

POWER ELECTRONICS FOR WIND TURBINES



# Wind Energy



# Performance Range

This 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 4 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 SKiiP4 IPMs and power electronic stacks.

## YAW & PITCHDRIVES

### 5kW - 100kW

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Compact designs and high power density

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High peak overload capabilities

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

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Highest reliability and lifetime

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#### Products

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SEMITOP E1/E2

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MiniSKiiP

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SEMiX 6 Press-Fit

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SEMIPACK

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Drivers

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## MAIN CONVERTER

# 1MW - 18MW

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Compact designs and high power density

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High reliability in harsh environments

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up to 2200V<sub>DC</sub> and 1380V<sub>AC</sub>

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### Products

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SEMiX 3 Press-Fit

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SEMITRANS

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SEMITRANS 10

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SEMITRANS 20

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SKiiP 3/4 IPM

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Drivers

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Power Electronics Stacks

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## SPARE PARTS & SERVICE

# 1MW - 18MW

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Semikron Danfoss advanced power modules

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for maximum reliability and efficiency

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Customized stacks for dedicated wind turbine converters

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Customized heatsinks for IPMs (SKiiP)

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for integration into converters

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### Products

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SEMiX

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SKiM 63/93

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SEMITRANS

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SEMIPACK

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SKiiP 3/4 IPM

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Drivers

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Power Electronic Stacks

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# Operation & Maintenance

## Wind Turbine O&M

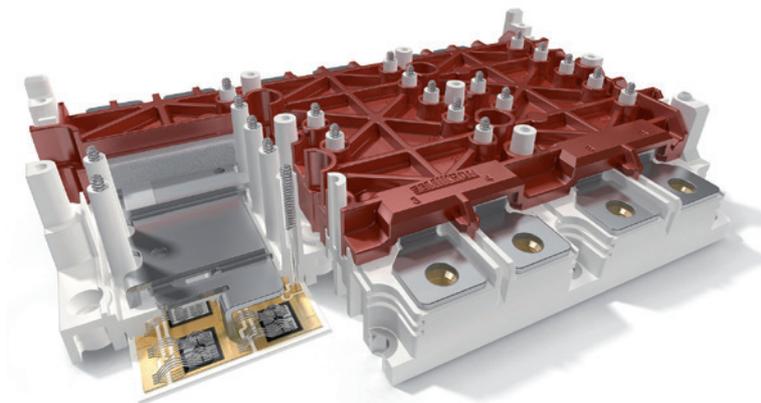
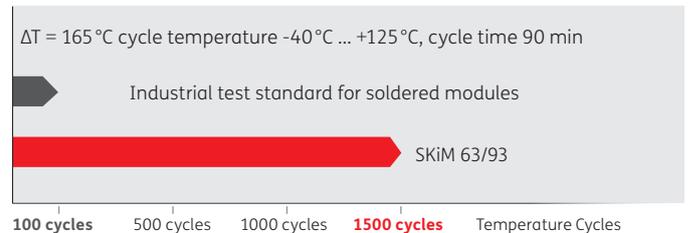
Today, over 400,000 wind turbines are in operation in the field world-wide. The demand for reliable spare parts to ensure continuous energy harvesting until the end of the turbine life is becoming increasingly important. Semikron Danfoss has a broad portfolio of products to ensure reliable operation and maintenance for wind turbine converters. 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 optimised 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



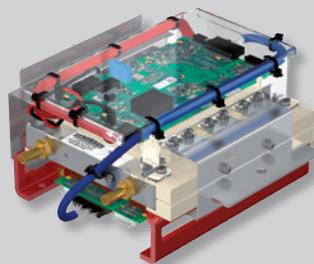
SKiM 63/93



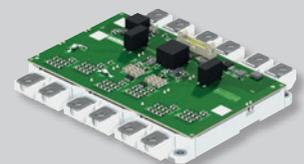
Industry standard power modules



Intelligent power modules



Customized power electronic stacks



Drivers and adapter boards

GENERATION  
**LGBT** 7

# Pushing 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.

SEMITRANS 10 MLI enables wind turbine converters to reach voltage ranges up to  $1000V_{AC}$  ( $1500V_{DC}$ ) in 3-level NPC topology and increases converter efficiency.

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

## Key features

Reduced system cost thanks to 3-level topology

Up to 1.5MW without paralleling

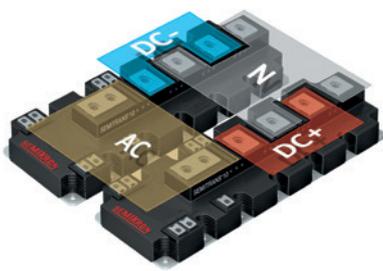
Lower switching losses thanks to 1200V IGBT

Generation 7 IGBTs

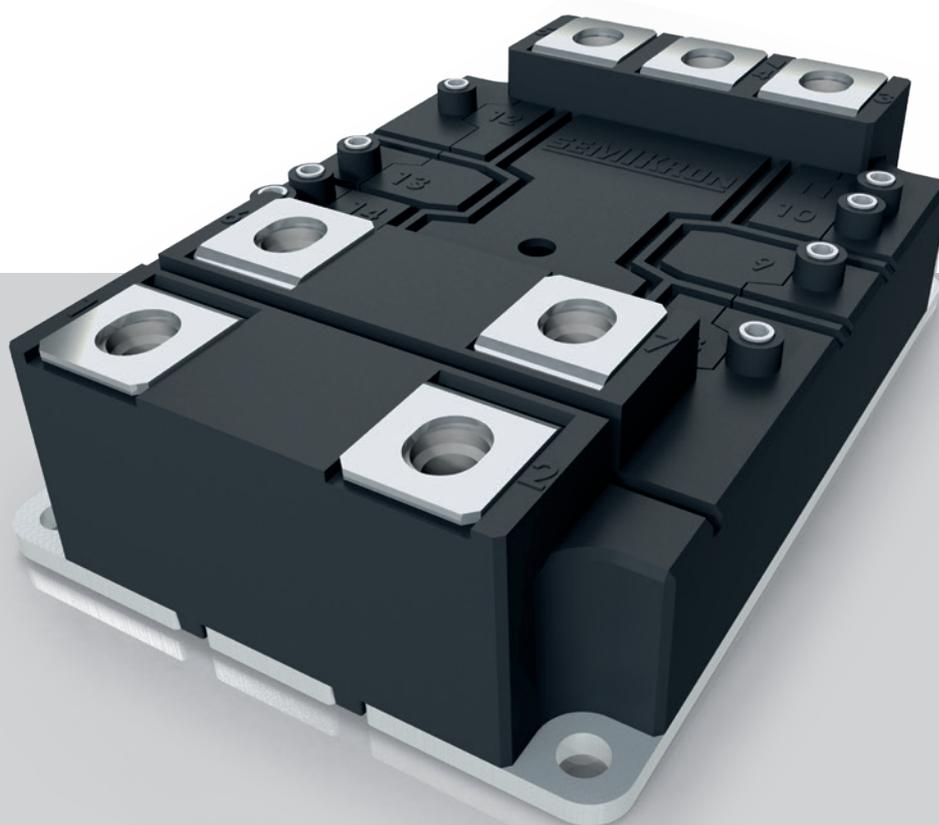
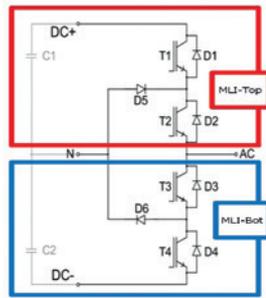
Lower THD means lower filter requirements

Reduced cable diameters or cable losses

Reduced cooling requirements



Compact 1.5MW phase-leg with SEMITRANS 10 MLI



**SEMITRANS®20**

500kW up to 2MW



# Product Portfolio

## IGBT and Rectifier Modules



GENERATION  
IGBT  
7

### SEMISTOP® E1/E2

0.4kW up to 30kW

#### Exceeding the standard for superior performance

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

650V and 1200V: 10A to 100A

IGBT 4 and IGBT T7

CIB and sixpack topologies

Optimised mounting concept and pre-applied

High Performance Thermal Paste provide lowest thermal resistance in class

Increased power density thanks to

Generation 7 IGBT T7

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



GENERATION  
IGBT  
7

### MiniSKiiP®

0.4kW up to 110kW

#### Solder-free spring technology for minimum assembly time

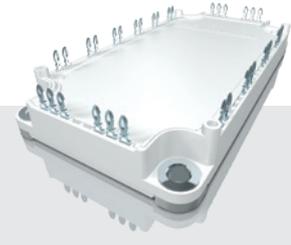
Full family of power modules up to 110kW

650V / 1200V / 1700V IGBT: 4A to 400A

1200V Hybrid SiC: 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



GENERATION  
IGBT  
7

### SEMIX® 6 Press-Fit

15kW up to 75kW

#### The complete press-fit standard

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

650V, 1200V IGBT 4 and IGBT M7:

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



GENERATION  
IGBT  
7

### SEMIx3® Press-Fit

55kW up to 1MW

#### 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



GENERATION  
IGBT  
7

### SEMISTRANS® 10

500kW up to 2MW

#### Robust high power module

Established high power module package

1200V IGBT: 1400A and 1800A

1700V IGBT: 1000A and 1400A

Half-bridge and split NPC topologies

Latest Generation 7 IGBTs for for 3-level

NPC modules



GENERATION  
IGBT  
7

### SEMISTRANS® 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

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 or water cooling, also with customized heatsinks. 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

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1200V and 1700V

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Half-bridge and sixpack

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500A to 3600A

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Flexible cooling options: air, water or customized cooling options, high performance cooling, single and double side mounting water coolers

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Paralleled operation for even higher output power possible

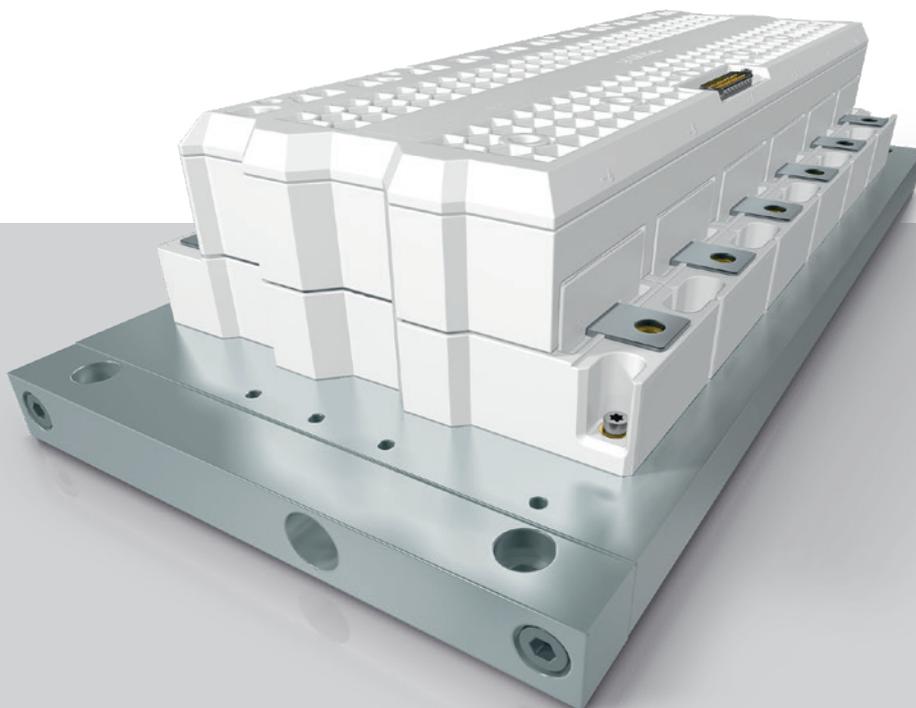
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The SKiiP 4, available in half-bridge topology, has been optimized for highest power cycling requirements and covers the higher power range up to 3600A.

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 parameter and reading application parameter.

High performance 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



# 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

## Customised Stacks

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

## Four key factors for your success

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Shortest time to market

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Cost savings in R&D, production and qualification

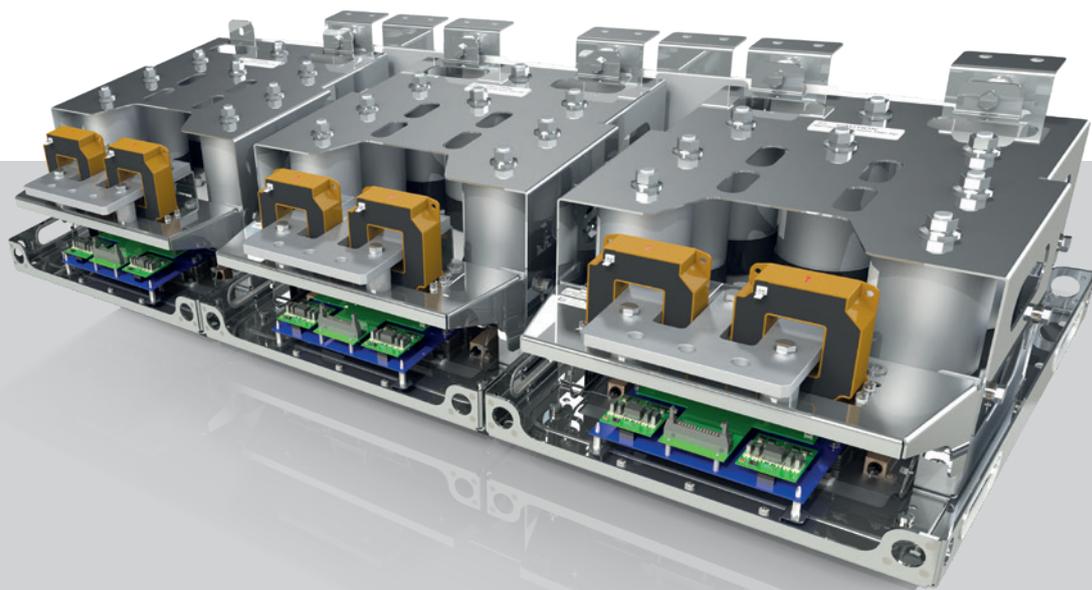
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Global Semikron Danfoss stack production footprint

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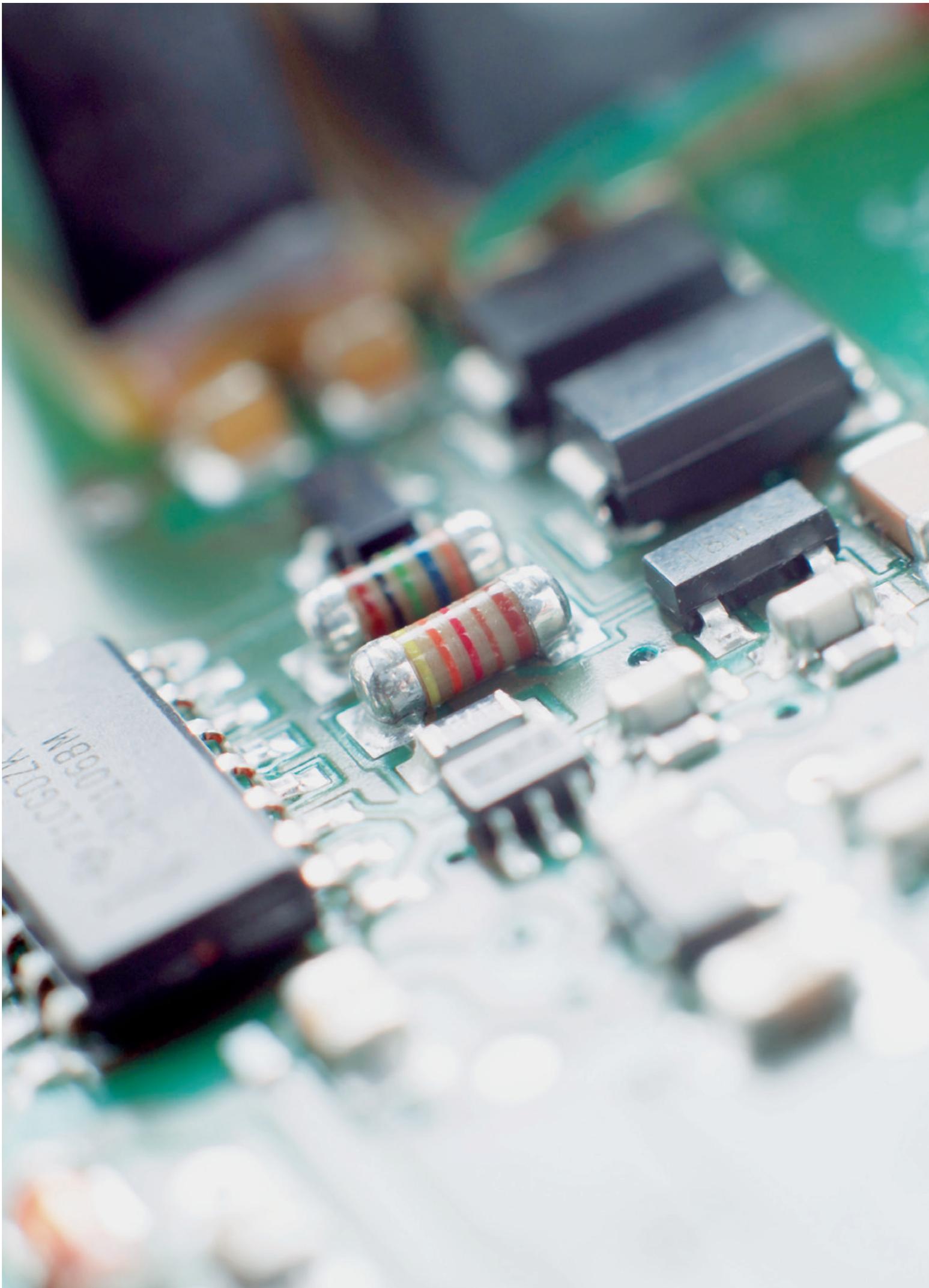
Highly experienced engineering team

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**SEMIKUBE®MLI**

Water-Cooled 3-Level NPC Stack



# Product Portfolio IGBT Driver

## Above the Standard

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.

### Key factors

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Reinforced insulation for signal and power transmission

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Two-channel driver

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Up to 1700V transients

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Up to 1500V continuous DC bus voltage

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8Apk to 35Apk per channel

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1W to 4.2W peak per channel

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Suitable for multi-level topologies and Generation 7 IGBT

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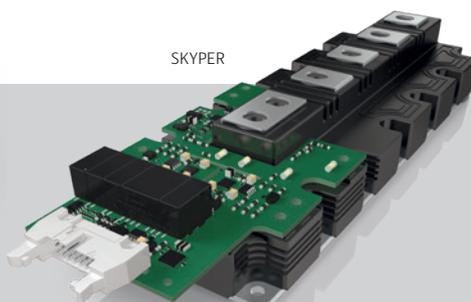
SKYPER & SKHI



### Driver Cores

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

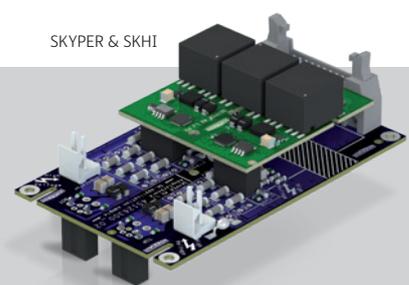
SKYPER



### 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. With more than two decades of field experience and more than 17 million pre-printed modules in the field, benchmarks are being set. The modules with pre-applied TIM are printed in a clean environment on an automated and SPC controlled silkscreen and stencil printing line.

For each requirement, we offer the right choice of material. In addition to the standard silicone thermal grease, phase change materials and high performance thermal paste with improved thermal performance are also available.

Semikron Danfoss offers either thermal grease or phase change materials depending on customer requirements (e.g. performance increase, reduced handling effort) and module type (with or without baseplate). Phase change materials have a solid consistency at room temperature, fully exploiting the advantages a non-smearing TIM layer offers, with no drawbacks. Baseplate-less modules, on the other hand, usually require a lower-viscosity material to help improve robustness during assembly. Here, thermal grease is the preferred solution.

### Key features

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Increased productivity thanks to reduced handling costs and improved logistics

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Low thermal resistance with optimised TIM layer thickness

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Improved lifetime and reliability

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Improved assembly robustness

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Modules can be shipped directly to the assembly line without any additional treatment processes

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Lower overall costs

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### Portfolio

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**P8:** Phase Change Material for highest performance

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**HT:** Phase Change Material for highest sink temperature

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**HPTP:** High Performance Thermal Paste

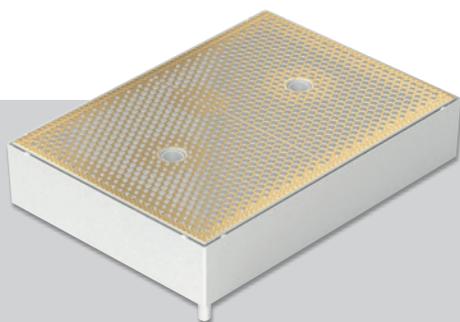
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**P12:** Standard Thermal Paste

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**HP-PCM:** High Performance Phase Change Material

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**Baseplate-less  
Power Modules**



**Baseplate  
Power Modules**

## 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<sub>2</sub> 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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Note: All information is based on our present knowledge and is to be used for information purposes only. The specifications of our products may not be considered as an assurance of component characteristics.

