POWER ELECTRONICS FOR TRACTION APPLICATIONS

SEMIKRON DANFOSS

Rail Traction Systems

Performance Range

Whenever we talk about traction applications, we see extremely high demand for reliability, lifetime and safety. Semikron Danfoss has met these requirements for our customers since we developed the first isolated power module on the market in 1975. For more than 25 years, our highly reliable SKiiP IPMs have driven light rails, trams and subways all over the world.

With our SEMITRANS 20 power module family, Semikron Danfoss brings the latest sinter and bonding technology to a high power standard package. Semikron Danfoss also offers innovative solutions for auxiliary power supplies: our silicon and silicon carbide powered devices, especially the SEMITRANS and SEMITOP module families, allow reliable, efficient and compact systems.

AUXILIARY POWER SUPPLY

5kW - 500kW

- Compact designs and high power density
- High reliability in harsh environments
- High power quality
- High efficiency

Products

- SEMITOP E
- SEMiX 3 Press-Fit
- SEMITRANS Classic
- SEMITRANS 10
- SEMITRANS 20
- Drivers

MAIN TRACTION DRIVE

500kW - 10MW

- Highest reliability and lifetime
- High power cycling capability
- Long lifetime and availability

Products

- SEMITRANS 10
- SEMITRANS 20
- SEMIPACK
- SKiiP 4/7 IPM
- Drivers

PRODUCT HIGHLIGHT

The New **High Power Standard** in Rail Traction Drives

The SEMITRANS 20 product family increases product lifetime and power output. SEMITRANS 20 modules deliver significant advantages for the traction market:

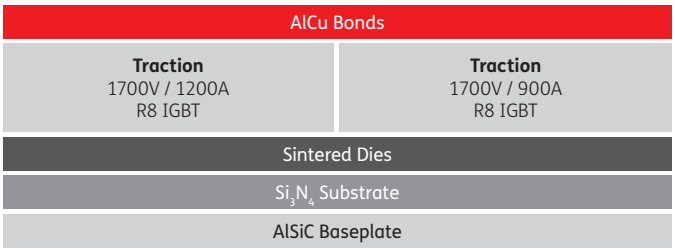
- A simplified inverter design leads to reduced costs for mounting materials as well as in the inverter assembly process
- More space for driver boards and less EMC disturbance from high current bus bars to the driver
- Three AC terminal connectors for low operating temperatures even at high loads
- Less de-rating at parallel operation thanks to the low inductance bus bar layout and the extremely low module inductance
- Ideal for cost-effective inverter design and scaling

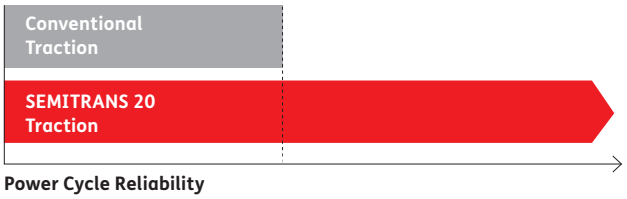
On top of this, the SEMITRANS 20 Traction module provides Semikron Danfoss innovative technologies such as sintered chips and AlCu wire bonds. Additionally the SEMITRANS 20 Traction features silicon nitride (Si_3N_4) substrate and AlSiC baseplates to enable a higher isolation voltage of 6kV and lower partial discharge.

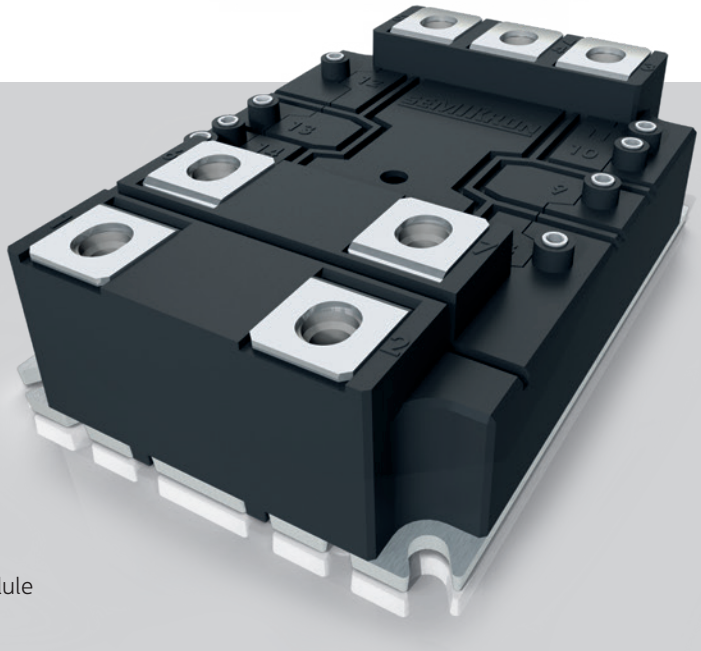
- Superior product lifetime
- Lower cost per kW
- Higher power density

Key Features

Standard package for traction and industrial applications
Innovative technologies with sintered chips and AlCu wire bonds
Next level lifetime and power density
Lower mounting and material cost in inverter assemblies
Ideal for paralleling and scaling







SEMITRANS® 20
1700V half-bridge module

PRODUCT HIGHLIGHT

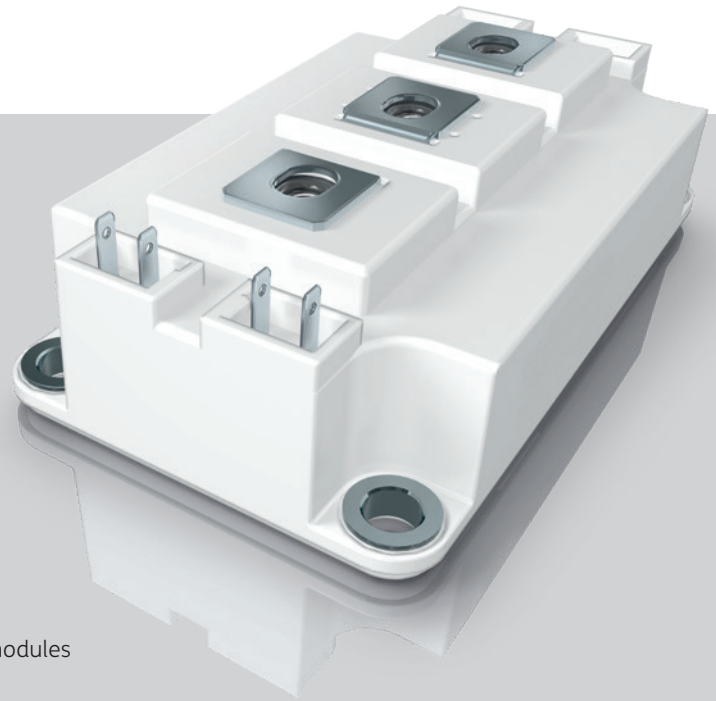
SiC and Hybrid SiC Modules for Auxiliary Power Supplies

The SEMITRANS 3 product family is growing with its new full and hybrid SiC half-bridge modules in 1200V and 1700V. This new portfolio extension allows highly efficient auxiliary power supplies. Due to the high switching frequency of the silicon carbide devices, the size of the passive components can be reduced, and inaudible to the human ear, allowing reduced acoustic insulation.

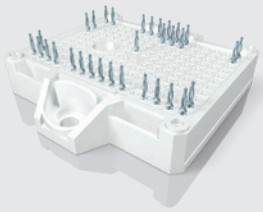
The decreased losses reduce service and maintenance costs, thanks to passive cooling of the power electronic components. Multiple sourcing down to chip level ensures maximum supply chain safety. Available in 1200V from 250A to 500A and in 1700V from 230A to 260A.

Benefits of SiC Technology in Auxiliary Power Supplies

High switching frequencies >20kHz are not audible to human ear
Low switching losses allow passive cooling for reduced maintenance
Dramatically reduced filter size thanks to high switching frequencies
Dramatically reduced transformer size of DC/DC converters
Smaller total size and volume of complete auxiliary converter



SEMITRANS® 3
1200V and 1700V
SiC and hybrid SiC modules



SEMITOP® E

5kVA to 300kVA

Exceeding the Standard for Superior Performance

- Industry standard baseplate-less housing in two sizes
- PCB-based, press-fit connections
- 650V / 1200V IGBT: 10A to 200A
  1200V SiC: 30A to 250A
- Sixpack, half-bridge, buck/boost/symmetrical boost and 3-Level NPC/TNPC topologies
- Optimized mounting concept and pre-applied TIM provide lowest thermal resistance in class

SEMITRANS® Classic

5kW up to 200kW

The Proven Power Electronics Package

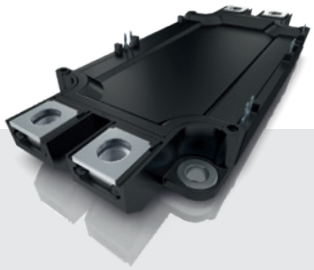
- Robust industry standard package for multiple sourcing in 6 housing sizes
- 600V/650V/1200V/1700V IGBT: 50A to 900A
  1200V/1700V SiC: up to 500A
- Half-bridge, single switch and buck/boost topologies, ready for TNPC / NPC / ANPC topology
- Multiple IGBT sources including Generation 7 IGBT M7
- Extended 62mm portfolio
  1200V IGBT: 800A
  1700V IGBT: 500A

Product Portfolio
IGBT and Rectifier Modules

SEMIPACK®
800V up to 2200V

Bipolar Modules from the Market Leader

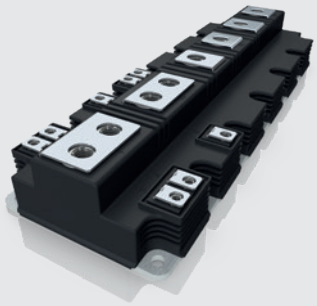
- 6 housing sizes SEMIPACK 1 to 6
- 800V to 2200V: 20A to 1360A
- Semikron Danfoss diode and thyristor chips
- Diodes, thyristors in un-, half- and full-controlled topologies
- High reliability pressure contact or cost-effective wire bonded modules
- Available with line frequency or high speed diodes



SEMiX®3 Press-Fit
55kW up to 350kW

Exceeding the Standard for Superior Performance

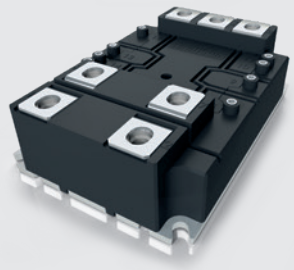
- Industry standard press-fit design with 17mm high housing
- 650V/1200V/1700V IGBT: 225A to to 900A
  1200V Hybrid SiC: 600A
- Direct driver assembly
- Solder-free contacts for highest durability
- Increased power density thanks to Generation 7 IGBT M7
- Available with integrated shunt resistor



SEMITRANS® 10/10+
200kW up to 1MW

Robust High Power Modules

- Established high power module package
- 1200V IGBT: 1400A and 1800A
  1700V IGBT: 1000A, 1400A and 1800A
  1200V Split-NPC: 1400A
  1200V TNPC: 900A
  1200V NPC: 700A
- Half-bridge, split NPC, TNPC and buck/boost topologies
- Full multiple sourcing thanks to alternative 1700V chip source and IGBT M7



SEMITRANS® 20
200kW up to 1MW

The New Standard in High Power

- The latest standard power module for high power traction inverters
- 1700V IGBT: 900A and 1200A
  2000V SiC: 1700A/1mOhm (Industry Version)
- 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.

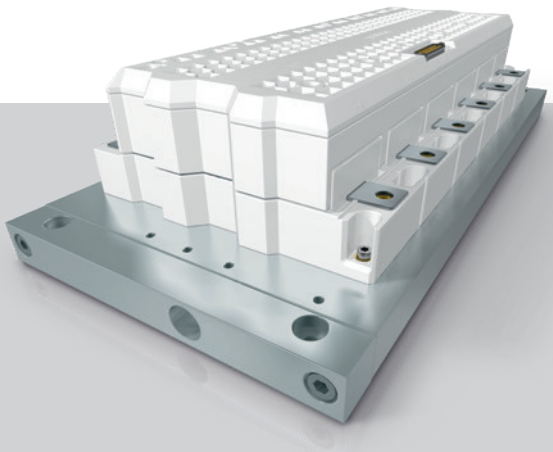
To ensure maximum reliability and service life, the power circuitry is 100% solder-free. Sinter die attach technology replaces the solder layer, the common cause of module lifetime limitations, thus improving power and thermal cycling capability.

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.

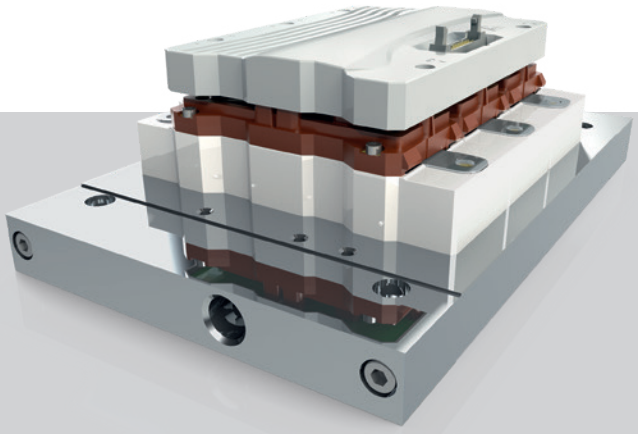
The integrated gate driver in the SKiiP 4 has set new standards in terms of reliability and enhanced functionality through its CAN interface. The digital driver guarantees safe isolation between the primary and secondary side for both switching signals and parameter measurements. The CAN interface allows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

Key Features

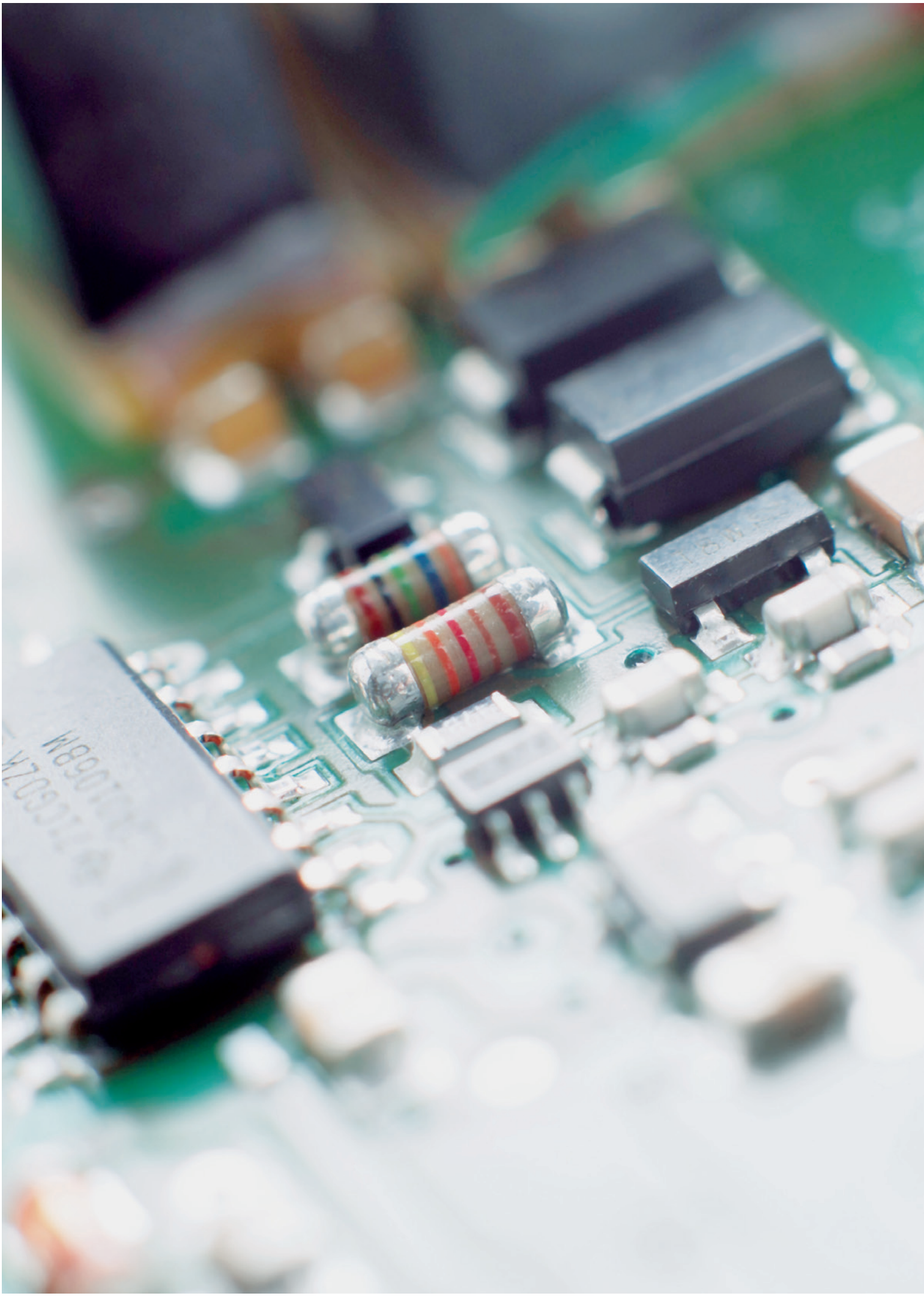
Half-bridges and sixpacks
1200V / 1700V IGBT: 500A to 3600A 2000V SiC: 1200A to 2400A
Flexible cooling options: air, water or customized cooling options
Parallel operation for even higher output power possible



SKiiP®4
Up to 2MW
available with SiC MOSFETs



SKiiP®7
150kW up to 2.4MW



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.

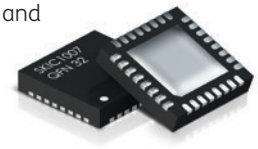
Our IGBT drivers are available as two- channel driver cores suitable for any standard semiconductor power module or as Plug-and-Play solutions, which perfectly fit the SEMiX 3 Press-Fit, SEMITRANS 10 and compatible modules.

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.

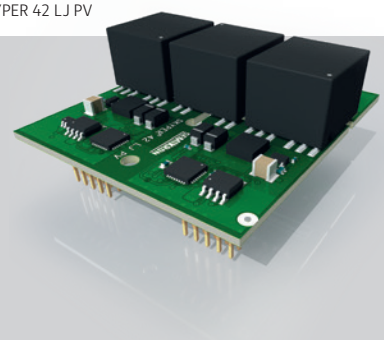
Compact Design
Our SKIC ASIC technology enables very compact system design with minimal peripheral components. With highly integrated signal processing and multi-channel failure management, our ASICs offer robust gate control



Key Factors

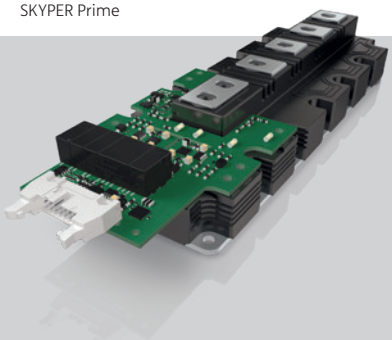
Reinforced insulation for signal and power transmission
Two-channel driver
Up to 1700V transients
Up to 1500V continuous DC bus voltage
8Apk to 35Apk per channel
1W to 4.2W peak per channel
Suitable for multi-level topologies and Generation 7 IGBT

SKYPER 42 LJ PV



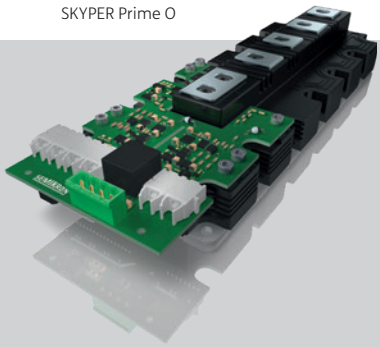
Driver Cores
Two-channel driver cores for PCB integration with Semikron Danfoss ASIC technology and integrated safety functions

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 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.

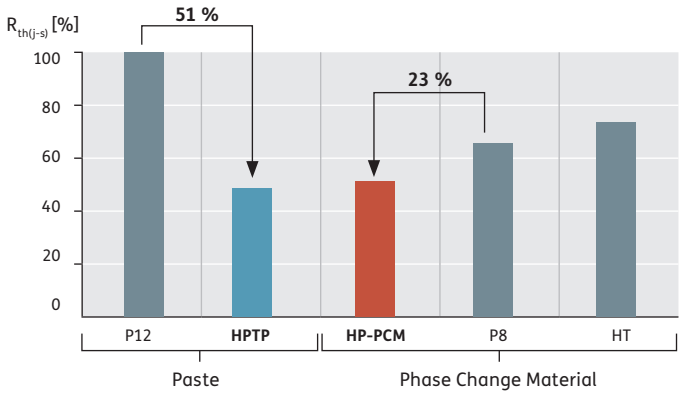
Key Features

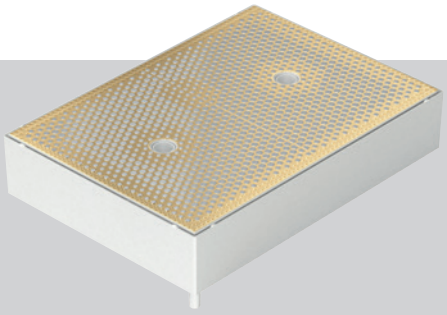
- Module-specific patterns for optimized TIM distribution
- Simplified logistics and reduced production costs
- Improved assembly robustness
- Increased lifetime and reliability

Portfolio

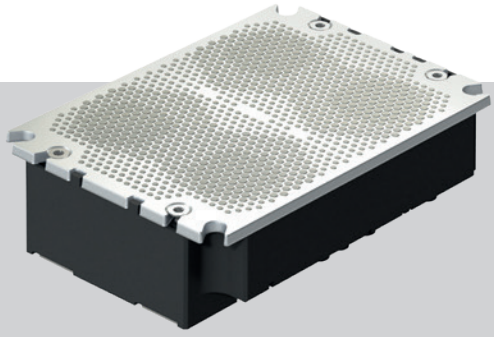
HPTP: High Performance Thermal Paste

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.

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