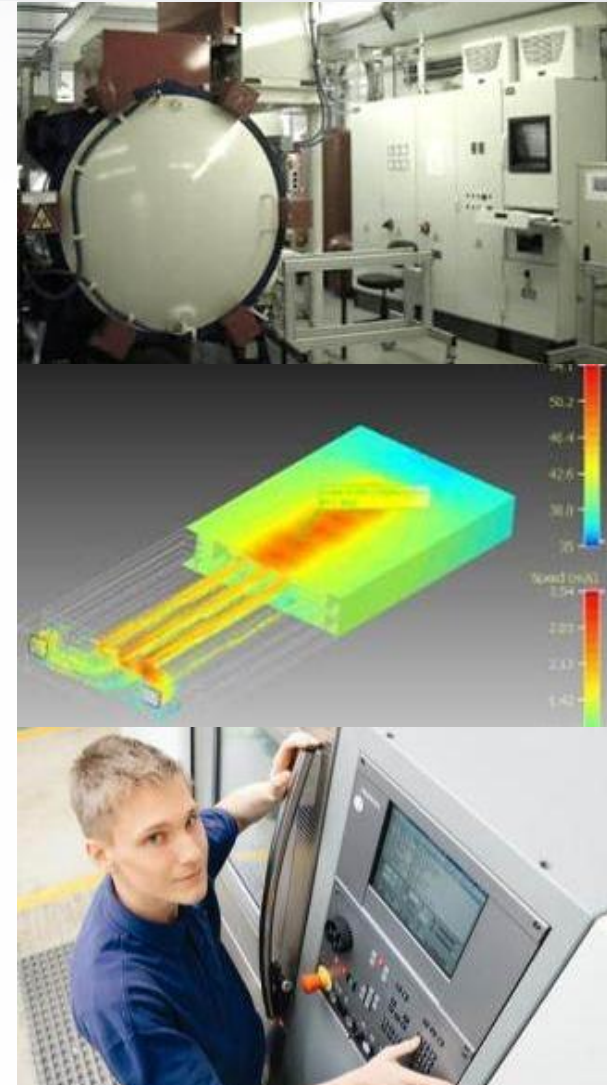


The Product Portfolio includes

- Air cooled heat sinks
- Water cooled coldplates
- Vacuum brazed heat sinks
- Heatpipes
- Busbars

Center of Excellence

- 3D CAD design
- CFD modeling
- CFD thermal simulation
- Mechanical testing
- Leak testing (incl. He)
- Extended life testing
- Infrared thermal testing
- X-Ray / for critical parts
- Thermal testing



The Best Solution for our Customers

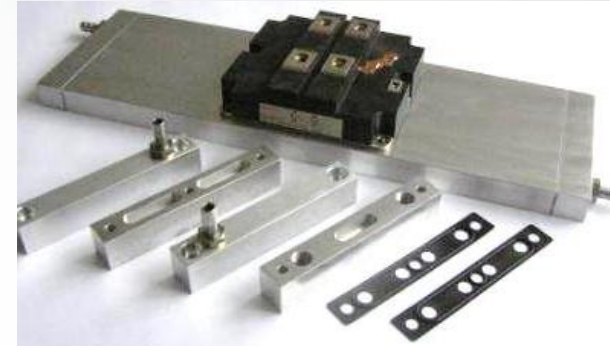
DAU with its thermal solution products offers

- Very high thermal performance with lowest R_{th} value
- Custom specific solutions with a high degree of flexibility
- Air, liquid and heat pipe cooling from one source
- High quality lifetime solutions



Advantages EASY-System and KS-System

- Reasonable solution
- Comfort design
- Easy to create flexible water routing
- Great thermal performance



Heat Sinks – Liquid Cooling – Systems (II)

Advantages KP-System

- Low weight
- Implementation of stainless steel or cooper / Cu & Cu alloy tubes into Al-base plate possible
- Resistant to aggressive fluids – no corrosion
- Flexible water routing possible
- Good thermal performance
- Additional surface protection if needed

Advantages KLD-System

- Low weight
- Implementation of stainless steel or cooper / Cu & Cu alloy tubes into Al-base plate possible
- Resistant to aggressive fluids
- Flexible water routing possible



Vacuum Brazed Liquid Cooled Heat Sinks

Thermal Protection of Semiconductors and Thermal Conditioning

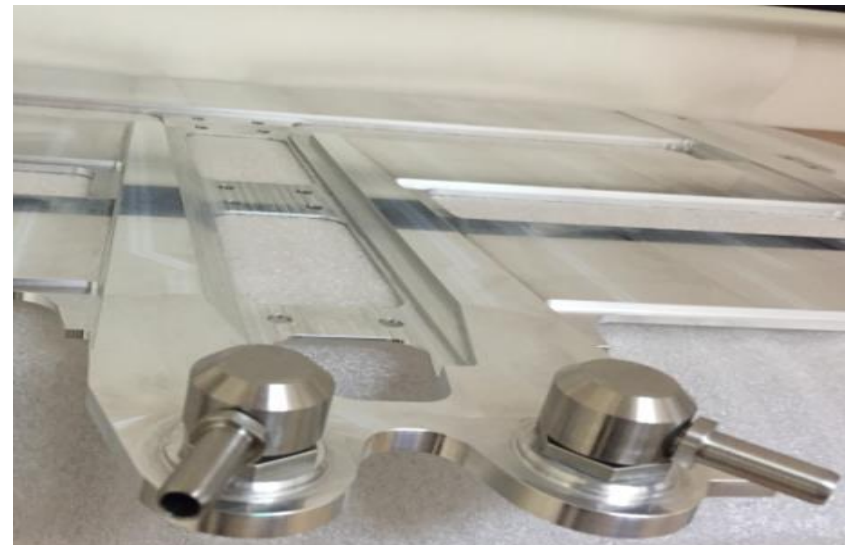
Innovation in Motion



| | |
|-----------------------|--|
| Function | Heat dissipation or thermal conditioning (incl. tempering) |
| Possible applications | High performance converters and switches Battery packs for vehicles |
| Benefit / advantage | Thermal characteristics and pressure drop variable in a wide range Thermal resistance down to 0,005K/W Water and He tightness available (down to 0.00005 mbar/l.s) |



Heatsink
dimensions:
100 mm to
> 800 mm



Liquid Cooled Heat Sinks Application Range

Thermal Protection and Thermal Conditioning

Innovation in Motion



- Converter for charging systems (AC and DC charging)
- Battery modules
- Power control unit (DC-AC)
- Charging converter (AC-DC)
- Motor control unit



Motor control unit



PCU



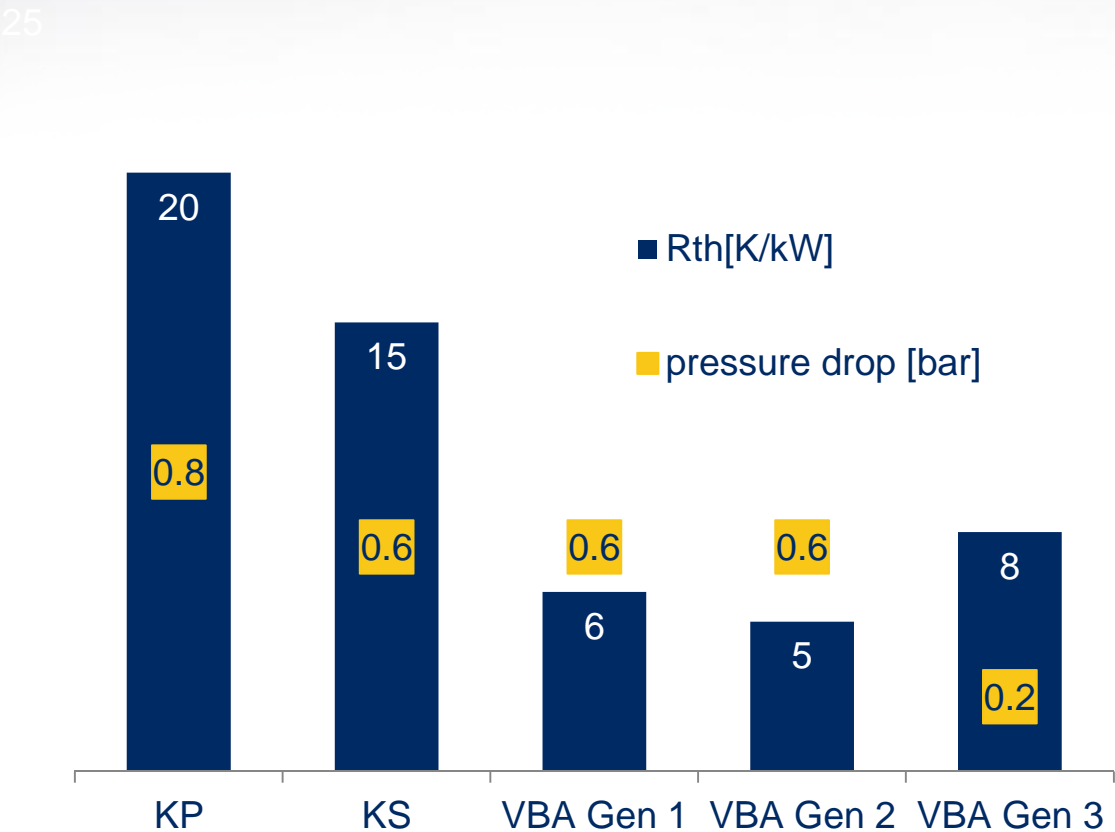
Charging system

Battery packs

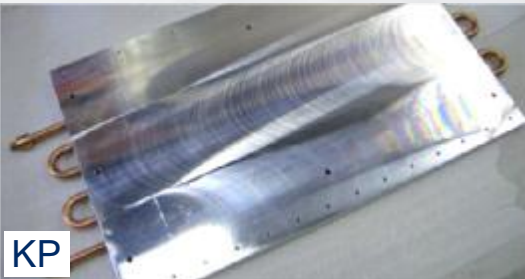


Liquid Cooled Heat Sink Performance

Typical test date @ 6 L / min.



Realized examples



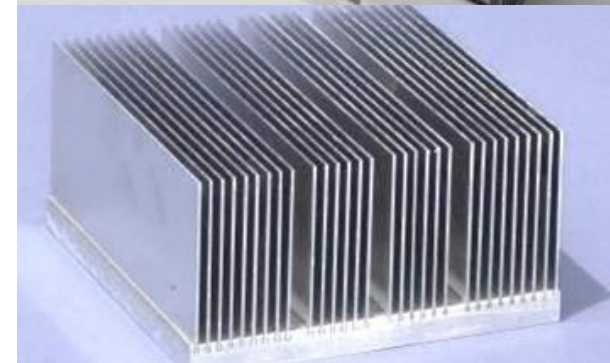
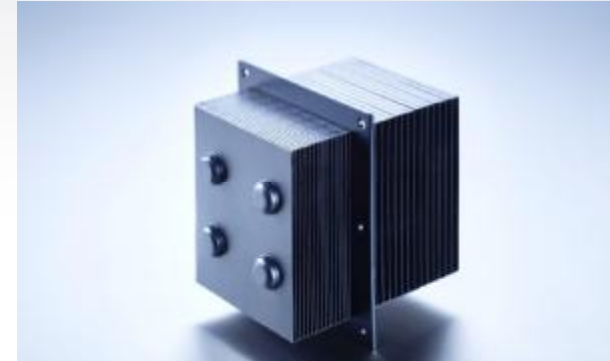
Heat Sinks – Air Cooling – Systems

Advantages AKK-BF/SF Heat Sinks

- Production of different fin spacing possible
- Good thermal transfer from base to fins due to usage of special glue filled with more than 80% with metallic particles
- Production of customized heat sinks possible

Advantages AKK-PRE Heat Sinks

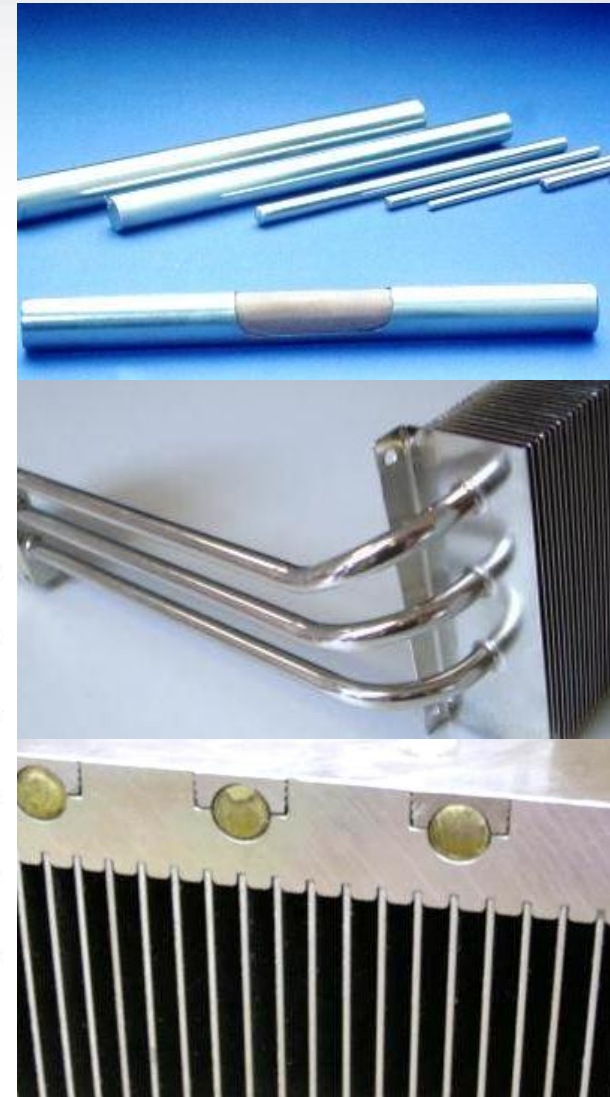
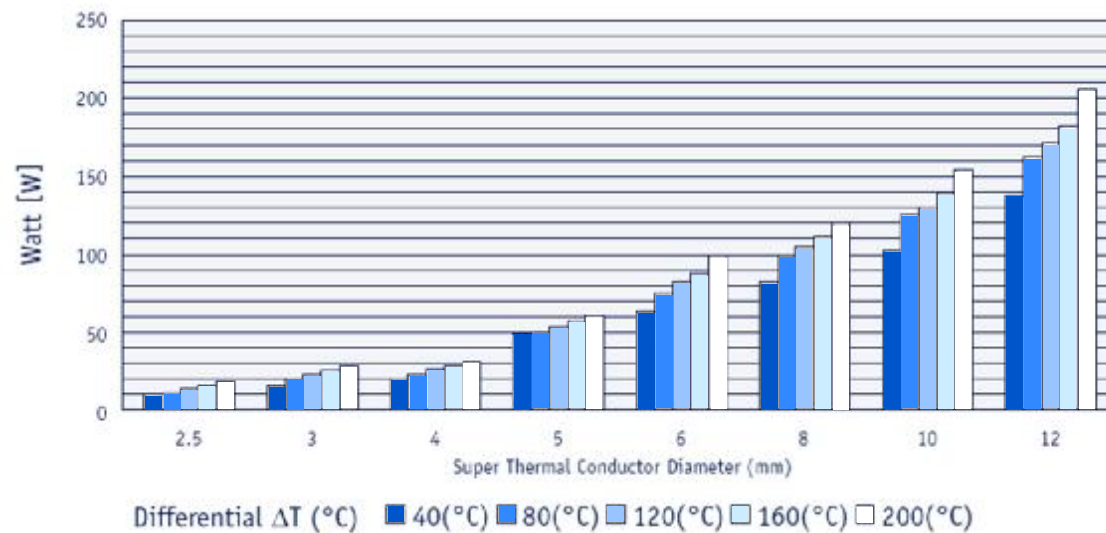
- Base and fins are extruded
- Good thermal transfer from base to fins due to cold welding joint between base and fins
- Very good thermal performance
- Able to support high forces
- Patent-protected technology



Heat Pipe – Systems

Advantages

- Very fast heat transfer by phase transition liquid-vapour
- Heat transfer power easy scalable
- Diameter from 3 mm up to 25 mm
- Temperature range from -40°C up to +275 °C



Contact



EBG Elektronische Bauelemente GmbH

Kirchbach 382
8082 Kirchbach, Austria
T +43/3116/2624-0
sales@ebg-at.com
www.ebg-at.com

EBG Shenzhen

Shenzhen Science & Industry Park Area
Nantou, Shenzhen
Guangdong 518057 China
T +86/755/26 63 26 04
szebg@ebg.com.cn
www.ebg.com.cn

EBG Resistors, LLC

460 Spruce Street
Middletown, PA 17057 USA
T +1/717/73 79 877
sales@ebg-us.com
www.ebg-us.com

DAU GmbH & Co KG

Dietenberg 38
8563 Ligist, Austria
T +43/3143/2351
office@dau-at.com
www.dau-at.com

DAU Thermal Solutions North America

1657 East Park Drive
Macedon, NY 14502, USA
T +1/585/678-9025
sales@dau-us.com
www.dau-us.com

EDMS d.o.o.

Obrtna cesta 18
8310 Šentjernej, Slovenia
T +386/730/82020
info@edms-si.com
www.edms-si.com

Miba Energy Holding GmbH

Dr.-Mitterbauer-Strasse 3
4663 Laakirchen, Austria
T +43/7613/2541-1501
powerelectronics@miba.com
www.miba.com

Sales Offices:

Miba Germany

Max-Eyth-Straße 18
70736 Fellbach, Germany
office@dau-at.com

Miba France

Pentagon Plaza, 381 Av. du
General de Gaulle
92140 Clamart, France
M +33/672/71 23 92
pascal.theillere@dau-ebg-fr.com