ICT PHD

Research project for a PhD curriculum in ICT –Industrial Applications of ICT

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Proposed Title of the research: Wide-bandgap based Power converters for improved efficiency and reliability

Keywords: (5) Electrical machines, power density, Sustainability, Torque density, Green transportation

Research objectives: --(max 10 rows)

In the last years, the need for high power density and efficiency has become a central concern for electrical machines in the green transportation sector.
Next generation of modular and efficient electric vehicle EV powertrain architectures will benefit from the superior performance of wide-bandgap (WBG) semiconductor devices.
However, to take full advantage of improved efficiency and advanced integration, promised by these devices, there is an urgent need to develop advanced modulation and control techniques for the EV power converters, aiming to improve the EV powertrain performance without compromising the reliability, allowing for improved integration, lifetime extension, fault tolerance, predictive maintenance, reduced EMIs, and increased powertrain efficiency.

Proposed research activity -- (max 10 rows)

This project aims at increasing the performances and integration of power converters, making a suitable use of new wide-bandgap power devices. In particular, DC/AC grid connected converters have been widely adopted in the last years for the grid integration of low power distributed renewable sources. With the increasing penetration in the market of battery electric vehicles (BEV), it has been proposed to involve vehicles in the stability mechanism of electrical grids or future smart grids, using the energy stored in the batteries to meet the peak power request of the local areas. This requires a bi-directional operation of the on-board chargers, which includes most of the features already developed for grid connected renewables (i.e., PV inverters), such as grid formation, fault ride through, active and reactive power managements, etc.
However, special attention must be paid to common mode currents that may recirculate in the system, leading to EMI concerns and fast equipment deterioration. This is especially true when fast common mode voltage variations, triggered by WBG devices, are generated during converter operation. Therefore, new converter architectures and control algorithms must be developed to achieve more efficient solutions for power electronics.

Supporting research projects (and Department)

The successful candidates will become part of the MeltingLab research team, working of electrical machines and converters of the University of Modena and Reggio Emilia. The candidate will be involved in the activities of the project YesVGan, a EU funded project which aims at the development of an industrial chain in Europe for the application of vertical GaN devices in power electronics.

Possible connections with research groups, companies, universities.

The project will see the involvement of the Universidad de Chile and Universidad Andrés Bello in Chile, which will participate in the study and analysis of the converter architecture.