

ICT PHD

Research project for a PhD curriculum in ICT – Electronics and Telecommunication

Tutor: Giovanni Franceschini

Co-tutor: Davide Barater

Proposed Title of the research: Highly efficient motor drives for green transportation applications

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 in the green transportation sector. To meet the challenging requirements of modern ground propulsion and transport applications, the trend is to increase the fundamental operating frequencies of electrical machines, leading to smaller and lighter motors and generators. New power devices based on wide bandgap semiconductors (SiC and GaN) with extremely short switching times, are enabling technologies in this sense. However, higher operating frequencies also means increased power losses in windings, as well as faster devices commutations are known to trigger faster degradation of coil insulation and cause greater susceptibility to EMI. This research aims to identify new mindset for component and system designs, pursuing efficiency and reliability (as transport is a safety-critical application), as well as multidisciplinary approaches to combine multiphysics in a comprehensive design for converters and machines, which are instead usually realized in separate processes.

Proposed research activity -- (max 10 rows)

Wide-Bandgap devices are renowned for their outstanding performance in terms of efficiency and power density, but the electrical stress associated to the high voltage gradient they can achieve, together with the combined action of other environmental stresses (such as temperature, pressure, moisture), can decrease the lifetime of the insulation system of PWM-driven electrical motors. The successful candidate will be engaged in the development of novel solutions for:

- Integrated architectures (machine and drive) for high power density and reliability.
- New modelling techniques and processes for high power density designs;
- New drive architectures, based on wide bandgap devices, for fast switching commutation

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.

Possible connections with research groups, companies, universities.

The project will see the involvement of the University of Nottingham UK (UoN), which will participate in the study and electromagnetic analysis of the proposed electrical machine. Dual Degree with UoN is possible as well.