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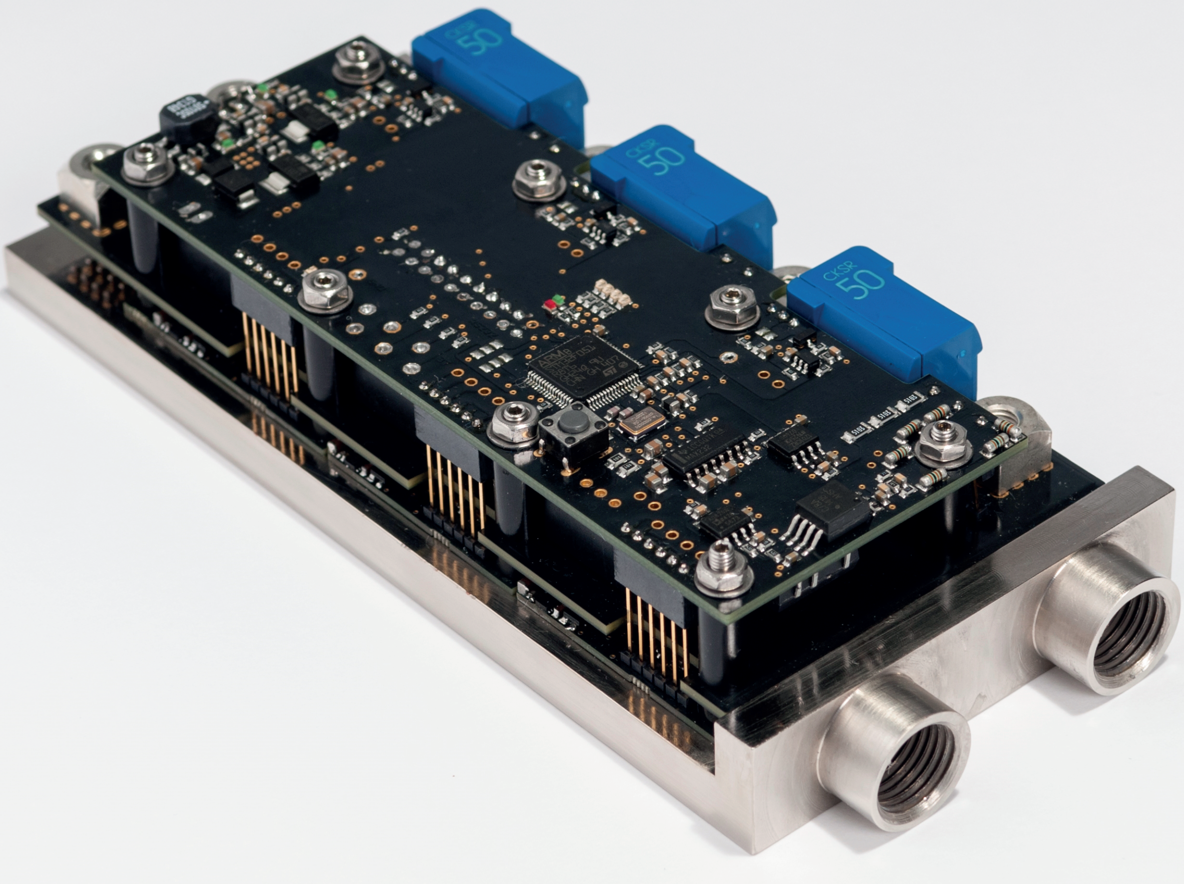
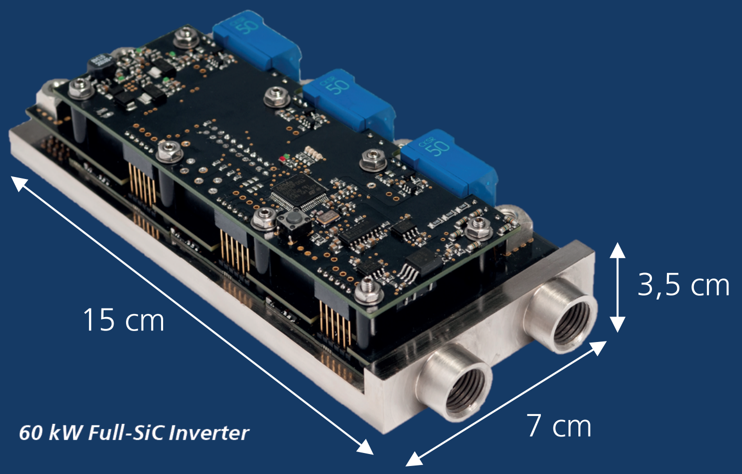
60 kW SiC-Inverter for High-Speed Drives





60 kW Full-SiC Inverter

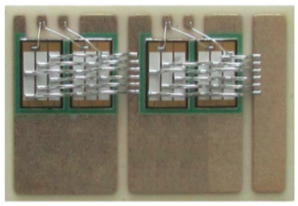
Power Density 160 kW / l

Inverter for High-Speed Applications

High-speed electric motors – like traction drives, compressors and electric turbochargers – require higher inverter output-frequencies and therefore higher switching-frequencies to avoid additional losses and torque-ripple within the machine. With state-of-the-art inverter systems (e.g. using Si-IGBTs and Si-diodes) the switching frequency in the considered power-range is typically limited to values of 10 to 20 kHz due to higher switching losses.

In order to meet these demands, a 60 kW inverter system for high-speed electric machines was developed and realized. The use of siliconcarbide 1200 V MOSFETs, ceramic-capacitors and a low inductive system design allow switching frequencies up to 100 kHz at reasonable efficiencies.

The novel semiconductors with their reduced losses enabled a power-density of the overall power-stage of >150 kW/l which is far beyond state-of-the-art. This offers also the possibility to integrate the inverter directly into electric machines.



SiC DCB design

Inverter Design

The power stage is realized in B6 topology and consists of three half-bridge DCB-powermodules equipped with 25 mOhm SiC-MOSFETs. Antiferroelectric ceramic capacitors with a high current-ripple capability are placed directly above the switches to achieve best switching performance. Integrated drivers provide the required gate-voltages for the semiconductors (+20 V to -5 V) as well as safety and monitoring functions.

The inverter system is realized in a highly integrated mechatronic package. In order to achieve the best cooling performance and overall power-density, the DCB-modules are directly attached to a pin-fin cooling structure.

Sensorless Motor Control

A sensorless motor control software was developed which is optimized for high speed electric drives. The algorithm uses the induced stator-voltages (caused by the back electromotive force) and avoids any additional sensors for the rotor position which are costly and hardly available for higher motor-speeds.

Main target for the software development was an efficient control of the complete electric drive to meet the potentials of the 60 kW SiC inverter. The software is able to drive Permanent Magnet Synchronous Motors (PMSM) and Brushless DC-Motors (BLDC) and can either run the inverter with block- or sinusoidal-commutation.

Contact Us!

The Fraunhofer IISB is your research and development partner for innovative electric drives and power electronic components!

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Technical Data

Max. output power	60 kW (at 900 V_{DC}) 30 kW (at 450 V_{DC})
Input voltage range	900 V_{DC} to 200 V_{DC}
Max. phase current	95 A_{rms}
Max. switching frequency	100 kHz
Dimension power stage	~ 15 x 7 x 3,5 cm^3
Volume	~ 0,37 l