

## High-Performance Inverters for e-Mobility

# Inverter with 600 kW Continuous Power – Thanks to PCB Embedding

### Fast Facts

1. 3-phase drive inverter with a peak efficiency of 98.7 %
2. Continuous power of 600 kW (835 V x 720 ARMS)
3. Peak power of 720 kW (800 V x 900 ARMS)
4. Commutation inductance of 1.1 nH
5. 3D-printed cooling system with only 20K temperature rise
6. Power density of 200 kVA per liter

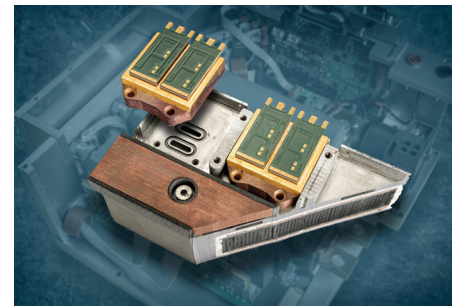
Power inverters for electric mobility prepare the electrical energy from the high-voltage battery for the motor. The Fraunhofer Institute for Reliability and Microintegration IZM has now redefined this central module: Improved cooling management and the use of silicon carbide (SiC) semiconductors enable an efficiency of 98.7 percent. A special process for embedding the semiconductor modules not only reduces module inductance but also allows cost-effective mass production. Thanks to specially developed software, all processes run smoothly.

The basis for this success is 48 1200V SiC transistors, grouped into three modules. DC link capacitors with PolyCharge NanoLam technology are also used, offering twice the energy density of conventional polypropylene capacitors.

A special PCB process for embedding the components makes it possible to keep the distance between the supply and return conductors short, thereby reducing the leak inductance of the commutation circuit. This in turn allows full utilization of the semiconductor performance through faster switching transition which further reduces losses.

Despite the compact design, heat generation remains low. This is ensured by the two-stage cooling system: the temperature-critical components are connected to copper cooling elements through silver sintering. These copper elements not only have high thermal conductivity, but their manufacture in a 3D printer guarantees a perfect fit with the adjacent components. In a second step, the heat is transferred from the copper to an aluminum component, which is also manufactured using 3D printing. It guides the cooling water in a parallel cooling structure that optimally distributes the pressure in the system. At 10 liters of coolant per minute, the pressure drop is only 150 millibars, which is extremely low. Measurements after 15 minutes of continuous operation showed a temperature difference between the casing and the coolant of only 20 Kelvin, and the greatest increase in temperature measured at the cooled outputs was a mere 41 Kelvin.

At 200 kVA per liter, the power density of the inverter is two to four times higher than in converters commonly used in electric cars.



*Section of one of the 600kW inverter's three phase-modules*

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