SEMIKRON
innovation + service

E-Mobility and Utility Electric Vehicles

Power Electronics

Power Electronics for Utility Electric Vehicles and E-Mobility

Utility Electric Vehicles

The utility electric vehicles segment today comprises primarely the traditional material handling market where battery operated vehicles like fork-lifts have been well established for decades. SEMIKRON has been serving this market for more than 20 years and offers complete SKAI inverter systems for low voltages as well as for voltages of $800V_{DC}$.

The electrification of vehicles in the agriculture and construction sector, in contrast, is still in its infancy. There is, however, substantial potential for this area to grow in the future thanks to the cost benefits of battery driven functions. SEMIKRON's SKiM 93 power modules are the ideal choice for traction drives, while our SKAI HV inverters, which can incorporate auxiliary functions as well, are suitable for higher integration levels.
The utility vehicle segment segment typically relies on industrial standard products.

Material Handling

Inverters for Electric Drive Train up to $96V_{DC}$
SKAI LV

Inverters for Electric Drive Train
SKAI HV

Agriculture

Inverters for Electric Drive Train
SKAI HV

Power Modules for Electric Drive Systems
SKiM 93

Construction

Inverters for Electric Drive Train
SKAI HV

Power Modules for Electric Drive Systems
SKiM 93

E-Mobility

The e-mobility segment includes passenger cars as well as medium/heavy duty buses and trucks and light electric vehicles. This market is driven by statutory CO_2 emissions limits and the components and systems used in e-mobility applications must comply with automotive standards. Compactness and inverter efficiency are the key to reducing energy consumption in electric vehicles. The high-volume passenger car segment is the fastest growing e-mobility market.

SEMIKRON adresses this market with a dedicated module for traction drives - the eMPack. For the bus and truck market, SEMIKRON also offers complete SKAI inverter systems. The light electric vehicle market, a highly fragmented market with power ranges of up to around 40kW, includes two-wheelers, small delivery trucks, recreational / neighborhood vehicles and many more smaller, yet fast growing niches. SKAI LV is the dedicated product for these applications.

Passenger Cars

Power Modules for Electric Drive Train
eMPack

Light Electric Vehicles

Inverters for Electric Drive Train up to $96V_{DC}$
SKAI LV

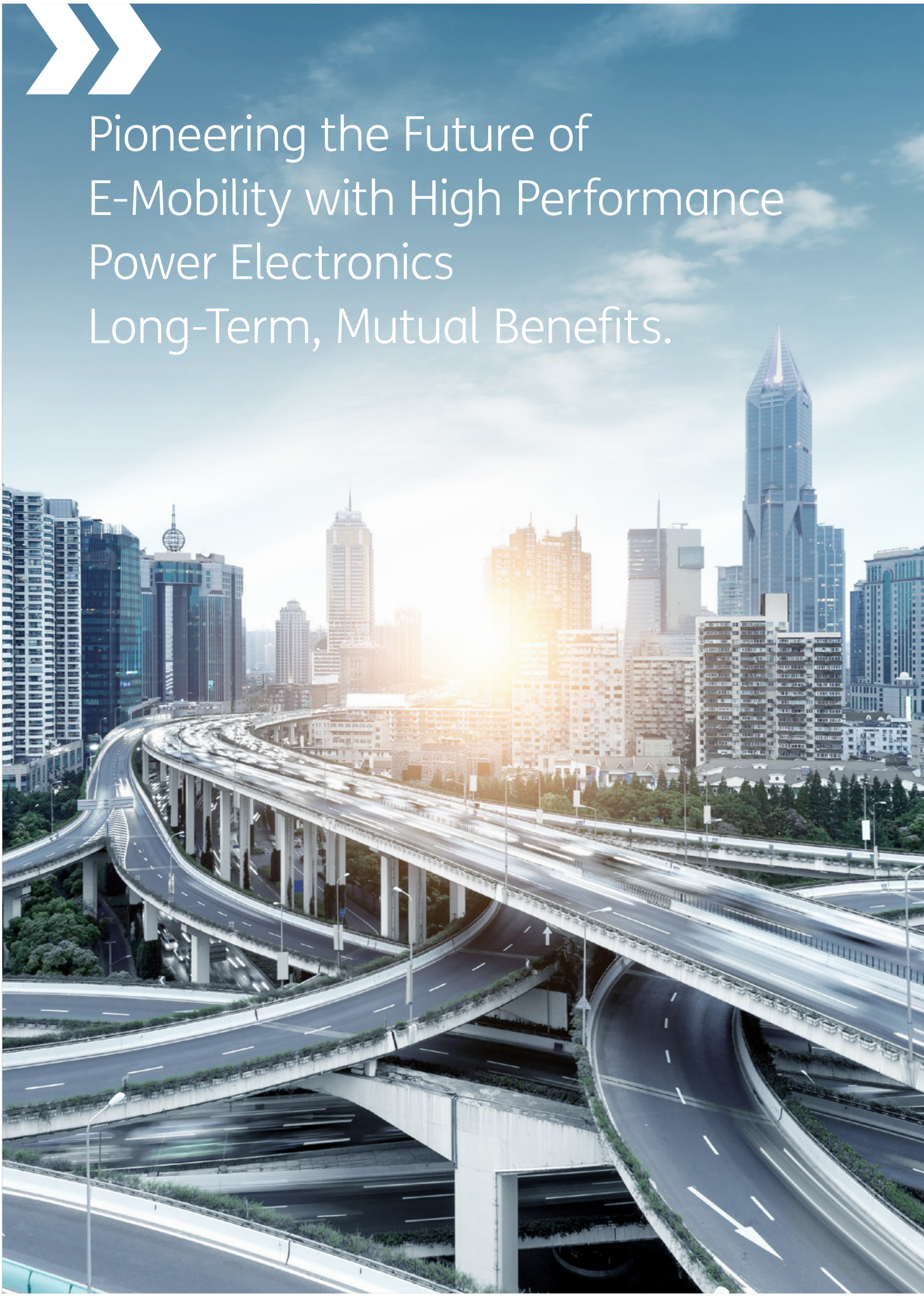
Trucks and Buses

Inverters for Electric Drive Train
SKAI HV

Inverters for 48V board net
SKAI LV

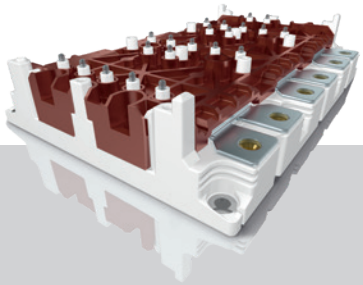
Power Modules for Electric Drive Train
eMPack

Pioneering the Future of E-Mobility with High Performance Power Electronics Long-Term, Mutual Benefits.



Product Portfolio

Power Modules



eMPack®

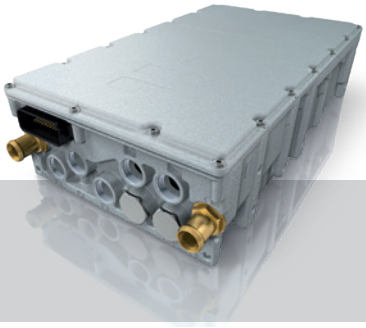
High Performance Package for eMobility
Silicon carbide MOSFET and full silicon carbide technology
750V / 1200V Sixpack compatible package for up to 900A_{RMS}
Double Sided Sintering package for automotive grade reliability
Low thermal resistance thanks to DPD technology
Flexible cooler arrangements
2.5nH package stray inductance including terminals

SKiM® 93

High Reliability Design using Chip Sinter Technology
Power module in sixpack configuration
650V / 1200V / 1700V IGBT: 300A to 900A 1200V Hybrid SiC: 450A
Low inductance design thanks to symmetrical layout
Solder-free module and driver PCB mounting
Benchmark performance in power and thermal cycling tests thanks to sintered chips, AlCu wire bonds and pressure contacts
Increased power density thanks to baseplate-less module design

Product Portfolio

Power Electronic Systems



SKAI® HV

Inverter for On- and Off-Road Vehicles up to 800V
Suitable for battery voltages up to 800V_{DC}
Sintered power semiconductors
EMI compliant
Peak current 400 A_{rms}
Peak apparent power 300kVA

SKAI® LV

Low Voltage MOSFET inverter system up to 120V
Power platform for utility and light electric vehicles
For compact designs
30kVA/l power density
$V_{battery}$:24V_{DC} up to 96V_{DC}
600A_{rms} peak current during acceleration
Easy-to-use gate driver
IP66 enclosure

In passenger car applications, power electronics have to rise to considerable challenges: they have to be compact and efficient, while remaining robust and reliable under the changing conditions that occur during cold start and repeated acceleration and deceleration. SEMIKRON offers a wide range of products that rise to the occasion in any application in the automotive sector, be it battery-powered electric vehicles, mild hybrids, plug-in hybrids or other hybrid drive vehicles.

SEMIKRON's dedicated automotive portfolio includes power modules and integrated converter/inverter systems that are often based on innovative semiconductor technologies such as silicon carbide (SiC), significantly improving efficiency in standard passenger vehicle applications in comparison to silicon-based technology (IGBTs).

Power Module Platform

The transition of complete car platforms to full electric battery vehicle architectures is progressing rapidly. These architectures will demand scalable power electronics solutions for electric drive systems (EDS) that are capable of realizing a wide performance range in an economic way, resulting in competitive advantage to vehicle manufacturers.

SEMIKRON's new power module platform eMPack, which is based on a common module concept, is being developed for EDS inverter architectures covering a power range from 100kW up to 750kW. eMPack covers 400V and 800V battery system applications.

The combination of Silicon Carbide technology with SEMIKRON's fully sintered, low stray inductance Direct Pressed Die Technology (DPD) enables unmatched power densities combined with high reliability for automotive application.

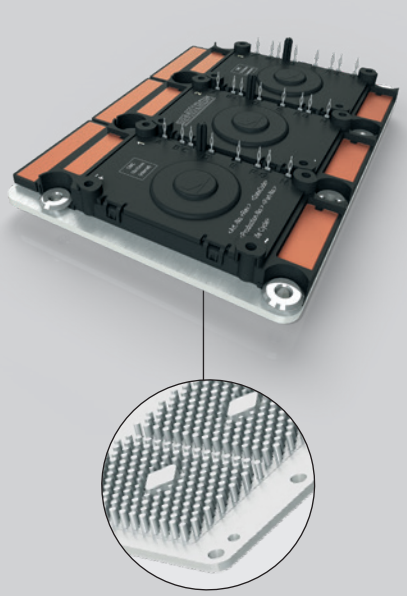
Product features

- High efficiency SiC technology
- Ultra-low stray inductance
- Superior reliability in a fully sintered package
- Dedicated configurations for all BEV power ranges
- Compact package

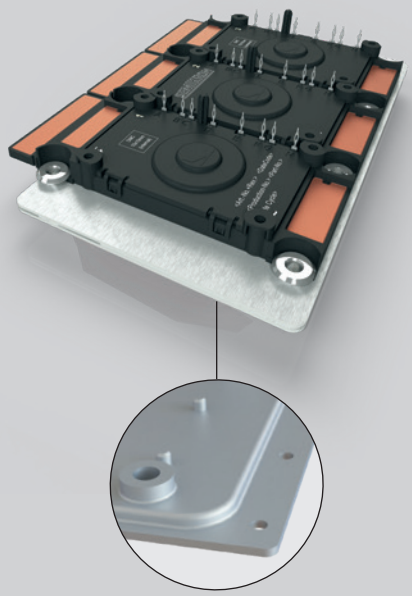
eMPack®

100kW up to 750kW

Direct Pressed Die Technology®



PINFIN cooler option



Customer-specific cooler options, e.g. closed aluminium cooler

More and more utility vehicles such as forklift trucks now run on electric power. In fact, what was once state of the art for indoor vehicles, is now increasingly finding its way into outdoor vehicles, as powertrain electrification continues to advance and enter new vehicular applications. Today, power electronic systems are as commonplace in motorbikes, quads and other light electric vehicles as they are in agricultural and construction vehicles.

The SKAI LV converter/inverter system is a platform solution that is designed for use in combination with existing or optimised controller systems, enabling the quick development of optimised, cost-efficient custom solutions for utility and light electric vehicles. The compact design of the SKAI LV makes it the right fit for use in industrial forklift trucks as well as in other industrial or road vehicles.

Ultra Compact MOSFET Inverter Platform

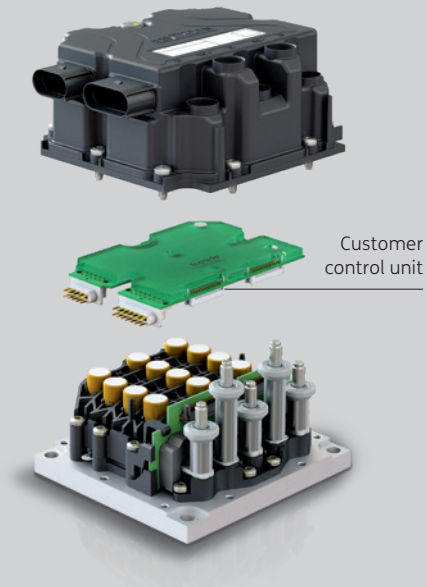
The SKAI LV is a platform for low-voltage inverter systems for on- and off-road applications. This platform constitutes the 3rd generation of low-voltage inverter systems and the 7th generation of MOSFET inverter technology developed by SEMIKRON, with more than 1.5 million MOSFET inverters in the field.

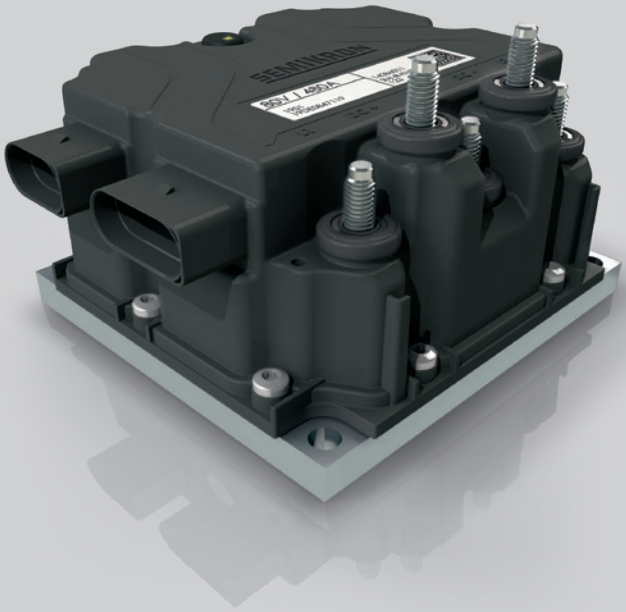
To create an optimized application-specific motor control system, simply integrate a customized control board. The SKAI LV platform is based on the same power-technology found in high-voltage, high-reliability applications today, providing access to high-power, maximum reliability technologies across a wide range of low-voltage on and off-road applications.

Product features

- Voltage, current and temperature sensors
- Gate driver with protection
- Low inductance, low loss power section
- DC link capacitors
- Air and plate cooling
- Easy-to-use gate driver interface
- Platform for customised designs

Enjoy the video





SKAI® LV

MOSFET Inverter System up to 55kVA

Hybrid electric or all-electric buses are already in widespread use in our cities today and are an effective way of reducing pollutant emissions or avoiding them altogether. This move towards cleaner mobility is also being seen in trucks, with more and more manufacturers introducing hybrid electric or all-electric trucks to their fleets.

In heavy-duty off-road utility vehicles such as construction site vehicles and agricultural machinery, the power electronics are exposed to particularly harsh ambient conditions. They have to be ultra-compact and lightweight, while exhibiting good vibration, impact and shock resistance in order for them to work reliably on uneven terrain. They have to be able to work at both very low and very high ambient and coolant temperatures and boast excellent thermal and power cycling capabilities at the same time.

Compact Power Electronic System

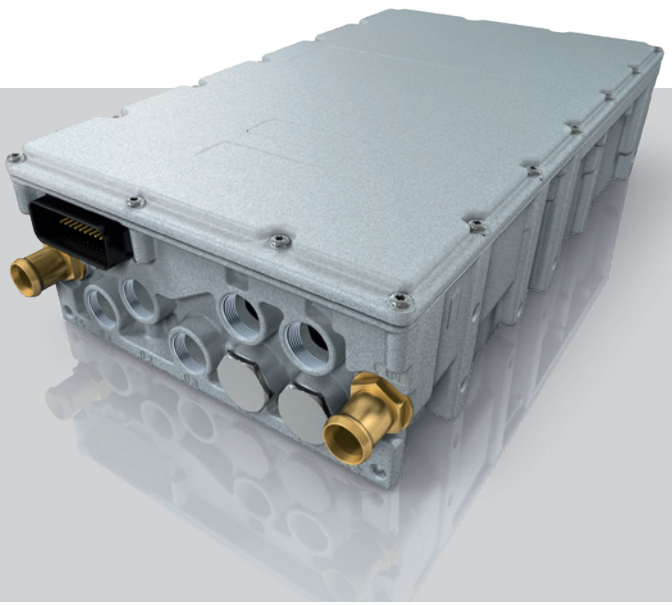
SKAI HV comprises a versatile 3-phase converter platform designed for use in electrified vehicles. It covers key requirements such as high power density, exceptional ruggedness and automotive EMI compliance. The integrated motor control software SKAIware ensures highly efficient operation of the electric drive train.

The SKAI HV power electronic platform comprises highly integrated motor controllers, which provide the ideal powertrain solution for mobile electric and hybrid applications. Power densities of up to 24kVA/litre bring notable size reductions compared with other existing standard motor controller products. The systems are designed to operate with supply voltages of up to $800V_{DC}$ and with output power ratings of up to 300kVA. The IGBT based SKAI HV motor controller operates on sintered, 100% solder free 1200V power semiconductors and features polypropylene film DC-link capacitors, all integrated into a waterproof IP67 enclosure. The compact motor controllers can withstand high vibration amplitudes of up to $10g_{RMS}$.

SKAIware motor control software adds to the system function and completes off this tried-and-tested package for the SKAI HV nicely. SEMIKRON provides engineering services to support customers with the integration of SKAI HV motor controller systems. Other available services include lifetime estimation, field application support, individual parameterization of motor control software, and more.

Product features

- Compact integration into IP67 enclosure
- Voltage, current and temperature sensors
- Gate driver with protection
- IGBT power semiconductors
- Fully programmable digital signal processor
- EMI filters
- Versatile cooling system (liquid cooled, forced air cooled, base plate)
- DC-link capacitors
- Motor control software



SKAI® 2 HV
100kVA up to 300kVA

Technology

A Breakthrough in Power Electronics Packaging

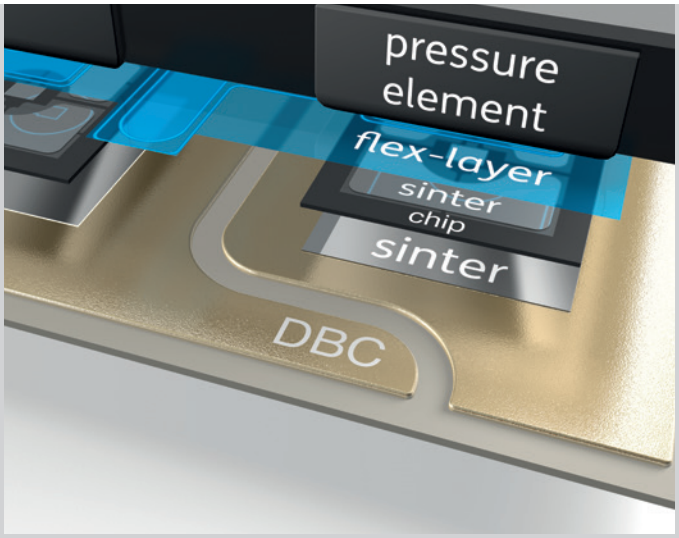
Direct Press Die Technology

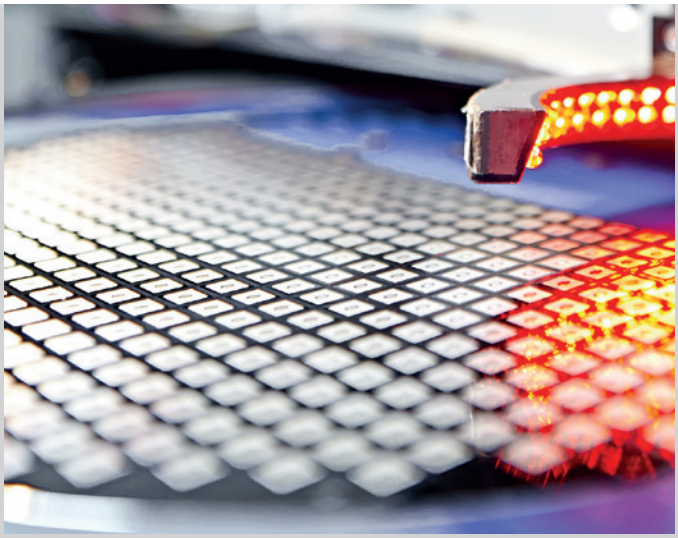
Direct Pressed Die (DPD) technology includes a Double Sided Sintered (DSS) chip on a ceramic substrate that is pressed onto the heatsink by a defined force a defined force applied directly onto the top of the chip. This optimises reliability and thermal resistance, combined with flexibility with regard to cooling and integration in standard power modules.

Silcon Carbide

Silcon Carbide is a key enabler of highly efficient traction inverters, resulting in increased range. Due to its physical properties, enhanced power density and high temperature profile, it requires very robust packaging technologies. SEMIKRON's fully sintered, low stray inductance Direct Pressed Die Technology (DPD) is the key to fully leveraging the benefits of SiC technology in eMPack power modules.

Direct Pressed Die Technology®





Key features of DPD and SiC

- Flex layer interconection with minimum inductance to facilitate fast switching
- Fully sintered package for high reliability
- Minimized thermal resistance allowing maximum SiC power densities
- Flexible chip set arrangements perfectly matching customer requirements


SEMIKRON

Service

Helping Your Business Use Our Products

Application expertise is our strength

Being able to access service, technical support and experts that our customers can always rely on is instrumental to our customers' success.

Today, increased product diversity in power semiconductors calls for customer support far beyond the information contained in data sheets. Only comparison under application-specific conditions – such as voltage, switching frequency or cooling conditions – can demonstrate the differences in performance of available devices. That's why we continue to invest in our professional application engineering support, including lab space and reference designs.

In recent years, we have built a network comprising 24 sites across the globe to provide fast, comprehensive application support. Our application engineering teams work with our customers both locally and globally. throughout the entire project life cycle. We strive to understand and help our customers overcome both big and small challenges throughout their projects. For example, we conduct topology studies to fully understand the advantages in the end user application and carry out benchmark investigations when needed. It is this application-centred approach that sets us apart from others.

How can SEMIKRON help you with inverter design?
Application and performance calculations
DC link design and capacitor selection
Isolation coordination
Lifetime calculations
Measurement support
Application samples and reference designs

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Note: All information is based on our present knowledge and is to be used for information purposes only. The specifications of our components may not be considered as an assurance of component characteristics.

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