

Technical datasheet

E-axle power train

The smallest SiC inverter for smart integration



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Federal Ministry of Education and Research



Mercedes-Benz



TLK-Thermo GmbH

Publicly funded project: „SiCmodul“ in „Reliable, intelligent and efficient electronics for the e-mobility (ZIEL-eMobil)“, Project number: EM2ZIEL021

Advantages / characteristics

General issues

- Ultra compact design for simple system integration
- Integrated inverter for unshielded ultra short motor cables
- One common cooling circuit for motor and inverter

Inverter issues

- Peak Power of 255 kVA (for <math>t < 1s</math>)
- 24 SiC MOSFETs
- High performance switching cells with very low $L_g = 1.7$ nH
- Ultra fast switching speeds for lowest switching losses
- 6 phases for redundant e-machines
- 6 integrated phase shunt current sensors (for each phase)
- 12 integrated PTC temperature sensors (for each switch)
- Ultra fast short-circuit current detector
- Integrated EMC filter
- High temperature application up to 175°C junction temperature

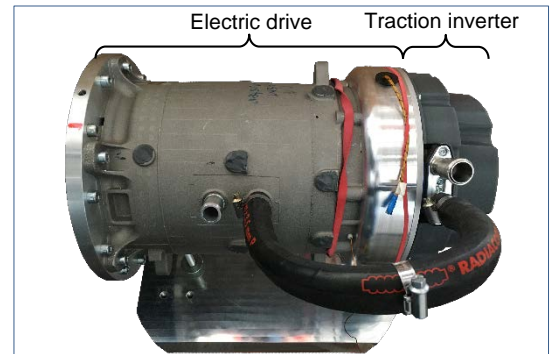


Fig. 1: Electrical motor with the axial integrated 6 phase SiC power inverter

Motor characteristics	
Motor type	Asynchronous machine
Winding scheme	Dual three-phase machine with modified winding scheme to support 6 phase operation
Peak power [kW]	> 150 (standalone)
Power factor (cos phi)	0.79
Stator length [mm]	180
Machine diameter [mm]	200
Winding	0.56 mm enamel wire, Grade 3
Cooling medium and circuit	Glycantine, shared cooling circuit with the inverter
Mass [kg]	48.5 kg

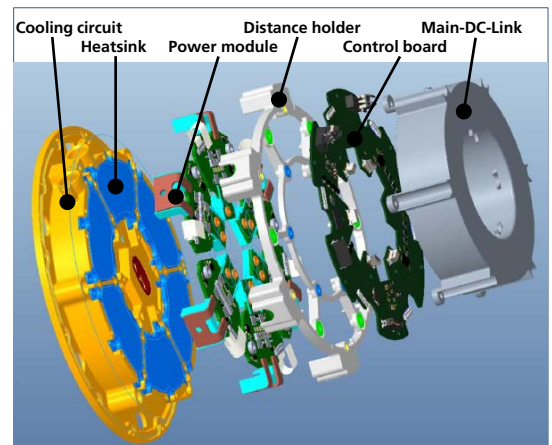


Fig. 2: Exploded view of the 6 phase SiC power inverter

Inverter characteristics

Electrical characteristics		
Maximum apparent inverter power [kVA]	231 (rms),	255 (rms_max for <math>t < 1 s</math>)
Forceable motor power [kW] (motor with $\cos \varphi = 0.79$)	182 (rms),	201 (rms_max for <math>t < 1 s</math>)
DC input voltage [V]	600 min <math>< 850</math> nom <math>< 910</math> max	
Maximum output current [A]	107 (rms),	118 (rms_max for <math>t < 1 s</math>)
Switching frequency [kHz]	24	
Local DC-Link capacitance (on-module; per module) [μ F]	0.08	
Main DC-Link capacitance [μ F]	133	
Semiconductors	24 SiC MOSFETs, Infineon IMZ120R045M1, chip size: 3.14 mm x 3.83 mm	
Number of phases	6	

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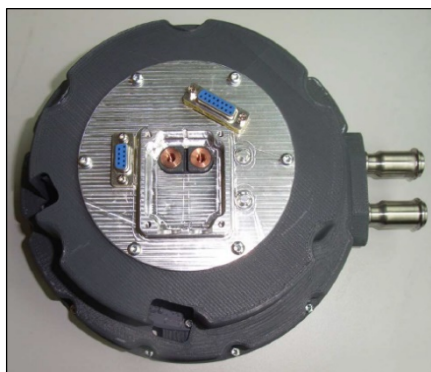


Fig. 3: Six phase SiC power inverter

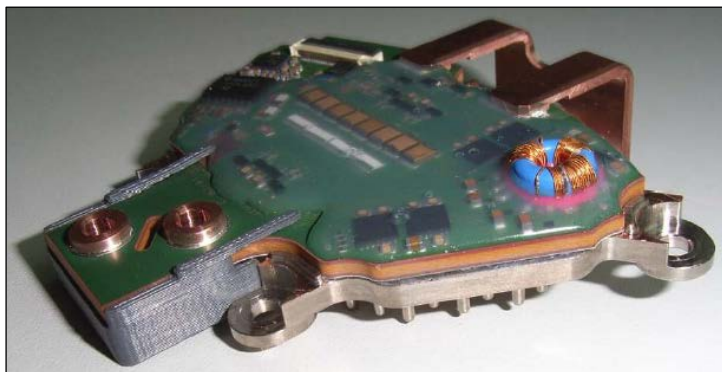


Fig. 4: One of six power modules of the SiC power inverter soldered on the heatsink

Inverter characteristics (Continuing)

Mechanical characteristics	
Mass [kg]	5.1
Volume [Liter]	3.5
Geometry [mm]	Lower diameter: 252 mm with a height: 48 mm Upper diameter: 200 mm with a height: 50.5 mm Connector block: Height: 31 mm, length: 60.5 mm, width: 50 mm Overall width with fittings: 297.7 mm Overall height: 129.5 mm
Protection class (in accordance to ISO 20653)	IP69 (with proper connectors)

Thermal characteristics	
Thermal resistance per chip from junction to fluid [K/W]	0.73 (worst chip of the 6 phase inverter)
Cooling medium and circuit	Glysantine, shared loop with the motor
Inlet cooling temperature [°C]	65
Flow rate [l/min]	5
Pressure drop (Inlet to outlet)	185 mbar