POWER ELECTRONICS FOR WIND TURBINES

SEMIKRON DANFOSS

Wind Energy

Performance Range

YAW & PITCH DRIVES

5kW - 100kW

Compact designs and high power density

High peak overload capabilities

Multiple axes in one drive or modular drives with common DC bus

Highest reliability and lifetime

Products

SEMITOP E

MiniSKiiP

SEMiX 2

SEMiX 6

SEMIPACK

Drivers

Our portfolio includes a wide range of products for wind energy applications, from small to medium power modules for pitch and yaw drives to high power components for multi-megawatt power converters. From individual modules including dedicated drivers to high power SKiiP IPMs and ready-to-use power electronic stacks – Semikron Danfoss has the solution.

The demand for reliable spare parts to ensure continuous energy harvesting until the end of the turbine life is becoming increasingly important. Semikron Danfoss has a broad portfolio of products to ensure reliable operation and maintenance for wind turbine converters.

Our products offer maximum reliability for on- and offshore wind turbines both in industry standard packages and in high power SKiiP IPMs and power electronic stacks.

MAIN CONVERTER

1MW - 18MW

Compact designs and high power density

High reliability in harsh environments
up to 2200V_{DC} and 1380V_{AC}

Products

SEMiX 3 Press-Fit

SEMITRANS Classic

SEMITRANS 10

SEMITRANS 20

SKiiP 4/7 IPM

Drivers

Power Electronics Stacks

SPARE PARTS & SERVICE

1MW - 18MW

Semikron Danfoss advanced power modules
for maximum reliability and efficiency

Customized stacks for dedicated wind turbine converters

Customized heatsinks for IPMs (SKiiP)
for integration into converters

Products

SEMiX Spring

SKiM 93

SEMITRANS Classic

SEMIPACK

SKiiP 4/7 IPM

Drivers

Power Electronic Stacks

Operation & Maintenance

Wind Turbine O&M

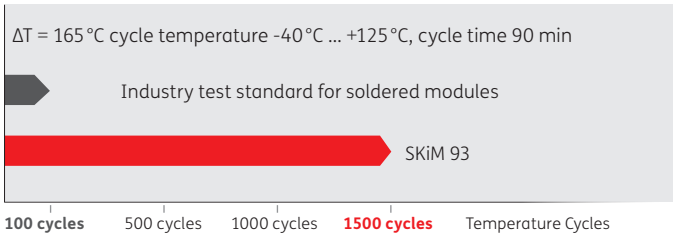
Today, over 400,000 wind turbines are in operation in the field worldwide. The demand for reliable spare parts to ensure continuous energy harvesting until the end of turbine life is becoming increasingly important. Semikron Danfoss has a broad portfolio of products to ensure reliable operation and maintenance for wind turbine converters. From individual power modules, IPMs and drivers to dedicated, customized retrofit stacks – Semikron Danfoss has the right solution.

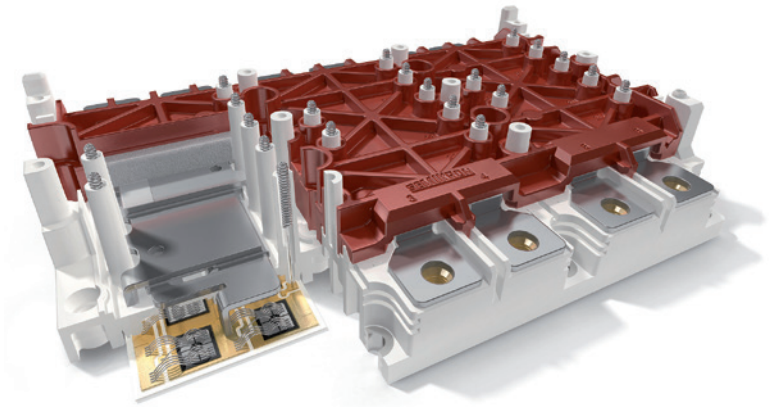
Benefits

Semikron Danfoss offers a broad portfolio with industry standard power modules such as the SEMITRANS and SEMiX family. It includes SKiiP IPMs with customized coolers to fit into your wind turbine converter. The range is rounded off with highly reliable stacks based on solder-free SKiM 93 modules featuring sintered chips. This technology allows for optimized thermal conductivity from chip to heatsink and runs the chip at about 20°C lower than the OEM stack. Semikron Danfoss also offers newly designed driver boards based on the latest Semikron Danfoss ASIC technology with digital signal transmission and additional protection functions.

Key Features

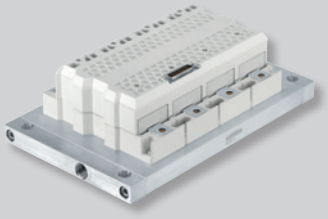
- Broad portfolio of industry standard modules
- Semikron Danfoss advanced power modules for maximum reliability and efficiency
- Customized stacks for dedicated wind turbine converters
- Customized heatsinks for IPMs (SKiiP) for integration into converters
- Drivers and adapter boards with highly reliable Semikron Danfoss ASIC technology



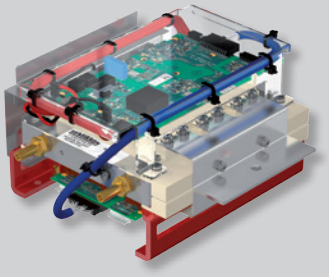


SKiM 93

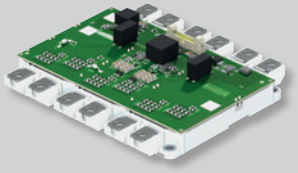
Industry standard power modules



Intelligent power modules



Customized power electronic stacks



Drivers and adapter boards

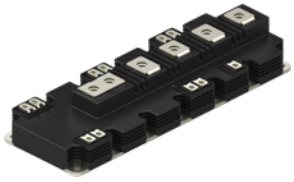
Pushing Performance in **SEMITRANS 10** 3-Level Topologies

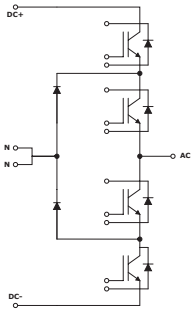
Whenever power quality and efficiency are driving factors in power electronics applications, 3-level topologies are the key. This is especially true for renewable energy applications where the combination with the latest Generation 7 IGBTs sets new benchmarks.

SEMITRANS 10 MLI and SEMITRANS 10 P3L enable wind turbine converters to reach voltage ranges up to 1000V_{AC} (1500V_{DC}) in 3-level NPC topology and increase converter efficiency. On top of that, less number of modules are allowed in system under given power when you compare with 3-level topology constructed by standard half-bridge modules. Constraining the long commutation loop to one or two modules makes stray inductance lower than ever in high power application.

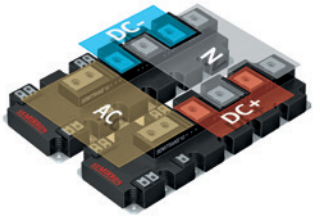
Key Features

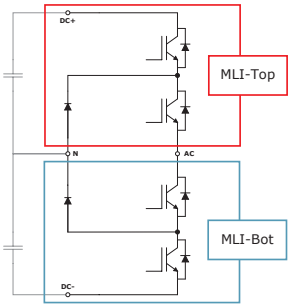
- Reduced system cost thanks to 3-level topology
- Up to 1.5MW without paralleling
- Lower switching losses thanks to 1200V IGBT
- Generation 7 IGBTs change to available with Generation 7 IGBTs
- Lower THD means lower filter requirements
- Reduced cable diameters or cable losses
- Reduced cooling requirements
- High power density
- Low stray inductance



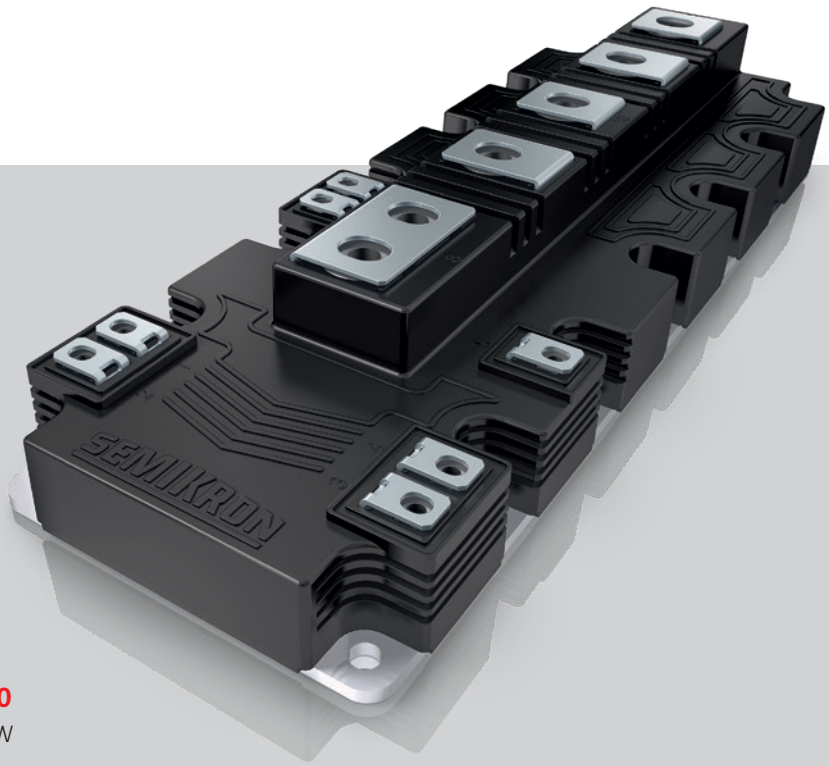


SEMITRANS 10 P3L®
750kW phase leg with single SEMITRANS 10 P3L





SEMITRANS® 10 MLI
Compact 1.5MW phase-leg with SEMITRANS 10 MLI



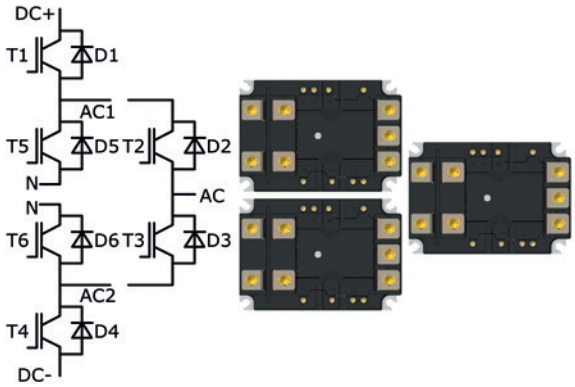
SEMITRANS®10
500kW up to 4MW

Pushing Performance in **SEMITRANS 20** 3-Level Topologies

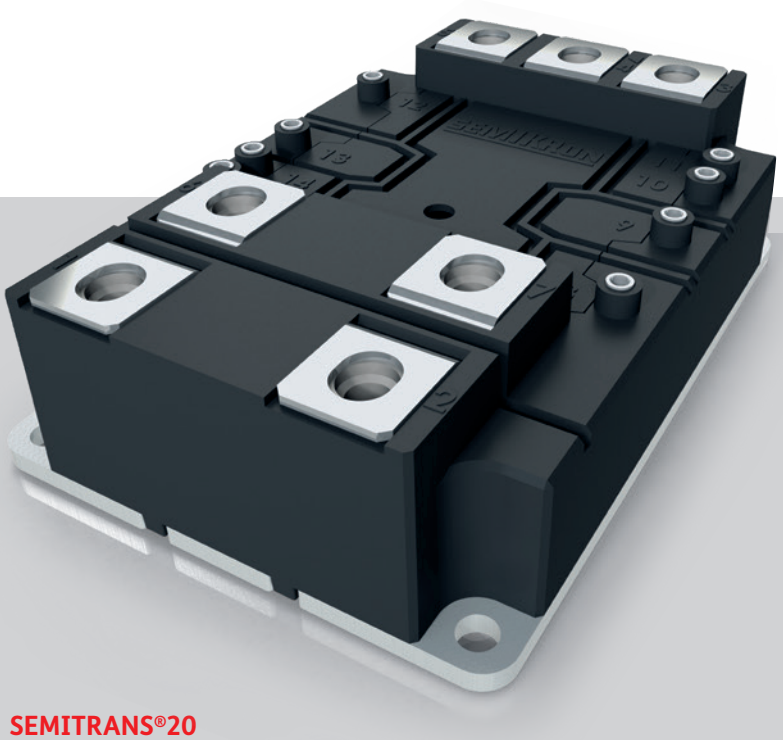
For ANPC topologies, our new SEMITRANS 20 power module combines the lowest stray inductance, highest power density, and latest Generation 7 IGBTs to set a new benchmark. Its design, based on standard half-bridge topology, allows an easy ANPC setup and a low inductance DC-link connection. Combined with sintering technology, power cycling capability is further strengthened, up to 5 times longer lifetime compared to previous generations of soldering technology. This guarantees safe and reliable operation during the entire lifetime. Our experienced engineers will help you with device selection, simulation, and mechanical design under a variety of application scenarios.

Key Features

- New standard package for multiple source strategy
- As low as 10nH stray inductance
- Easy DC-link connection
- Easy interconnection of input and output stages
- High power density
- Symmetrical structure ensures perfect current sharing in multi-module paralleling
- Flexible and scalable solution to cover various power ranges



Up to 1.5MW ANPC phase leg with three SEMITRANS 20 modules; can be expanded to 6MW with four legs in parallel



SEMITRANS®20
500kW up to 6MW

Tailor-made SEMiX®3 Press-Fit for Wind Applications

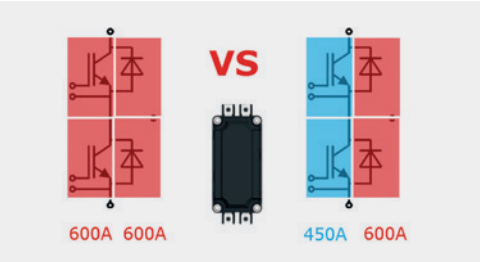
SEMiX 3 Press-Fit helps you reach the same target with less effort. With a deep understanding of user requirements and rich application experience, we are able to allocate valuable silicon to the right circuit position. The lead types of optimized-diode half-bridge and brake chopper modules are perfect examples of our never-ending innovation.

An optimized chipset allows you to achieve cost-effective solutions. The 1700V/450A diode enhanced version with less material can achieve the same performance as a 600A standard half-bridge on the machine side. For the brake chopper circuit, a dedicated chopper version with 1700V/450A diodes offers considerable savings over using a half-bridge. Next generation tailor-made SEMiX 3 Press-Fit modules with increased density and higher efficiency features are already available. You can reach out to us for 750A diode enhanced and 900A GAL module which will significantly increase your output power with same mechnical design.

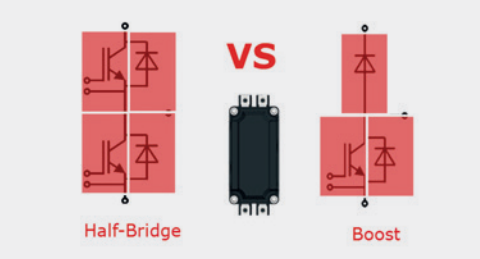
It's Your Choice:
A flexible, cost-effective solution with the same performance or a standard module.

Key Features

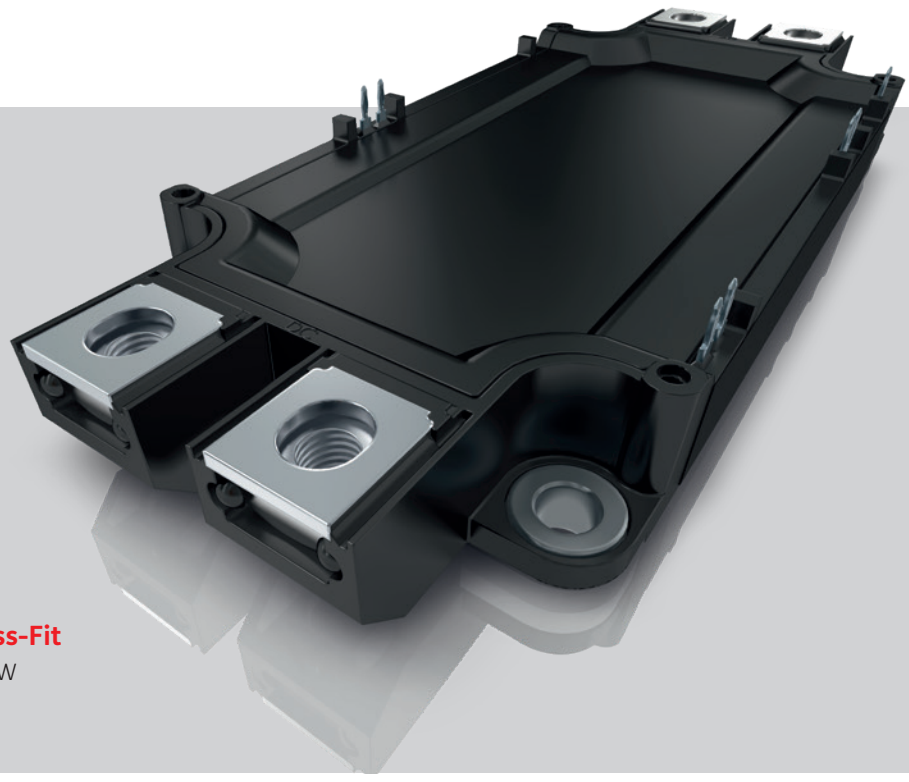
- Cost-effective solution strengthens your competitiveness
- Less material without sacrificing performance and reliability
- Standard package
- More balanced design pushes extreme utilization rate of Si material
- Open to customized requirements



Diode enhanced version used for machine side

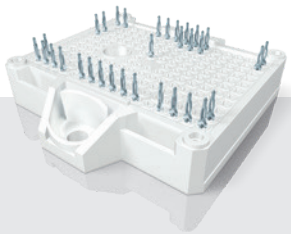


Boost topology used as brake chopper



SEMiX®3 Press-Fit
55kW up to 4MW

Product Portfolio
IGBT and Rectifier Modules



SEMITOP® E
0.4kW up to 55kW

Exceeding the Standard for Superior Performance

PCB-based and press-fit connected baseplate-less industry standard power module in two housing sizes

650V / 1200V IGBT: 10A to 200A

Rectifier, CI, CIB and sixpack topologies

Optimized mounting concept and pre-applied High Performance Thermal Paste provide lowest thermal resistance in class

Full line-up with Generation 7 IGBT

Hybrid and full SiC modules up to 1200V/250A

MiniSKiiP®
0.4kW up to 110kW

Solder-Free Spring Technology for Minimum Assembly Time

Full family of power modules up to 110kW

650V / 1200V / 1700V IGBT: 4A to 400A
1200V hybrid SiC and full SiC: 50A to 150A

Comprehensive set of topologies: CIB, sixpack, twelvepacks, H-bridge, half-bridge, 3-level, bridge rectifiers with brake chopper

Easy and flexible PCB routing without pin holes

Easy manufacturing of single-PCB multi-axis designs

SEMiX® 6
15kW up to 75kW

The Complete Press-Fit Standard

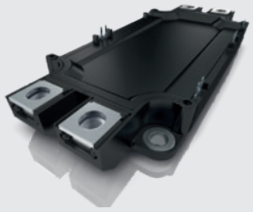
PCB-based and press-fit based industry standard baseplate power module.

650V / 1200V IGBT: 75A to 250A
1600V and 2200V rectifier diodes: 200A and 300A

Bridge rectifier (B6U), CIB and sixpack topologies

Latest press-fit pin technology for optimal assembly and connection reliability

IGBT 4 and Generation 7 IGBT M7 ensure high supply chain safety



SEMiX®3 Press-Fit
55kW up to 4MW

Exceeding the Standard for Superior Performance

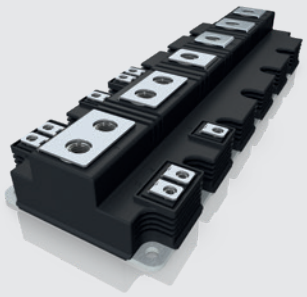
Industry standard press-fit design with 17mm high housing

650V / 1200V / 1700V IGBT: 225A to 900A
1200V Hybrid SiC: 600A

Half-bridge and split NPC topologies

Direct driver assembly

Available with integrated shunt resistor



SEMITRANS® 10
500kW up to 4MW

Robust High Power Module

Established high power module package

1200V IGBT: 1400A and 1800A
1700V IGBT: 1000A and 1400A
2300V IGBT: 1800A

Half-bridge and split NPC topologies

Latest Generation 7 IGBTs for for 3-level NPC modules

SEMITRANS® 20
500kW up to 6MW

The New Standard in High Power

The latest industry standard power module for high power applications

1200V / 1700V IGBT: 900A to 1400A
2000V SiC: 1700A/1mOhm

Half-bridge topology

Low stray inductance, high power density package

Increased reliability thanks to the latest packaging technology

Intelligent Power Modules – IPMs
The Most Powerful IPM in the Market

The SKiiP IPM product line set the benchmark for high performance and robust inverter designs. Both SKiiP 4 and SKiiP 7 feature high power densities combined with flexible cooling options such as air or water cooling, as well as with customized heatsinks. Reliable driver technology, integrated current sensors and comprehensive protection functions complete the IPM design.

SKiiP 7 has become increasingly popular through the industrial applications. With its sixpack or half-bridge topologies, it covers a current range of 500A to 2400A.

The SKiiP 4, available in half-bridge topology, has been optimized for ultra-high power cycling requirements and covers a higher power range up to 3600A.

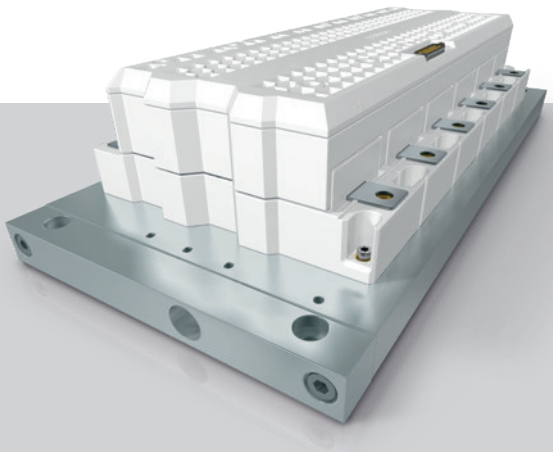
To ensure maximum reliability and service life, the power circuitry is 100% solder-free. Sinter die attach technology replaces the solder layer, the common cause of module lifetime limitations, thus improving power and thermal cycling capability.

High Performance Cooling (HPC) technology has been introduced, to provide 25% more output power capability compared to standard water cooling. A double-sided mounting HPC is also available, enabling ever higher power density.

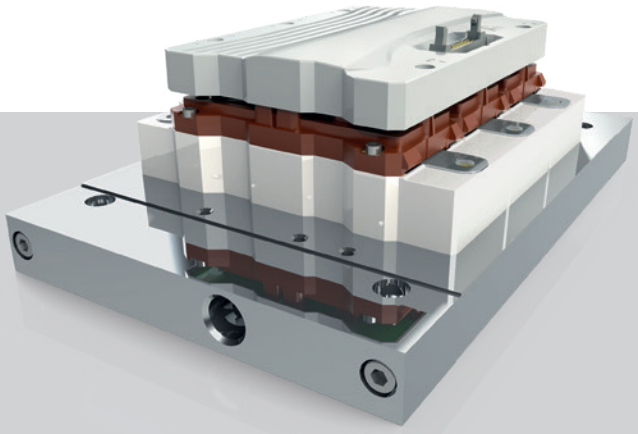
The integrated gate driver in the SKiiP 4 has set new standards in terms of reliability and enhanced functionality through its CAN interface. The digital driver guarantees safe isolation between the primary and secondary side for both switching signals and parameter measurements. The CAN interface allows setting the SKiiP 4 configuration parameter and reading application parameter.

Key Features

Half-bridges and sixpacks
1200V / 1700V IGBT: 500A to 3600A 2000V SiC: 1200A to 2400A
Flexible cooling options: air, water or customized cooling options
Parallel operation for even higher output power possible



SKiiP®4
Up to 2MW
available with full SiC MOSFETs



SKiiP®7
150kW up to 2.4MW


WLL 650/1300 kg

Power Electronic **Stack Platforms** for **Fully Qualified** Inverter Assemblies Tailored to Your **Specific Needs**

Standard Stacks

Our Power Electronic Stacks enable our customers to succeed in dynamic markets and meet any global challenge. We deliver IGBT- and SiC-based stacks for AC voltages from 380V to 1000V. Our standard stacks cover an output current range from 70A to 1400A. Our new SEMIKUBE MLI brings all benefits of 3-level topologies in an off-the-shelf product. It includes all safety and sensing measures for your fast time-to-market.

Water-Cooled Stacks

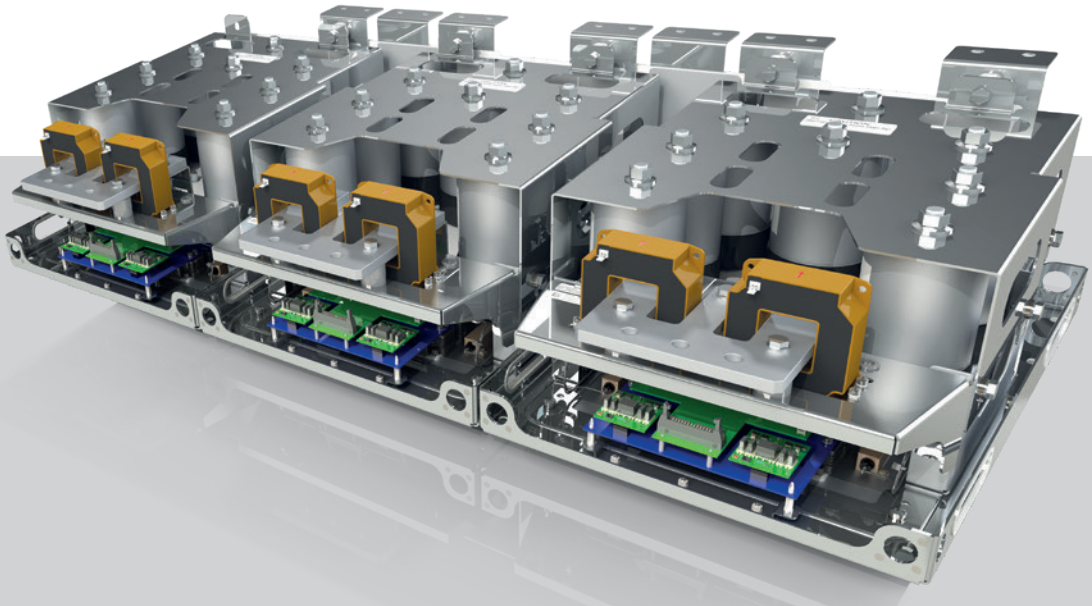
SEMIKUBE MLI
SEMISTACK RE

Customized Stacks

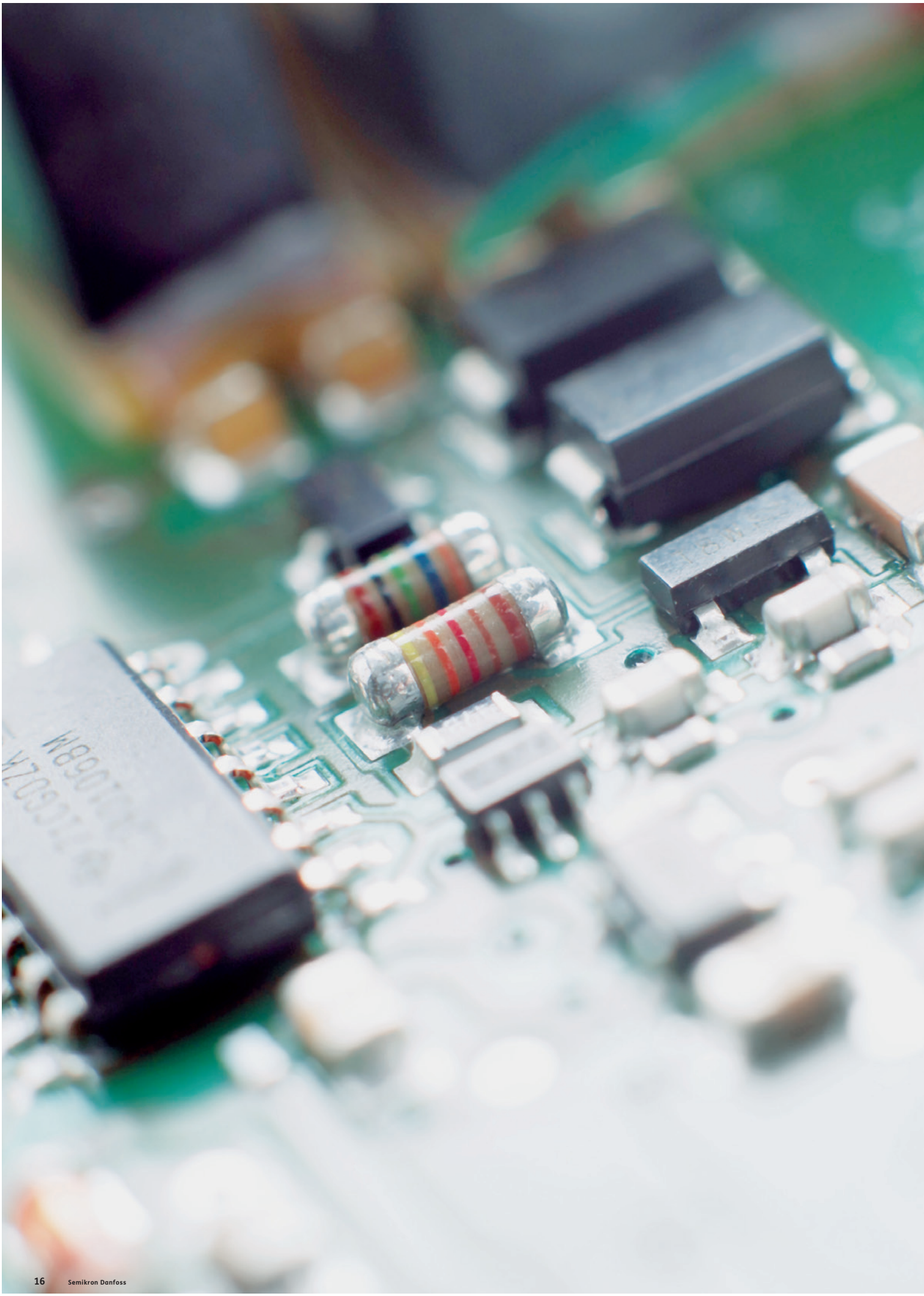
In addition to standard stacks, Semikron Danfoss has vast experience in developing customer-specific solutions. Engineers are available in our stack centers around the globe to offer specific solutions by adapting existing platforms or designing customized converters.

Four Key Factors to Your Success

- Shortest time to market
- Cost savings in R&D, production and qualification
- Global Semikron Danfoss stack production footprint
- Highly experienced engineering team



SEMIKUBE®MLI
Water-Cooled 3-Level NPC Stack



Product Portfolio
IGBT Driver

The unique product portfolio enables access to all established industries with a one-stop solution that combines state-of-the-art power modules and driver electronics.

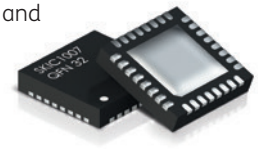
Our IGBT drivers are available as two- channel driver cores suitable for any standard semiconductor power module or as Plug-and-Play solutions, which perfectly fit the SEMiX 3 Press-Fit, SEMITRANS 10 and compatible modules.

Cost Efficient
Achieve outstanding system compactness and create space- and cost-effective inverter designs with our drivers, utilizing highly integrated ASIC technology. Isolated DC-link voltage and temperature sensor signals at the driver's interface along with over-voltage and over-temperature lockout also help to reduce system costs significantly.

Time Efficient
More than 25 years of experience in developing innovative IGBT driver electronics enables Semikron Danfoss to have a short-term solution for almost every challenge related to driver electronics. Our Plug-and-Play drivers connect directly to most common standard IGBT modules. The IGBT driver cores fit with the adapter boards or application sample PCBs. For the latter, Semikron Danfoss shares the entire manufacturing data to decrease development time, speeding up the time-to-market.

Reliable
Our SKYPER are well-known, highly robust and reliable IGBT driver solutions under demanding environmental conditions. Over many years of field operation experience the proprietary IGBT driver technology has been relentlessly developed further. This technology sets new standards for the essential features of safe gate control, reliable gate protection and reinforced insulation.

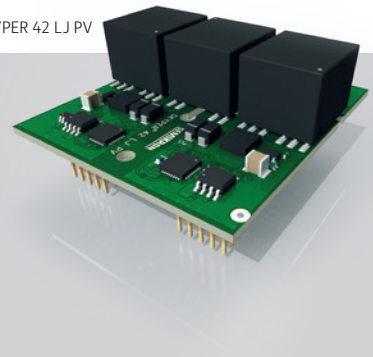
Compact Design
Our SKIC ASIC technology enables very compact system design with minimal peripheral components. With highly integrated signal processing and multi-channel failure management, our ASICs offer robust gate control



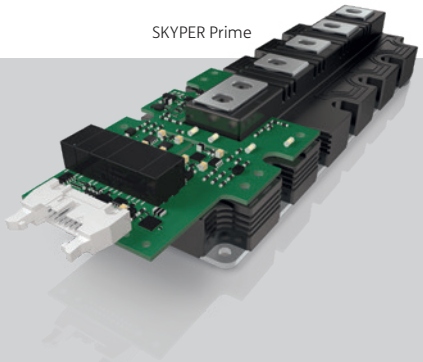
Key Factors

Reinforced insulation for signal and power transmission
Two-channel driver
Up to 1700V transients
Up to 1500V continuous DC bus voltage
8Apk to 35Apk per channel
1W to 4.2W peak per channel
Suitable for multi-level topologies and Generation 7 IGBT

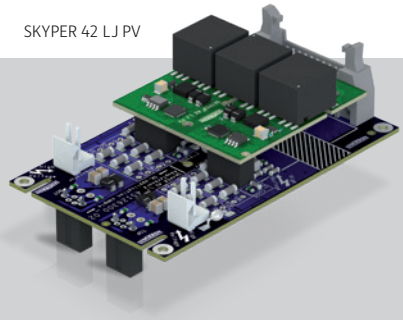
SKYPER 42 LJ PV



SKYPER Prime



SKYPER 42 LJ PV



Driver Cores
Two-channel driver cores for PCB integration with Semikron Danfoss ASIC technology and integrated safety functions

Plug-and-Play Driver
Two-channel drivers for direct module mounting with electrical or optical interface

Adapter Board and Application Samples
Adapter boards for driver core mounting to Semikron Danfoss IGBT and SiC modules

Thermal Interface Materials
Stay Cool: Heat Dissipation is Our Job

Semikron Danfoss was the first power module manufacturer on the market to offer power modules with pre-applied thermal interface material (TIM). We now have over two decades of experience and more than 30 million pre-printed modules in the field.

We design print patterns for each module type for the best TIM distribution and thickness when the module is mounted to a heatsink. These patterns are printed on the modules in a clean environment on an automated silkscreen and stencil printing line. Statistical process control (SPC) is used to guarantee consistency. Special packaging is implemented to ensure that the TIM arrives at your production line in pristine condition.

Semikron Danfoss offers either thermal grease or phase change material depending on customer requirements (e.g. performance increase, reduced handling effort) and module type (with or without baseplate). The reliable assembly of baseplate-less modules is aided by a low-viscosity material such as thermal paste. Our High Performance Thermal Paste (HPTP) achieves this and, with optimized filler content, provides best in class thermal performance.

Alternatively, for ease-of-handling during assembly, most power modules are also available with pre-applied phase change material (PCM). Phase change materials have a solid consistency at room temperature. With the application of heat during first operation, the PCM flows to fill gaps and provide a thermal interface. With HP-PCM, the new Semikron Danfoss-exclusive High Performance Phase Change Material, we combine the benefits of a phase change material with the performance of the best available paste.

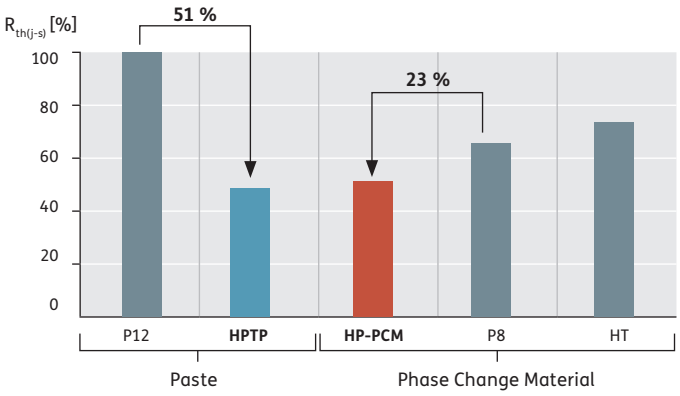
Key Features

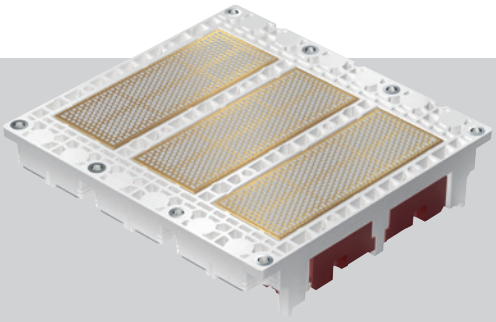
- Module-specific patterns for optimized TIM distribution
- Simplified logistics and reduced production costs
- Improved assembly robustness
- Increased lifetime and reliability

Portfolio

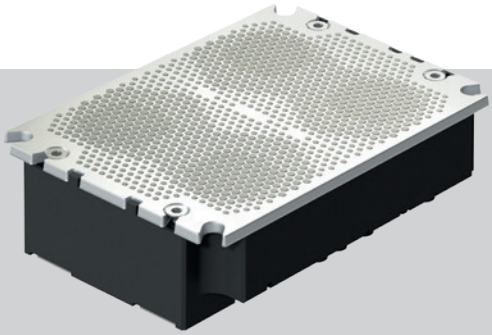
HPTP: High Performance Thermal Paste

HP-PCM: High Performance Phase Change Material





Baseplate-less module with pre-applied thermal paste



Baseplate module with pre-applied phase change material

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 CO_2 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.

05/2024

SEMIKRON DANFOSS

Semikron Danfoss GmbH
Husumer Strasse 251
24941 Flensburg, Germany

Semikron Danfoss International GmbH
Sigmundstrasse 200
90431 Nuremberg, Germany

www.semikron-danfoss.com