POWER ELECTRONICS FOR SOLAR/ESS

SEMIKRON DANFOSS

Solar and Energy Storage Systems

Solar Energy

This portfolio includes a wide range of products for efficient solar inverters in all power ranges: residential, industrial and utility scale. The products are scaleable, from individual modules, including dedicated drivers, to high power SKiiP 4 IPMs and ready-to-use power electronic stacks. We also offer a large portfolio of 3-level power modules, IPMs and power electronic stacks, which can reduce system costs significantly as well as optimize annual energy production, especially for increased DC voltages up to $1500V_{DC}$.

STRING INVERTERS

5kW - 250kW

- Residential
- Commercial/industrial
- Utility

$1500V_{DC}$ capability
High efficiency
High reliability to reduce downtime

Products

SEMITOP E1/E2
MiniSKiiP
SEMiX 5
Drivers

CENTRAL INVERTERS

250kW - 6MW

- Commercial/industrial
- Utility

$1500V_{DC}$ capability
High efficiency
High reliability to reduce downtime

Products

SEMiX 5
SEMiX 3 Press-Fit
SEMITRANS Classic
SEMITRANS 10
SEMITRANS 20
SKiiP 3/4 IPM
Drivers
Power Electronic Stacks

Energy Storage

With decentralized renewable energy sources in our power grid, the demand for energy storage systems to stabilize fluctuations is quickly growing. This portfolio includes a wide range of products for energy storage systems. From small and medium power modules for residential/industrial systems to high power components for utility scale systems, these products deliver maximum reliability. A variety of semiconductor packaging technologies are available to meet ESS industry lifetime requirements. From individual modules, including dedicated drivers, to high power SKiiP 4 IPMs and ready-to-use power electronic stacks – we have the solution.

LOW/MEDIUM POWER

8kW - 75kW

- Residential
- Commercial/industrial
- Solar plus storage

Compact designs and high power density
High efficiency
High reliability to reduce downtime

Products

SEMITOP E1/E2
MiniSKiiP
SEMiX 5
SEMiX 3 Press-Fit
SEMITRANS Classic
Drivers

MEDIUM/HIGH POWER

50kW - 5MW

- Commercial/industrial
- Utility scale
- Solar plus storage

1500V_{DC} capability
High efficiency
High reliability to reduce downtime

Products

SEMITOP E1/E2
SEMiX 5
SEMiX 3 Press-Fit
SEMITRANS Classic
SEMITRANS 10
SEMITRANS 20
SKiiP 3/4 IPM
Drivers
Power Electronics Stacks

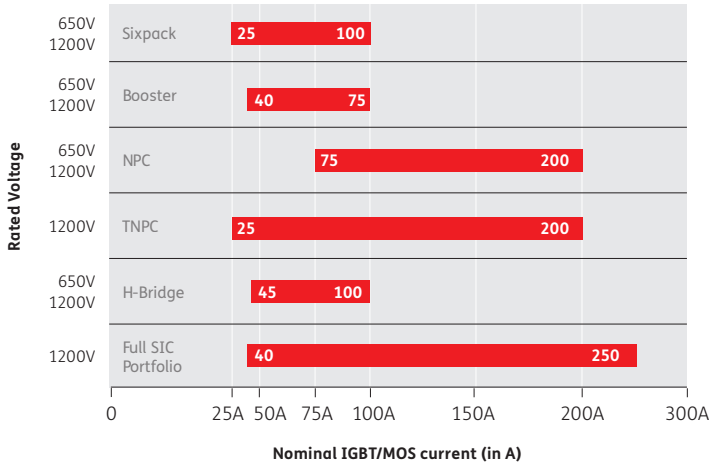
PRODUCT HIGHLIGHT

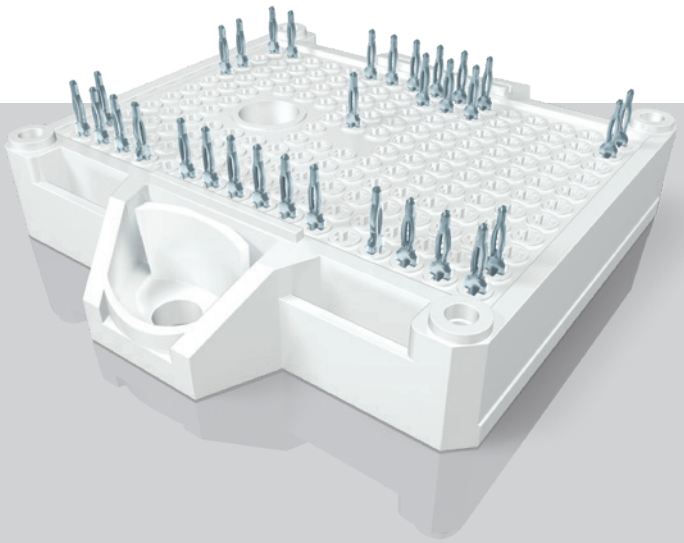
Comprehensive **3-Level and Booster** Module Family

The SEMITOP E1/E2 packages provide supply chain security with a standard industrial design. Press-fit pins offer reduced manufacturing time and a low inductance design. Ideal for fast switching chips, such as SiC, the SEMITOP has a wide portfolio of topologies, ready for your string inverter design.

Key Features

- Low stray inductance case
- Solder-free, press-fit assembly
- Optimized thermal performance
- Flexible architecture
- Available with silicon, full SiC, or hybrid SiC





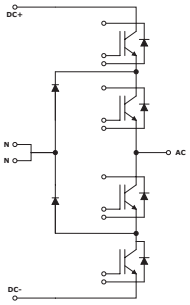
SEMITOP® E1/E2
8kW up to 225kW

Increased Performance in 3-Level Topologies

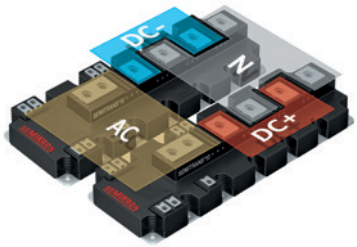
In order to achieve economy of scale, manufacturers typically use the same hardware for solar and energy storage converters. While the three-level NPC topology works well for solar, this can often mean de-rating for energy storage while in charging mode. Thanks to the chip shrinkage from Generation 4 to Generation 7 IGBTS, there is more space for diodes. Therefore, the SEMITRANS 10 MLI offers an increased clamping diode current rating. This enables energy storage converters to work at full power while charging and discharging batteries.

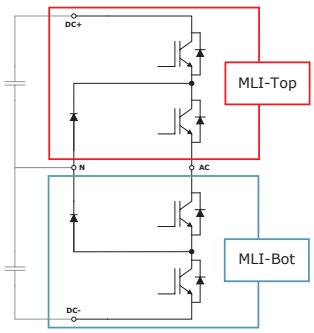
Key Features

- Reduced magnetics cost thanks to 3-level topology
- Up to 1.5MW with liquid cooling
- Based on latest Generation 7 IGBTs
- Reduced cable diameters or cable losses with up to 1500V_{DC} operation
- Reduced cooling requirements thanks to low losses

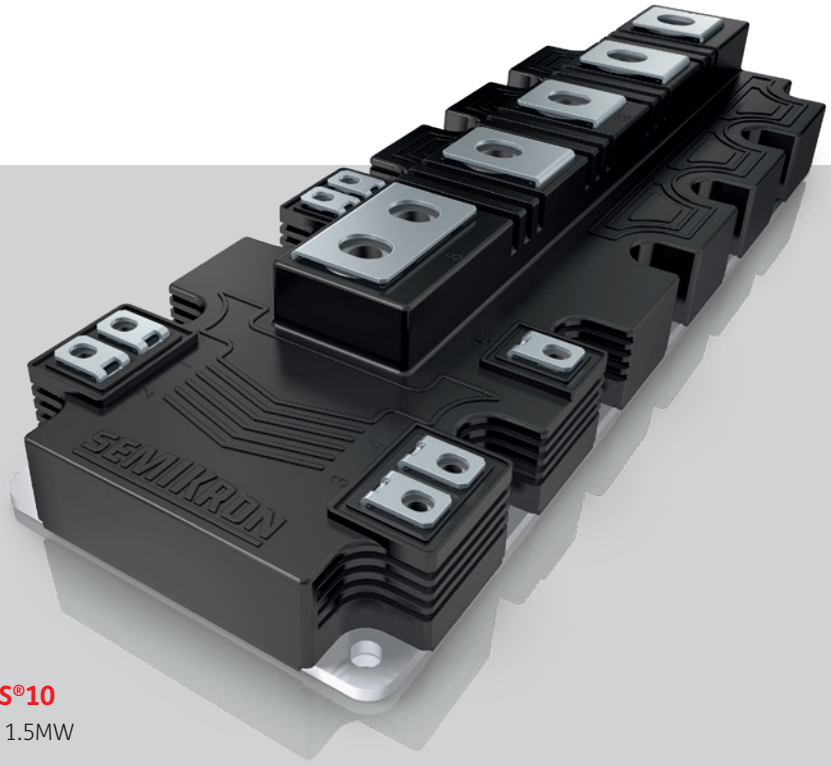


SEMITRANS® 10 P3L
Compact NPC phase-leg up to 500kW





SEMITRANS® 10 MLI
Split NPC phase-leg among two SEMITRANS 10 MLI modules for up to 1.5MW



SEMITRANS®10
500kW up to 1.5MW

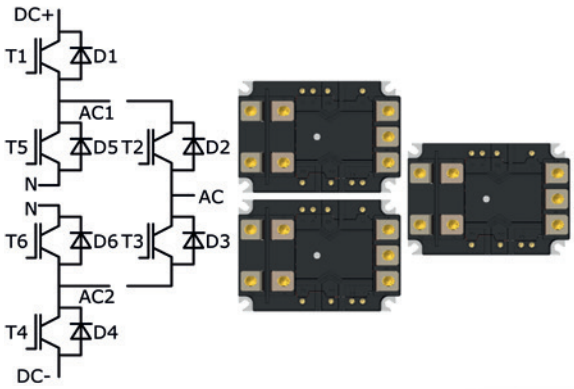
The **Latest Generation 7 IGBTs** for Highest **Supply Chain Safety**

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.

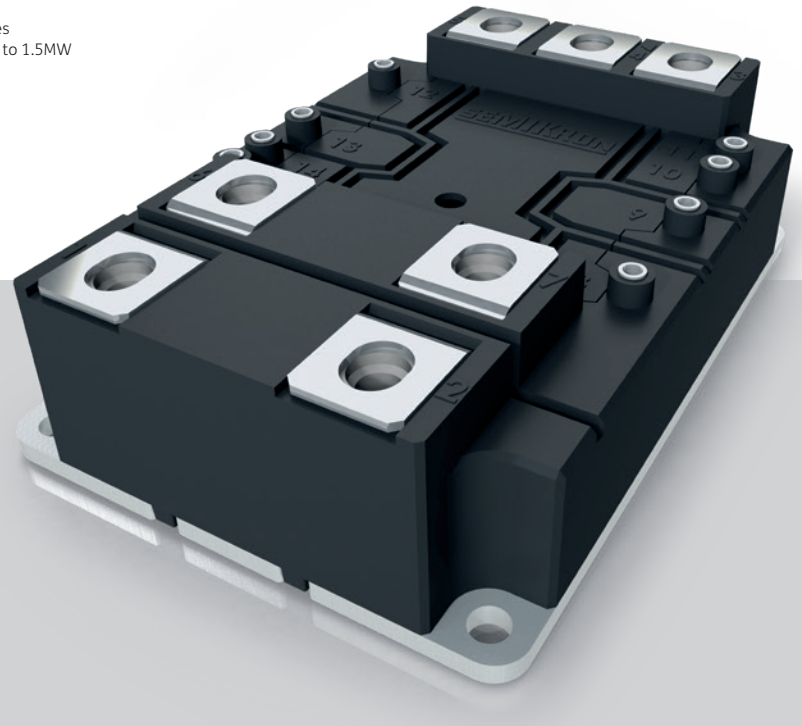
For ANPC topologies, our new SEMITRANS 20 power module combines low stray inductance, high power density and Generation 7 IGBTs to set a new benchmark. This package design, based on standard half-bridge topology, allows a simple ANPC layout with low inductance DC-link connections.

Key Features

- Reduced magnetics cost thanks to 3-level topology
- Up to 2MW without paralleling
- Reduced switching losses with 1200V IGBT
- Latest Generation 7 IGBTs
- Reduced cable diameters or cable losses
- Reduced cooling requirements



Three SEMITRANS 20 modules make ANPC phase-leg for up to 1.5MW



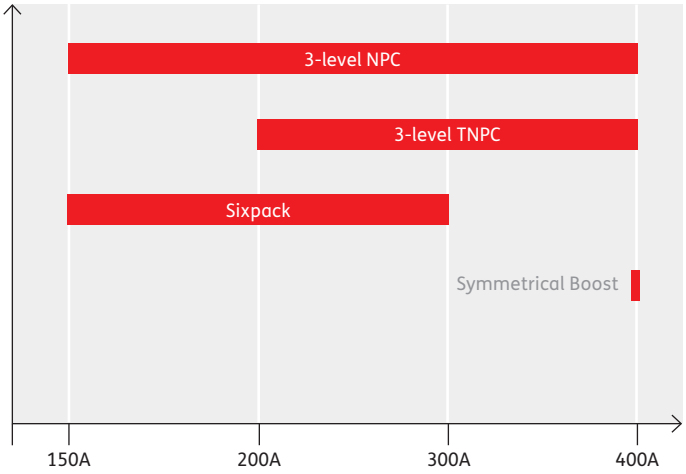
SEMITRANS®20
500kW up to 2MW

PRODUCT HIGHLIGHT

Comprehensive **Sixpack and 3-Level** Module Family

With its comprehensive portfolio and its optimized design, the SEMiX 5 is ideal for high-performance inverter architectures. The press-fit contacts ensure fast and solder-free driver board assembly, increased reliability and reduced assembly cost.

Adapter boards for easy gate drive integration are also available. The internal chip layout is optimized for enhanced thermal performance, reducing operating temperatures, thus boosting reliability. The housing features rugged moulded power terminals for superior mechanical stability.

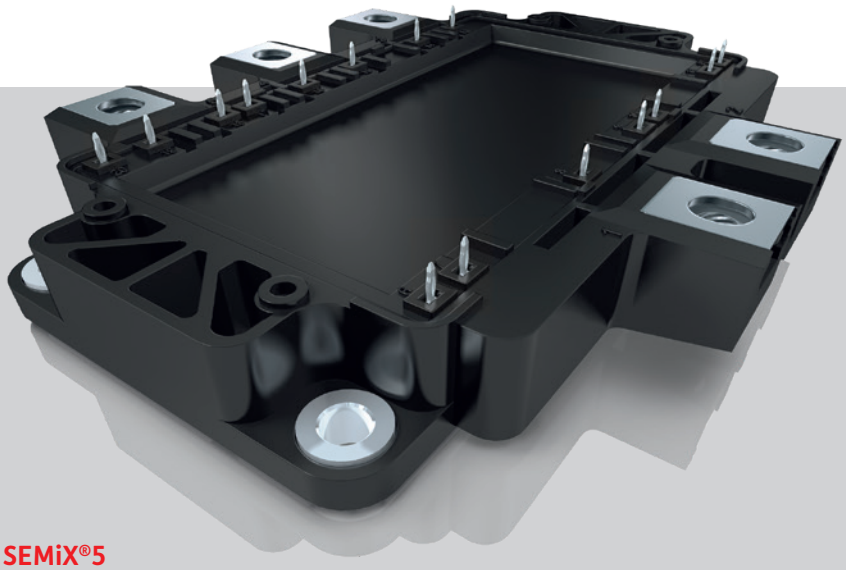


Key Features

- Low stray inductance package
- Solder-free assembly
- Optimized thermal performance
- Flexible architecture
- Press-fit design
- 17mm module height

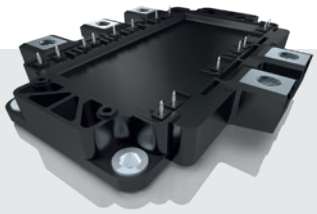
Exceeding the Standard

- Optimized module design for ultimate thermal footprint
- Effective heat spreading for improved thermal performance
- Longer lifetime for tighter reliability requirements
- Suitable for very fast switching applications thanks to very low inductance layouts



SEMiX®5
50kW up to 250kW

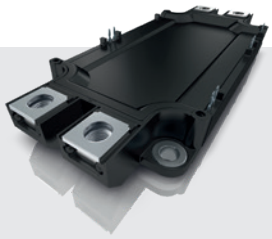
Product Portfolio
Power Modules for **Solar** and **Energy Storage Systems**



SEMiX®

50kW up to 150kW

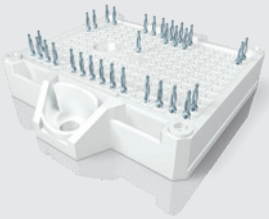
Extended Porfolio with Superior Thermal and Dynamic Performance
Industry standard baseplate module
650V / 1200V / 1700V IGBT: 150A to 400A
Sixpack, NPC and TNPC topologies
Optimized module layout for maximum heat transfer
Enhanced thermal and electrical diode performance



SEMiX® 3 Press-Fit

100kW up to 400kW

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



SEMITOP® E1/E2

8kW up to 225kW

Exceeding the Standard for Superior Performance
Baseplate-less industry standard power module in two housing sizes
Press-fit pins for solder-less connection to PCB
650V / 1200V IGBT: 10A to 250A
3-level NPC and ANPC, sixpack, H-bridge and half-bridge topologies
Optimized mounting concept provides lowest thermal resistance in class
Soft and fast switching 650V IGBT S5 and H5
Hybrid and full SiC modules up to 1200V/250A

MiniSKiiP®

20kW up to 300kW

Solder-Free Spring Technology for Minimum Assembly Time
Full family of power modules up to 300kW
650V / 1200V / 1700V IGBT: 4A to 400A
1200V Hybrid SiC: 50A to 150A
Sixpack, twelvepack, H-bridge, half-bridge and 3-level topologies
Easy and flexible PCB routing without pin holes

SEMITRANS® Classic

25kW up to 1MW

The Proven Power Electronics Package

Robust industry standard package for multiple sourcing in 6 housing sizes

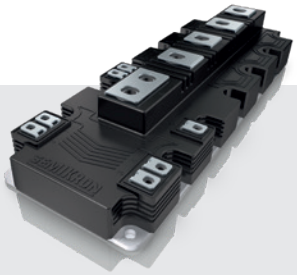
600V / 650V / 1200V / 1700V IGBT:
50A to 900A

1200V SiC: 125 to 500A
1700V SiC: 378A

Half-bridge, single switch and brake chopper topology

Multiple IGBT sources including Generation 7 IGBT M7

Extended 62mm portfolio
1200V IGBT: 800A
1700V IGBT: 500A



SEMITRANS® 10

500kW up to 2MW

Robust High Power Module

Established high power module package

1200V IGBT: 700A to 1400A
1700V IGBT: 1000A and 1800A

Half-bridge, NPC and split NPC topologies

Full second source thanks to alternative 1700V chip source

SEMITRANS® 20

500kW up to 2MW

The New Standard in High Power

The latest industry standard power module for high power applications

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

Half-bridge topology

Low stray inductance,
high power density package

Increased reliability thanks to the latest packaging technology

Intelligent Power Modules (IPMs) for **Maximum Reliability** for Solar and Energy Storage Converters

The SKiiP IPM product line sets a benchmark for high performance and robust inverter designs. Both SKiiP 3 and SKiiP 4 feature high power densities combined with flexible cooling options such as air and water cooling, also with customized heat sinks. Reliable driver technology, integrated current sensors and comprehensive protection functions complete the IPM design.

SKiiP 3 has propagated widely through the industrial drive segment. With its sixpack or half-bridge topologies, it covers a current range from 500A up to 2400A.

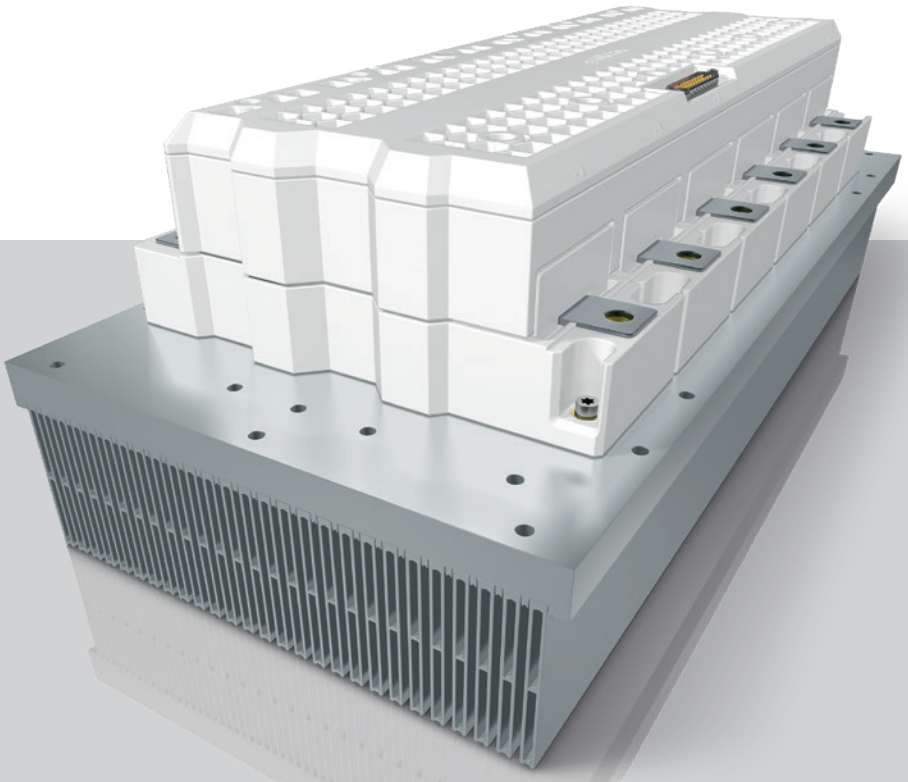
Key Features

1200V and 1700V
Half-bridge and sixpack
500A to 3600A
Flexible cooling options: air, water or customized cooling options, high performance cooling, single and double side mounting water coolers
Paralleled operation for even higher output power possible
Special version for 1500V_{DC} available

The SKiiP 4, available in a half-bridge topology, has been optimized for highest power cycling requirements and covers the higher power range up to 3600A. To ensure highest reliability and service life, the power circuitry is 100% solder-free. Sinter technology as die attach replaces the solder layer, which usually causes the limitation in lifetime. Hence, sintering improves power and thermal cycling capability.

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 measurement. The CAN interface allows setting the SKiiP 4 configuration parameters and reading application parameters.

High Perfomance Cooling (HPC) technology has been introduced providing approximately 25% more output capability compared to standard water cooling. A double side mounting HPC water cooler is also available and enables an even higher power density.



SKiiP®4
500kW up to 3MW
The most powerful IPM in the market


Energy storage

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 Rectifier-, IGBT- and SiC-based stacks for AC voltages from 380V to 1000V. Our standard stacks cover an output current range of 70A to 4000A and building blocks based on three level topologies that are ready to use in $1500V_{DC}$ environment.

Water-Cooled IGBT Stacks

SEMISTACK RE
SEMIKUBE MLI

Air-Cooled IGBT Stacks

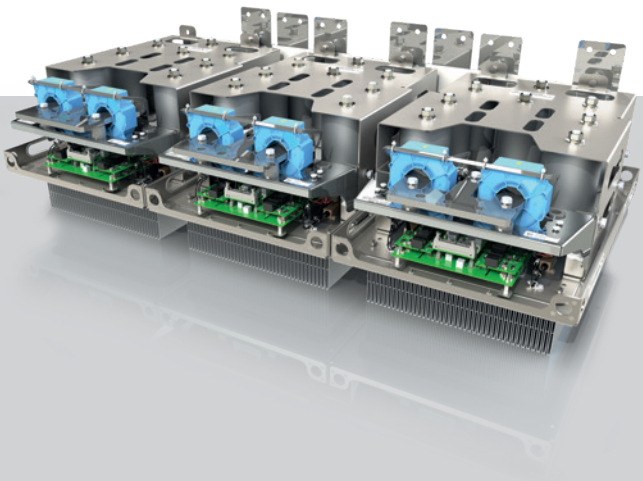
SEMIKUBE 1500V
SEMIKUBE SlimLine
SEMIKUBE MLI (1500V capable)

Customized Stacks

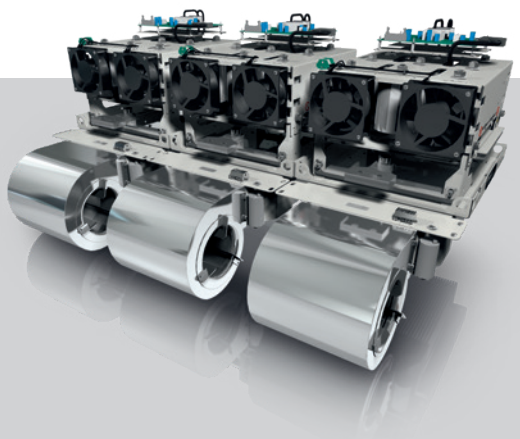
In addition to standard stacks, Semikron Danfoss has vast experience in developing customer-specific solutions. Engineers are available in our stack centers around the globe to offer specific solutions by adapting existing platforms or designing customized converters.

Four Key Factors to Your Success

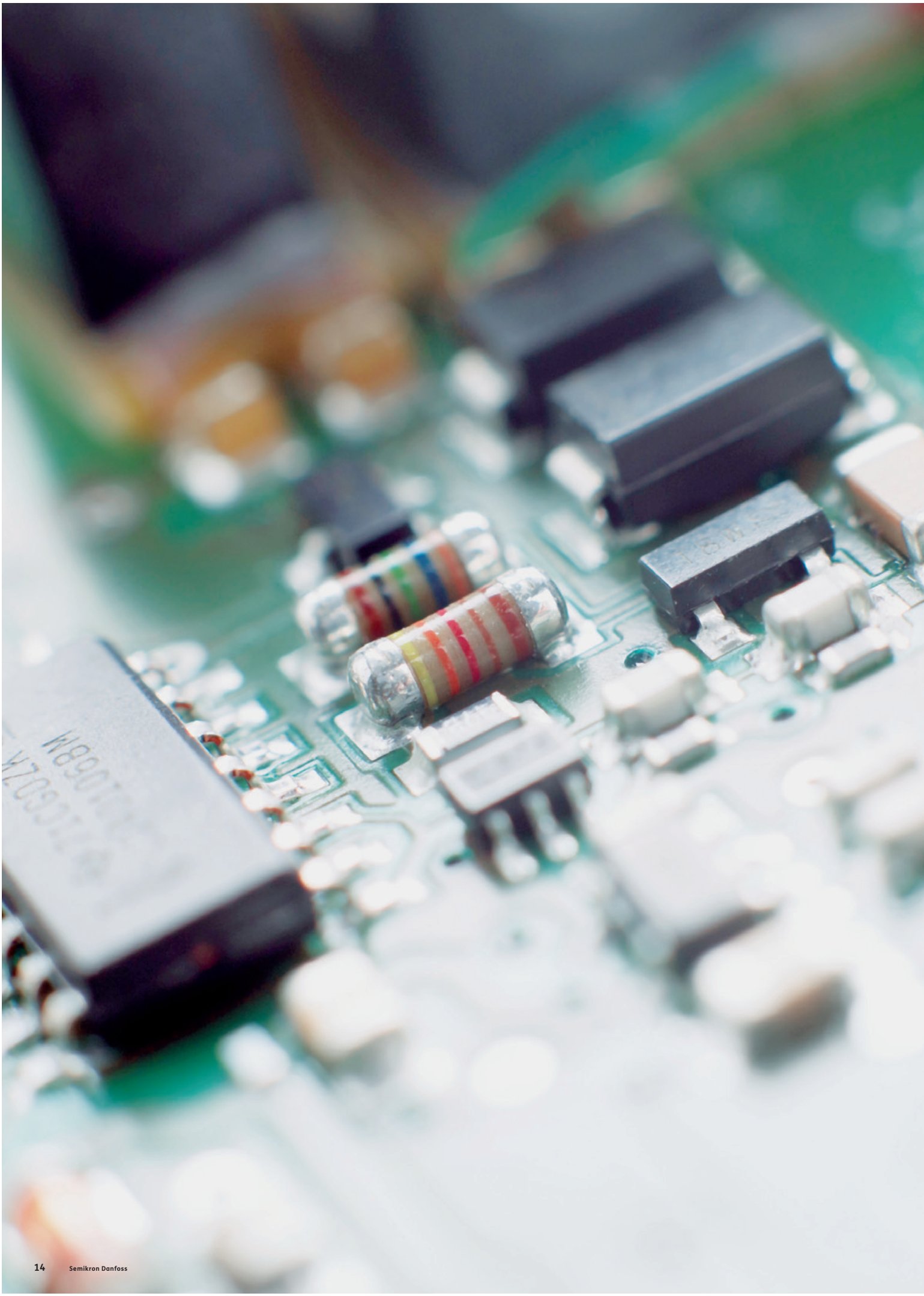
- Shortest time to market
- Cost savings in R&D, production and qualification
- Global Semikron Danfoss stack production footprint
- Highly experienced engineering team



SEMIKUBE® MLI
1.5MW 3-Level IGBT Topology



SEMIKUBE®
Air-cooled IGBT Power 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.

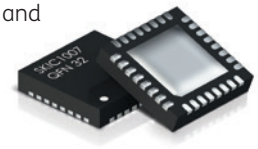
Our IGBT drivers are available as two- channel driver cores suitable for any standard semiconductor power module or as Plug-and-Play solutions, which perfectly fit the SEMiX 3 Press-Fit, SEMITRANS 10 and compatible modules.

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 and SKHI 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.

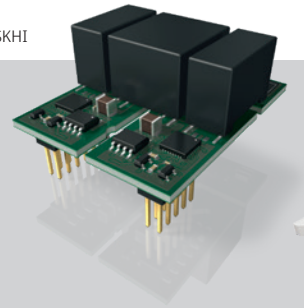
Compact Design
Our SKIC ASIC technology enables very compact system design with minimal peripheral components. With highly integrated signal processing and multi-channel failure management, our ASICs offer robust gate control



Key Factors

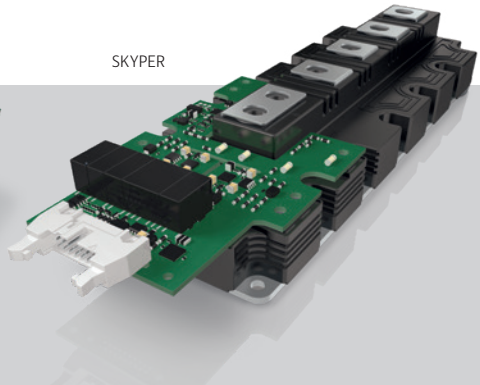
Reinforced insulation for signal and power transmission
Two-channel driver
Up to 1700V transients
Up to 1500V continuous DC bus voltage
8Apk to 35Apk per channel
1W to 4.2W peak per channel
Suitable for multi-level topologies and Generation 7 IGBT

SKYPER & SKHI



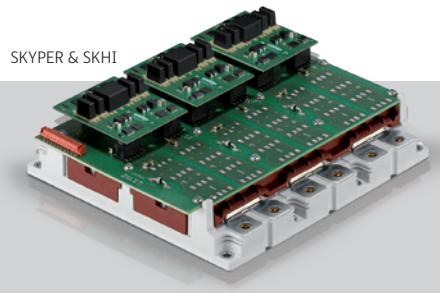
Driver Cores
Two-channel driver cores for PCB integration with Semikron Danfoss ASIC technology and integrated safety functions

SKYPER



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

SKYPER & SKHI



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 25 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.

In order to achieve the best thermal performance in all applications, Semikron Danfoss power modules can be supplied with our High Performance Thermal Paste (HPTP).

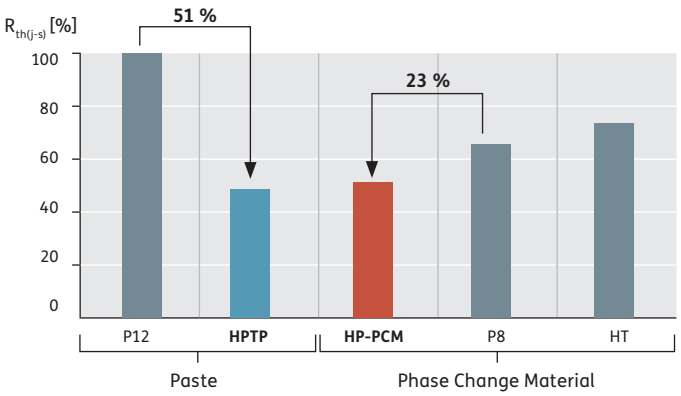
Alternatively, for ease-of-handling during assembly, most power modules are also available with pre-applied phase change material (PCM). Phase change materials have a solid consistency at room temperature. With the application of heat during first operation, the PCM flows to fill gaps and provide a thermal 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.

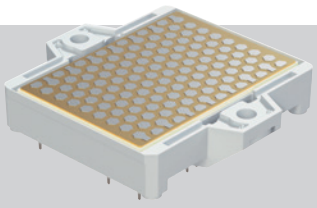
Key Features

- Best possible thermal performance
- Simplified logistics and reduced production costs
- Improved assembly robustness
- Increased lifetime and reliability

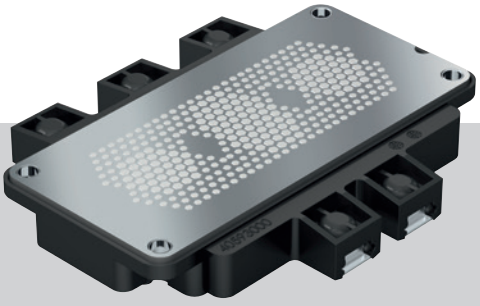
Portfolio

- **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 sustainable 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.

05/2023

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