Fraunhofer IISB

Fraunhofer Institute for Integrated Systems and Device Technology IISB

Up to 22 kW in three-phase configuration

Modular 3.6 kW On-board Charger

3.6 kW OBC with open case
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The 3.6 kW on-board charger (OBC) is designed to charge a 450 V battery from a single-phase grid with an AC voltage between 80 V_{rms} and 265 V_{rms}. Therefore, it can be used worldwide. Up to six units of this system can be stacked to realize a full three-phase 22 kW OBC. Each of the units can be controlled independently from the others and complies with EMC standards.

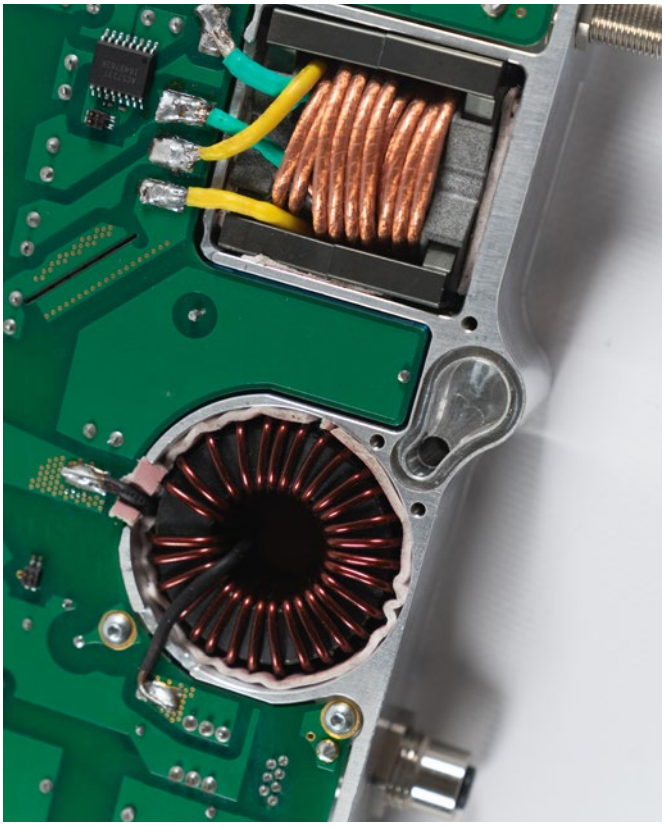
This isolated AC/DC converter combines a good efficiency with a very small volume of 1 dm^3 and therefore a high power density of 3.6 kW/dm^3. It contains a totem pole PFC stage and a full bridge resonant converter both using 900 V SiC MOSFETs and a passive rectifier on the secondary side. The system was developed using high performance materials provided by Hitachi Metals.

Up to six units of this system can be stacked to realize a full three-phase 22 kW on-board charger

Description

The total system consists of only three boards. All semiconductors are mounted on an insulated metal substrate (IMS). This provides a good thermal connection to the coolant underneath and an easy way for assembly. Above, there is the control board (CTRL) containing the microcontroller, power supply, measurement circuits and gate drivers. The third board (DIST) is distributing the current from the EMI filters to the IMS board. The power connection between the boards is done using 6.35 mm sword contacts. The order of the boards is labelled in the picture on the right.

The PFC stage is digitally controlled and runs at a switching frequency of 120 kHz. The choke is realized from a gapless amorphous ring core with a solid copper winding. The resonant converter is working at a fixed switching frequency of 250 kHz. The transformer is built of litz wire on a ferrite core with a small air gap. Its significant leakage inductance forms up the resonant tank of the LLC converter together with ceramic capacitors on the DIST board. The system is completed with EMI filters for the AC and the DC port, which are made from Finemet® material provided by Hitachi according to the specification by the IISB.



Detail of the inductive components of the OBC
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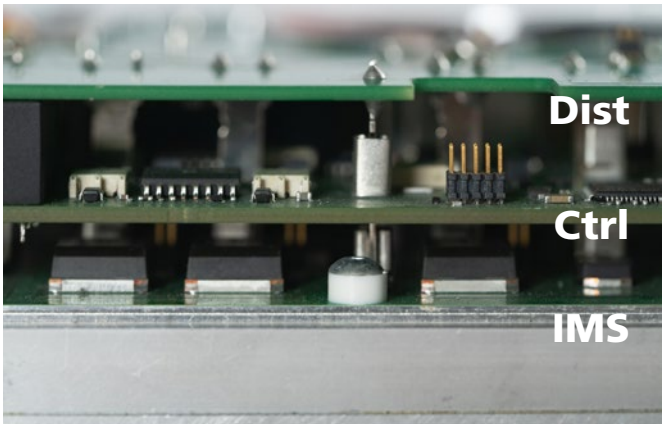
Highlights

- Galvanically isolated OBC module
- Ultra-low volume of 1 dm³
- High power density of 3.6 kW/dm³
- Directly stackable up to 6 modules and 22 kW
- Digitally controlled
- Core materials are made by Hitachi
- Amorphous PFC core (HLM50)
- Ferrite transformer core (ML29D)
- Finemet® CM chokes

Technical Data	Min	Max
V_{in}	80 V_{rms}	265 V_{rms}
V_{out}	300 V	450 V
P (per module)	0 kW	3.6 kW
Efficiency		95.4 %
Dimensions		11.2 x 21.1 x 4.2 cm



Side view of the OBC with naming of the three boards
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