POWER ELECTRONICS FOR SOLAR/ESS

SEMIKRON DANFOSS

Solar and Energy Storage Systems

Solar Energy

Our 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 4/7 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 E
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 4/7 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. Our 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 4/7 IPMs and ready-to-use power electronic stacks – we have the solution.

LOW/MEDIUM POWER

8kW - 250kW

- Residential
- Commercial/industrial
- Solar plus storage

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

Products

SEMITOP E
SEMiX 5
SEMiX 3 Press-Fit
SEMITRANS Classic
Drivers

MEDIUM/HIGH POWER

250kW - 6MW

- Commercial/industrial
- Utility
- Solar plus storage

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

Products

SEMITOP E
SEMiX 5
SEMiX 3 Press-Fit
SEMITRANS Classic
SEMITRANS 10
SEMITRANS 20
SKiiP 4/7 IPM
Drivers
Power Electronics Stacks

Innovative **Power Modules** and **Solutions** that **Push the Limits of SiC**

SEMITOP E2 for the Highest Performance

By utilizing advanced 2kV SiC technology, the SEMITOP E2 performs exceptionally well in 1500V solar and ESS applications. This cutting-edge design allows for compact installations while maximizing overall performance. Designed with low stray inductance, this module features an innovative baseplate-less design, optimized for efficient liquid cooling.

Key Features

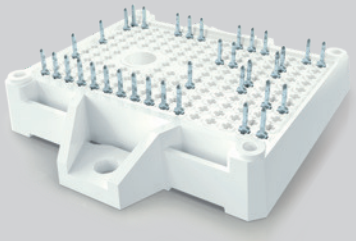
- Baseplate-less design, optimized for liquid cooling
- Industry standard package design
- 2kV blocking voltage enables 1500V_{DC} with 2-level topology
- Scalable through paralleling
- Low stray inductance
- Optimized thermal performance

SEMITRANS for Extreme Power Density

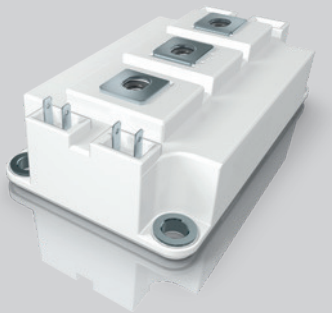
Thanks to new 2kV SiC technology, the SEMITRANS power modules boost the power density of power electronics compared to 3-level silicon solutions. A high blocking voltage capability offers safety for 2-level converters operating at 1500V, simplifying converter design. The SEMITRANS 20 offers an optimized construction for scaling to even higher power levels through paralleling. The SEMITRANS 3 enables medium power converter design, bridging the gap from low to high power.

Key Features

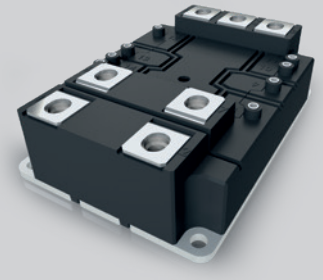
- Industry standard package design
- 2kV blocking voltage enables 1500V_{DC} with 2-level topology
- Scalable through paralleling
- Low thermal resistance package design
- Low inductance for fast switching
- 20% lower losses compared to 3-level silicon design, reducing cooling effort



SEMITOP®E2
150kW up to 250kW



SEMITRANS®3
200kW up to 400kW



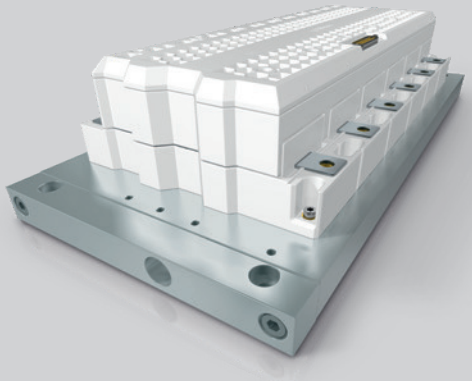
SEMITRANS®20
from 500kW

SKiiP 4 SiC IPM for Reduced Time-to-Profit

The new SKiiP 4 SiC with 2kV SiC devices enable safe operation of 1500V applications thanks to an integrated driver, current sensing, and protection functions. The SKiiP includes an air- or water-cooled heatsink and is 100% tested. The digital driver enables the use of multiple SiC MOSFET suppliers, and the current rating is adjustable based on the quantity of chips in parallel.

Key Features

- 2kV blocking voltage enables 1500V_{DC} with 2-level topology
- Includes driver, current sensor, and liquid- or air-cooled heatsink
- Driver includes Semikron Danfoss ASIC and multiple protection features
- 100% burn-in testing



SKiiP®4 SiC

500kW up to 2MW

SEMITACK RE SiC for Increased Integration

Our power electronic stacks empower customers to thrive in dynamic markets and tackle global challenges with confidence. The latest SEMISTACK RE leverages 2kV SiC technology, enabling a simplified 2-level design for 1500V applications. Its modular, interconnectable architecture integrates SKiiP 4 SiC with DC Link and busbarring, delivering higher integration and accelerating your time-to-profit.

Key Features

- 2kV blocking voltage enables 1500V_{DC} with 2-level topology
- Shortest time to market
- Cost savings in R&D, production and qualification
- Global Semikron Danfoss stack production footprint
- Highly experienced engineering team

SEMISTACK® RE SiC

1.5MW up to 8MW

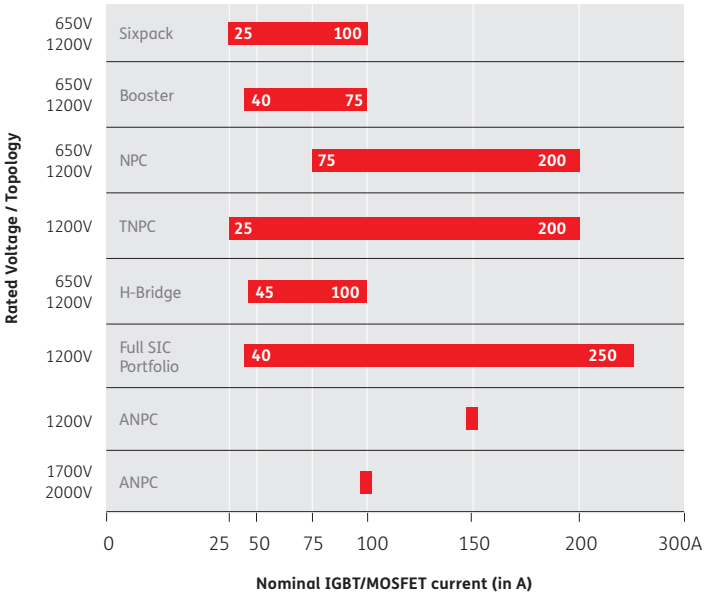
PRODUCT HIGHLIGHT

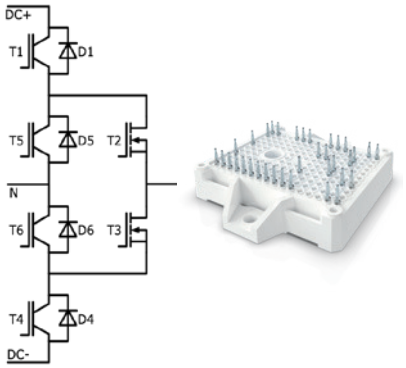
Comprehensive **3-Level and Booster** Module Family

The SEMITOP E 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.

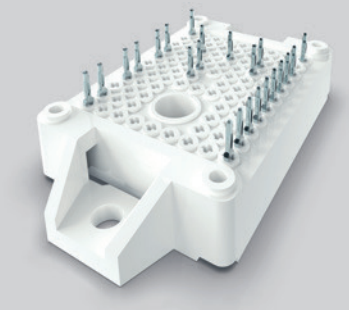
Key Features

- Ready for $1500V_{DC}$ and $2000V_{DC}$ applications
- Low stray inductance case
- Solder-free, press-fit assembly
- Optimized thermal performance
- Flexible architecture
- Available with silicon, full SiC, or hybrid SiC

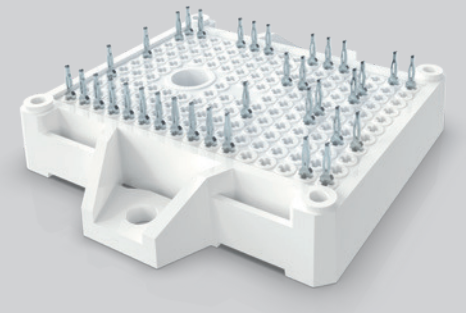




SEMITOP E2 with Si/SiC ANPC topology for $1500V_{DC}$ and $2000V_{DC}$ applications from 100kW



SEMITOP® E1
up to 50kW



SEMITOP® E2
up to 250kW

Increased Performance in 3-Level Topologies

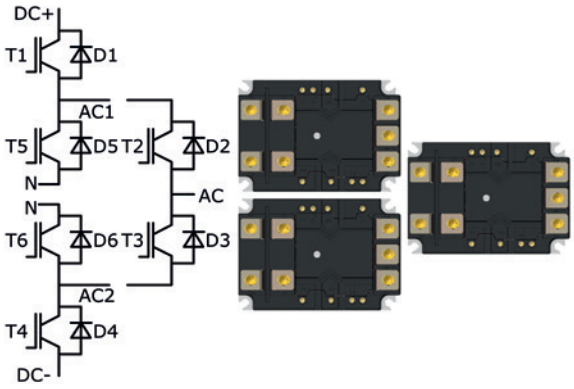
Whenever power quality and efficiency are driving factors in power electronics applications, 3-level topologies are the key. This is especially true for renewable energy applications where the combination with the latest Generation 7 IGBTs sets new benchmarks.

For ANPC topologies, our new SEMITRANS 20 power module combines the 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.

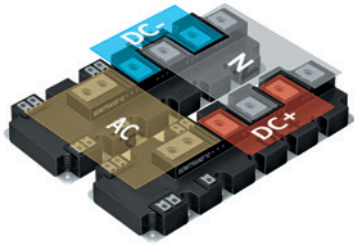
Thanks to the chip shrinkage from Generation 4 to Generation 7 IGBTS, there is more space for diodes. Therefore, the SEMITRANS 10 MLI offers an increased clamping diode current rating. This enables energy storage converters to work at full power while charging and discharging batteries.

Key Features

- Reduced magnetics cost thanks to 3-level topology
- Up to 2MW 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

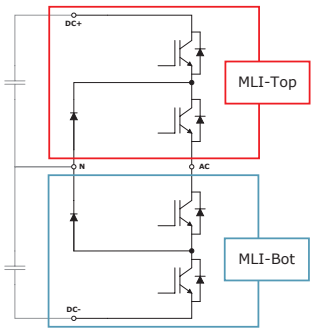


Three SEMITRANS 20 modules make ANPC phase-leg for up to 2MW

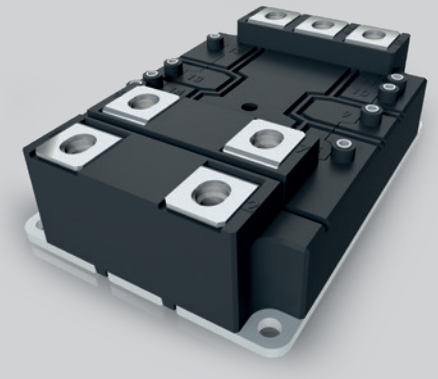


SEMITRANS® 10 MLI
Split NPC phase-leg among two SEMITRANS 10 MLI modules for up to 1.5MW

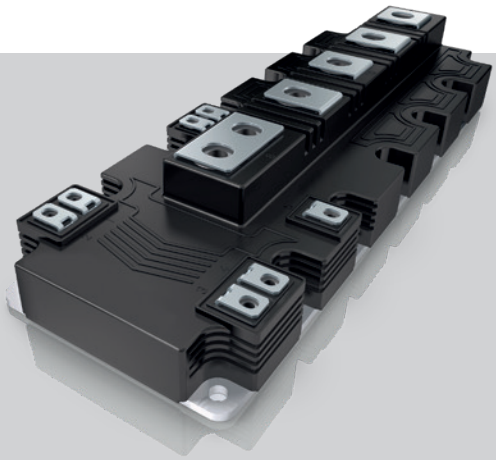
SKM1400MLI12TM7



SKM1400MLI12BM7

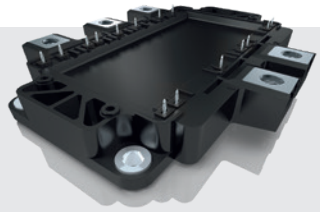


SEMITRANS® 20
from 500kW



SEMITRANS® 10
500kW up to 1.5MW

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

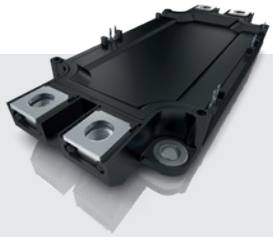


SEMiX® 5

50kW up to 250kW

Extended Porfolio with Superior Thermal and Dynamic Performance

- Industry standard baseplate module
- 650V / 950V / 1200V / 1700V IGBT: 150A to 400A
- Sixpack, NPC and TNPC topologies
- Optimized module layout for maximum heat transfer
- Enhanced thermal and electrical diode performance

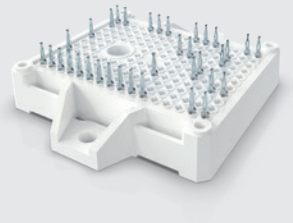


SEMiX® 3 Press-Fit

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 topology
- Direct driver assembly
- Available with integrated shunt resistor

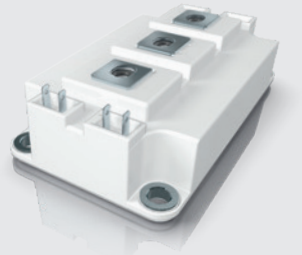


SEMITOP® E

8kW up to 250kW

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 200A
  1200V SiC: 30A to 300A
  2000V SiC: 150A to 200A
- Sixpack, H-bridge, half-bridge, NPC, TNPC, and ANPC topologies
- Optimized mounting concept provides lowest thermal resistance in class
- Soft and fast switching 650V IGBT S5 and H5

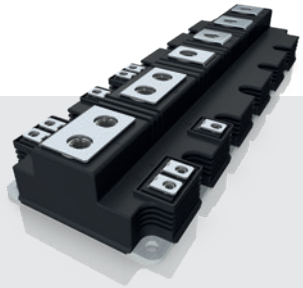


SEMITRANS® Classic

25kW up to 400kW

The Proven Power Electronics Package

- Robust industry standard package for multiple sourcing in six housing sizes
- 600V / 650V / 1200V / 1700V IGBT: 50A to 800A
  1200V SiC: 250A to 450A
  2000V: 350A to 650A
- Half-bridge, single switch and brake chopper topologies
- Multiple IGBT sources including Generation 7 IGBTs
- Extended 62mm portfolio
  1200V IGBT: 800A
  1700V IGBT: 500A



SEMITRANS® 10

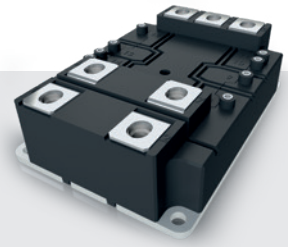
500kW up to 1.5MW

Robust High Power Module

Established high power module package

1200V / 1700V IGBT: 450A to 1800A
2300V IGBT: 1800A

Half-bridge, NPC and split NPC topologies



SEMITRANS® 20

from 500kW

The New Standard in High Power

The latest industry standard power module for high power applications

1200V / 1700V IGBT: 1200A to 1800A
2000V SiC: 1700A/1mOhm

Half-bridge topology

Low stray inductance, high power density package

High 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 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.

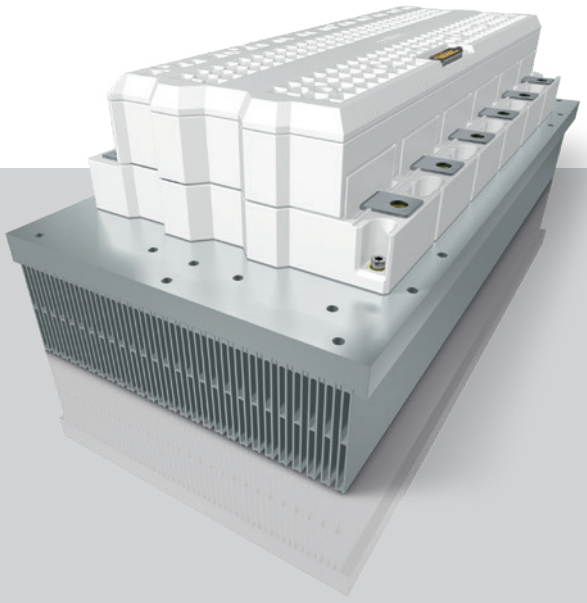
To ensure maximum reliability and service life, the power circuitry is 100% solder-free. Sinter die attach technology replaces the solder layer, the common cause of module lifetime limitations, thus improving power and thermal cycling capability.

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.

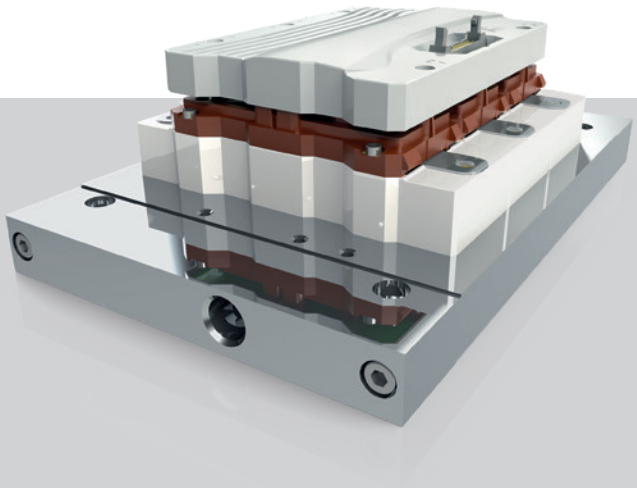
The integrated gate driver in the SKiiP 4 has set new standards in terms of reliability and enhanced functionality through its CAN interface. The digital driver guarantees safe isolation between the primary and secondary side for both switching signals and parameter measurements. The CAN interface allows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



SKiiP®7
150kW up to 2.4MW


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 SiC (1500V capable)
SEMIKUBE MLI (1500V capable)

Air-Cooled IGBT Stacks

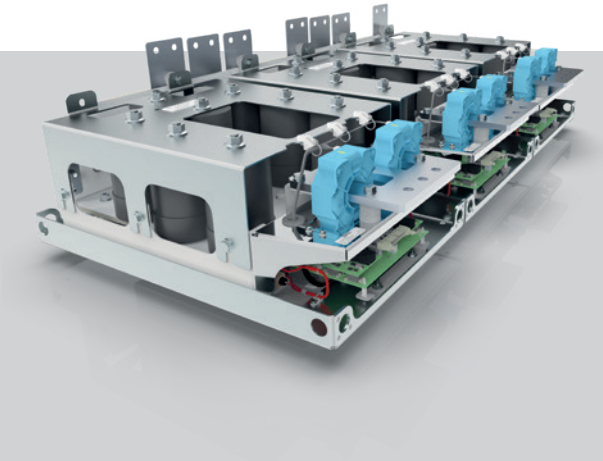
SEMIKUBE 1500V
SEMIKUBE SlimLine
SEMIKUBE MLI (1500V capable)

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.

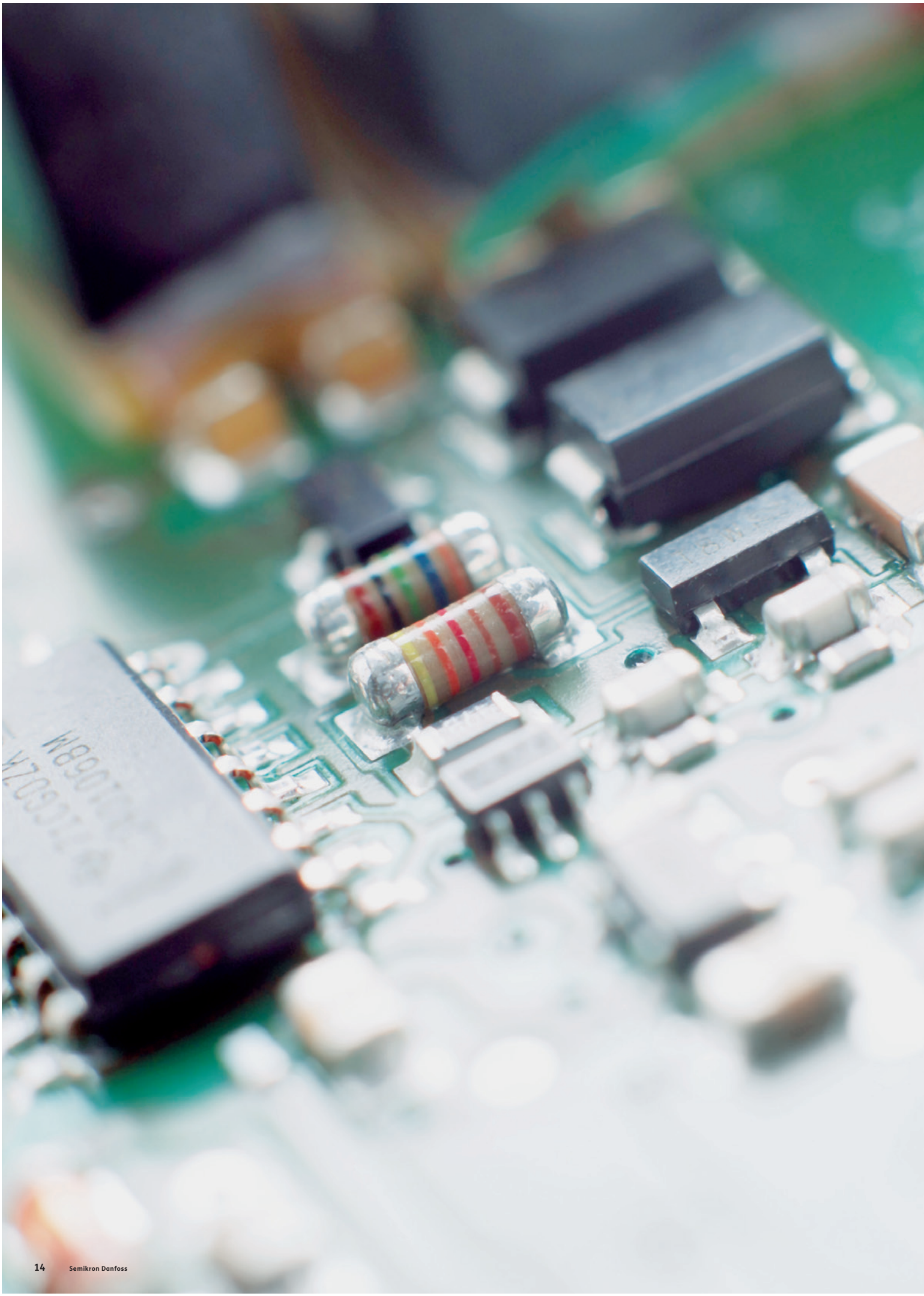
Four Key Factors to Your Success

- 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

SEMISTACK® RE
Liquid-cooled 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.

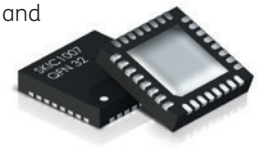
Our IGBT drivers are available as two- channel driver cores suitable for any standard semiconductor power module or as Plug-and-Play solutions, which perfectly fit the SEMiX 3 Press-Fit, SEMITRANS 10 and compatible modules.

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 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.

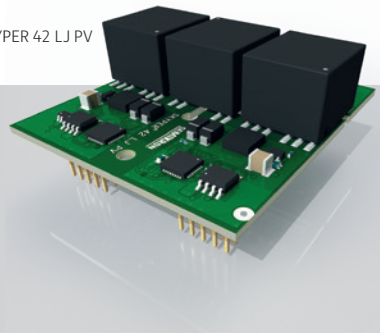
Compact Design
Our SKIC ASIC technology enables very compact system design with minimal peripheral components. With highly integrated signal processing and multi-channel failure management, our ASICs offer robust gate control



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

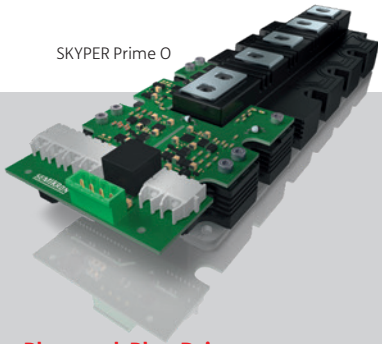


Driver Cores
Two-channel driver cores for PCB integration with Semikron Danfoss ASIC technology and integrated safety functions

SKYPER Prime

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

SKYPER Prime O



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

Thermal Interface Materials
Stay Cool: Heat Dissipation is Our Job

Semikron Danfoss was the first power module manufacturer to offer modules with pre-applied thermal interface material (TIM). We now have over two decades of experience and more than 33 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 in a clean environment using automated silkscreen and stencil machines. Statistical process control (SPC) is used to ensure consistency. Special packaging ensures the TIM arrives in pristine condition.

We offer either thermal grease or phase change material (PCM) based on customer needs (e.g., performance or reduced handling effort) and module type. Baseplate-less modules benefit from low-viscosity materials like thermal paste. Our High Performance Thermal Paste (HPTP) provides top-tier thermal performance with optimized filler content.

For easier assembly, most power modules are also available with pre-applied PCM. PCM is solid at room temperature but becomes fluid during operation, filling gaps for thermal contact. HP-PCM, our exclusive High Performance Phase Change Material, combines the benefits of PCM with the performance of the best thermal paste.

For field serviceability, compressible graphite sheets are an innovative option. Panasonic Industry has overcome the shortcomings of traditional graphite sheets with a new compressible pyrolytic graphite sheet called G-TIM (GraphiteTIM).

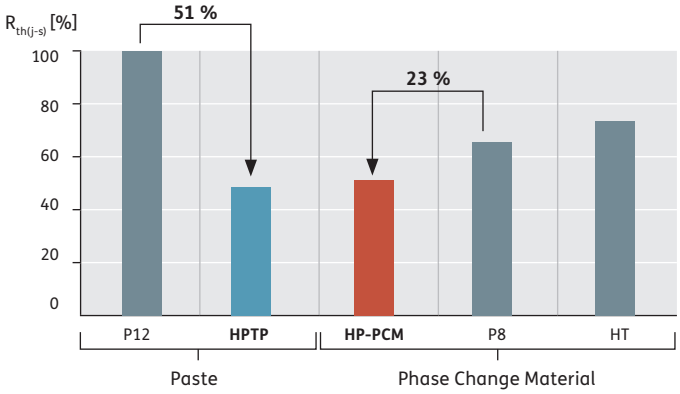
This compressible sheet conforms to the underside of the module during mounting. The crystalline structure of the graphite outstanding long-term stability. Panasonic offers pre-cut graphite sheets for Semikron Danfoss modules.

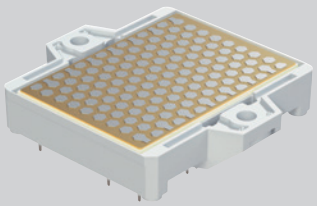
Key Features

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

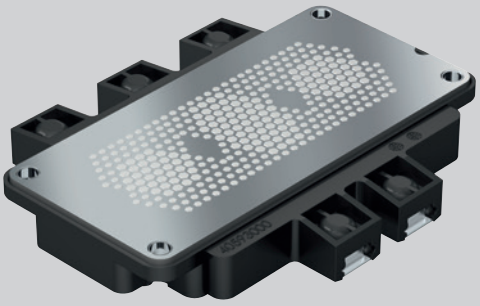
Portfolio

- **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

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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.

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