Consortium

- The University of Manchester (leader)
- The University of Bristol
- Imperial College, London
- The University of Nottingham
- The University of Strathclyde

Research Objectives

- To extend the performance and operating envelopes of high voltage AC-DC and DC-DC converter systems to 800 kV and beyond
- To transform the performance of compact power converters to achieve power densities of 30 kW/litre

Cross-Cutting Research Topics

- Structural and functional integration
- Design tools and optimisation
- Operational management and control

Project Description

The converters theme explores two distinct areas of converter technology where the potential exists to make significant gains in performance: the first is in very large scale, high-voltage converters for future power generation and transmission systems, whilst the second is in ultra-compact converters, which are needed for a wide range of power conversion functions such as on-board vehicles, aircraft, and ships.

Achievements – May 2015

Compact Converters

Based on the analysis of a SiC MOSFET / diode switching cell including parasitics, the team at Manchester is developing very-high-frequency, soft-switching, multi-kW DC-DC converters. Excellent initial results have been obtained showing a 50% reduction in switching losses compared with hard-switched operation and a reduction in dv/dt. The reduction in overall losses was around 70 W when operating at 12 kW, 112 kHz and 400 V [1].

The team at Bristol is investigating multi-level topologies for low-voltage applications. A four-level, π-type prototype is under development and switching-aid techniques for super-junction Si MOSFETs are also being researched [2].

Design Tools and Optimisation

Trade-off models are being assembled at Bristol to enable the team to undertake the optimisation of two-level SiC DC-AC converter including the line filter with the objective of maximising efficiency and minimising size.

Structural and Functional Integration

The team at Nottingham is focusing on the design of a double-sided ‘blade-socket’ connector (200A) for making a low inductance connection between a planar bus-bar DC-link from a power module and the DC-link capacitors. The connector will be suitable for automated manufacture and further component integration. The main design challenges are the fixing mechanism and ensuring voltage clearances.

High Voltage, High Power DC-DC Topologies

By means of a theoretical and simulation study the team at Strathclyde has shown that the quasi-two-level operated modular multilevel converter and the cascaded transition bridge two-level converter are able to meet the majority of the requirements needed for HVDC applications [3].

Operational Management and Control

The team at Imperial has focused on commissioning the 1500 V MMC/AAC prototype (10 cells per stack), in particular overcoming EMC and voltage isolation issues. Results have been obtained at 1200 V including data from DC fault tests. Simulation work has been continuing to examine converter operating strategies which reduce the stress on partially damaged / weakened devices or converter cells [4].

Publications:


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