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RESEARCH TOPICS

- Multi-level and multi-phase power electronic converters for more electric aircraft applications
- Control strategies for 3-phase 4-wire power supply units in smart grid applications
- Transportation electrification technologies
- DSP-FPGA control boards for power electronics and drives applications

MULTI-LEVEL AND MULTI-PHASE POWER ELECTRONIC CONVERTERS FOR MORE ELECTRIC AIRCRAFT APPLICATIONS

Keywords: efficiency, power density, design optimization, fault-tolerance

The target of this research is to investigate and to analyze novel solutions to obtain high efficiency and high specific power three-phase multi-level power converters. Research activities deal with the newly conceived five-level unidirectional T-rectifier, to be used in high speed gen-set units. Criteria are investigated for the power semiconductors selection to optimize the overall performance of the power conversion system. A complete set of analytical and simulation results based on 20 kVA prototypes of the proposed 5-level T-rectifier and the BTB E-Type converter, both 5-level and 7-level configurations, are analyzed as a case study. The converters are able to ensure a specific power higher than 3.5 kW/L and peak efficiency equal to 98.5% including filter, driver, control and fan. Modulation techniques are investigated to provide at least partial fault tolerance capability.

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CONTROL STRATEGIES FOR 3-PHASE 4-WIRE POWER SUPPLY UNITS IN SMART GRID APPLICATIONS

Keywords: distributed power generation, smart grid, stability, unbalanced loads, model based control strategies

The proposed activity is focused on the development of high performance control structures for inverters operating in 3-phase plus neutral in off-grid and grid-connected applications. In microgrid with common DC-bus, the output inverter is used to supply the electrical utility loads, which can be either single or three phase loads and, in the case of three phase loads, they can be either balanced or unbalanced. Hence, a four-wire electrical

distribution system must be arranged for the supply of such utility loads and, in order to ensure this, a stable and ripple-free neutral connection must be provided, so to avoid recirculation of currents through the system stray capacitances, in particular when the TT grounding arrangement is used. Within the research topic, detailed investigation is devoted to typical control algorithms such as multi-resonant controllers, repetitive control, dead-beat control and model predictive control.

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TRANSPORTATION ELECTRIFICATION TECHNOLOGIES

Keywords: electric mobility, charging stations, on-board power generation

Research activities are mainly focused on the key enabling technologies for transportation electrification with reference to automotive, constructions and railway sectors. From electric and hybrid propulsion systems to power electronics for charging stations and to power generating units on-board the vehicles. Different configurations and high-performance control algorithms have been investigated and proposed. Newly conceived, generating systems have been designed for hybrid vehicles, including combined power sources configurations. Power converters for energy recovery have been deployed and successfully tested.

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DSP-FPGA CONTROL BOARDS FOR POWER ELECTRONICS AND DRIVES APPLICATIONS

Keywords: control algorithms, Digital Signal Processors, FPGA, target boards, controllers

Nowadays, even a common power converter can exhibit an increased number of active devices and higher switching frequency than ever to satisfy a higher control performance demand. This results in an increased complexity related to the control board, where usually a combined μC (or μP, DSP) and FPGA structure is present. Specific control systems have been developed aiming the combined action of different targets to fulfill those requirements and constraints (i.e. synchronization, timing, space and computational capabilities).

References

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