ELECTRICAL, ELECTRONICS AND COMMUNICATIONS ENGINEERING

MUR DM 117/NEVC - Reliable WBG power electronics with diagnosis and prognostics for future eMobility

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Context of the research activity	Power electronics is one of the most impactful disciplines in the future electrification of transport and for this reason the last few years have seen a strong increase in investments by the automotive sector which have led to the development of new technologies. The development of new families of semiconductors called "wide-bandgap" (WBG), making use of silicon carbide (SiC) or gallium nitride (GaN) to replace the classic silicon (Si), now make it possible to create converters with and power densities unimaginable just a few years ago. Progetto finanziato nell'ambito del PNRR – DM 117/2023 - CUP E14D23002000004
Objectives	The WBG devices (SiC and GaN) have shown unprecedented performance with respect to the conventional Si-based devices in terms of switching frequency and efficiency. However, the dramatic increase in performance has not been matched by an equally dramatic increase in reliability. Often the use of wide bandgap semiconductors has been found to be the cause of unexpected failures due to increased stress on the components and the still imprecise manufacturing process. However, this is not acceptable in the automotive sector, where unexpected failure can lead to significant economic damage and endangerment of human lives. For this reason, the objective of the PhD thesis activity is to study, design and implement high efficiency and reliability traction, with the use of advanced diagnostic solutions. In particular, we want to develop an inverter able to evaluate the state of health of power components such as: semiconductors, capacitors, interconnections, electric motor and battery. Various solutions suitable for diagnostics have been previously presented in the literature, however many are inadequate to be implemented on a traction

	converter. For this reason, the thesis aims to find diagnostic solutions suitable to be implemented on a traction converter taking into account the technological and cost constraints imposed by the automotive sector. The topic of the doctoral thesis is consistent with the M2C2 - Energy transition and sustainable mobility component of the PNRR as it contributes to the development of innovative solutions of power electronics and storage systems for electric vehicles and therefore with zero polluting emissions. The activity for this thesis will be performed in an multi-disciplinary team of the Power Electronics Innovation Center of Politecnico di Torino and in cooperation with the National Electrical Vehicle Center (NEVC) Beijing - China.

Skills and competencies for the development of the activity	The research activity needs the following skills: • Excellent background in static power conversion, including power electronic devices, converter topologies and control techniques. • Hardware skills in design and testing of analog and power circuits. • Very good knowledge of simulation software for power electronics, such as PLECS and CAD for power electronics design, such as Altium Designer. • Teamwork mindset and ability to work in multi-disciplinary environment. • Good logical and analysis capability, including good self-organizational mindset.