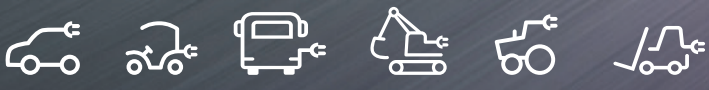


POWER ELECTRONICS



E-Mobility and Utility Electric Vehicles



Power Electronics for Utility Electric Vehicles and E-Mobility

Utility Electric Vehicles

The utility electric vehicles segment today comprises primarily the traditional material handling market where battery operated vehicles like fork-lifts have been well established for decades. Semikron Danfoss 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. 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 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

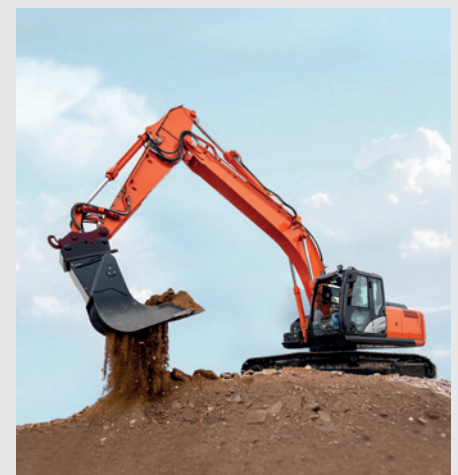
Power Modules for Electric Drive Systems
SKiM 93



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 CO₂ 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 Danfoss addresses this market with dedicated modules for traction drives - the DCM and the eMPack. For the bus and truck market, Semikron Danfoss 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

Power Modules for Electric Drive Train
DCM



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

Power Modules for Electric Drive Train
DCM



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



Product Portfolio

Power Modules



eMPack®

High Performance Package for e-mobility

- 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
- Multisourcing thanks to chip independency

DBB® Bonding and Joining Technology
ShowerPower® 3D Cooling Technology



DCM™

Flexible Design through Customization

- Si IGBT and full silicon carbide MOSFET technology
- 750V/1200V half-bridge design for up to 900 A_{rms}
- DBB Sintering Technology for high reliability
- Low thermal resistance thanks to ShowerPower®3D
- Robust molded module packaging, low warpage and reliable mechanical integration
- Highest power density
- Multisourcing thanks to chip independency



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

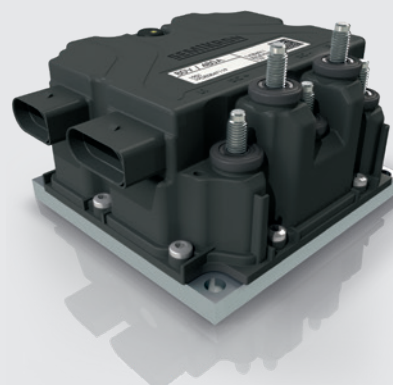
Power Electronic Systems



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 Danfoss 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.

Our 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 Danfoss' 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 our fully sintered, low stray inductance Direct Pressed Die Technology (DPD) enables unmatched power densities combined with high reliability for automotive application.

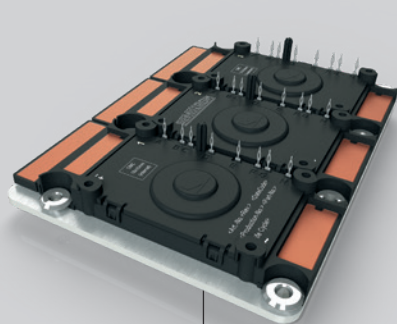
Product Features

- 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



To power up the fast-growing fleet of HEVs, PHEVs and BEVs, Semikron Danfoss has developed a power module technology platform, DCM™, for traction applications. With silicon (Si) and silicon carbide (SiC) being the main cost-drivers in power modules, our DCM™ technology platform aims at reducing the semiconductor surface enabled by combining patented technologies.

At the same time, the DCM™ also increases power density, reliability, robustness and lifetime of the inverter. By selecting the best fitting chips from a competitive supplier base and by carefully selecting the power module components, package and electrical configuration, we are able to use the semiconductors to their full potential.



Power Module Platform

The DCM™ technology platform is designed to be scalable. In the same package, we can scale the power up or down to meet different inverter voltage classes with blocking voltages of 750V-1200V, while having different output currents from 350 to 900A.

Furthermore, our power modules are based on quality components, patented packaging and cooling technologies to achieve outstanding, measurable results in terms of reliable performance and robustness – all adding up to ensure a cost-effective solution that lasts.

Our certified processes assure for consistent high quality and streamlined path from development to volume manufacturing.

Product Features

Highest flexibility in design, customized interfaces

Scalable across voltage classes

Advanced bonding technologies for highest power cycling robustness

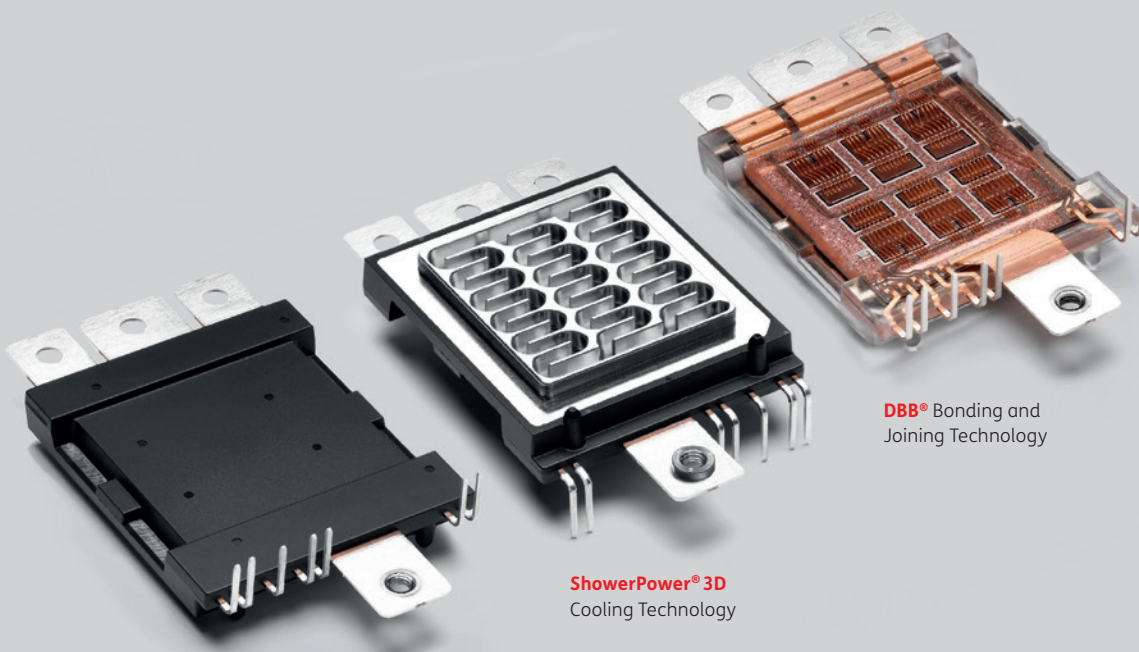
High power density

Robust molded module packaging

Direct liquid cooling with ShowerPower 3D

DCM™

100kW up to 750kW



DBB® Bonding and
Joining Technology

ShowerPower® 3D
Cooling Technology



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 Danfoss, 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

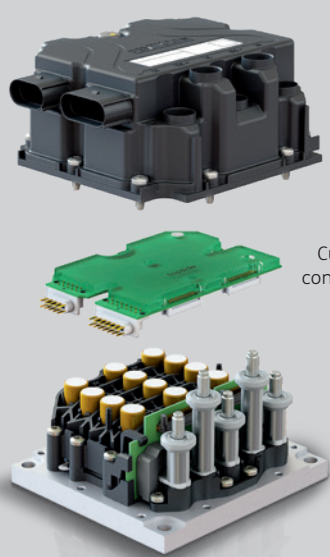
Air and plate cooling

Easy-to-use gate driver interface

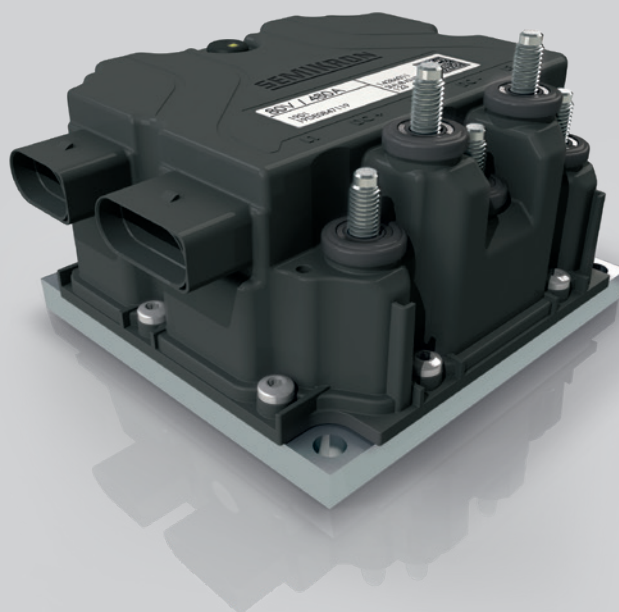
Platform for customised designs



Learn more



Customer control unit



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

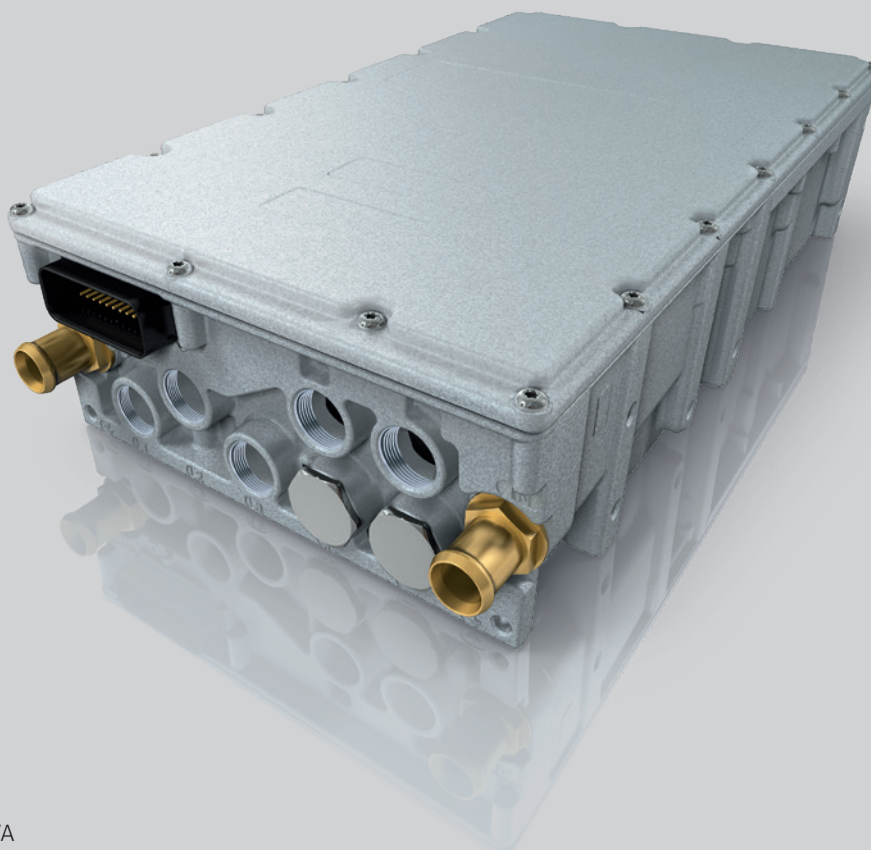
SKAI HV comprises a versatile 3-phase converter platform designed for use in electrified vehicles. It covers key requirements such as high power density, exceptional ruggedness and automotive EMI compliance. The integrated motor control software SKAIware ensures highly efficient operation of the electric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



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.

Customize your Power Solution

Besides standard configurations, Semikron Danfoss also offers customer specific topologies in various housings, addressing the market need for innovation and differentiation.

It allows us to provide an unmatched flexibility in power module designs. Our highly skilled and specialized engineers at Semikron Danfoss work closely with you to design power modules for your specific drivetrain design, allowing you to scale your power solution according to your specifications.

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 Danfoss 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

THE ULTIMATE PARTNER IN POWER ELECTRONICS

Semikron Danfoss is a global technology leader in power electronics. Our product offerings include semiconductor devices, power modules, stacks and systems. In a world that is going electric, Semikron Danfoss technologies are more relevant than ever. With our innovative solutions for automotive, industrial and renewable applications we help the world utilize energy more efficiently and sustainably and thus to significantly reduce overall CO₂ emissions – facing one of the biggest challenges today. We take care of our employees and create value for our customers by investing significantly in innovation, technology, capacity, and service to deliver best-in-industry performance and for a sustainable future.



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