High Power Density Non-Isolated DC-DC Converters for Harsh Operating Environments

Summary

Ph.D. student will work on non-isolated DC-DC converter topologies in applications with harsh environments characterized by unique operating conditions, like high magnetic field, high radiation, or high/low operating ambient temperature. These applications are limited by the availability of suitable components and, thus, require special design approaches that can ensure their high reliability, power density, and efficiency. This Ph.D. work includes but is not limited to developing novel topologies, control methods, and implementation approaches for non-isolated DC-DC converters.

Research field:	Electrical power engineering and mechatronics
Supervisors:	Dr. Andrii Chub Dr. Dmitri Vinnikov
Availability:	This position is available.
Offered by:	School of Engineering Department of Electrical Power Engineering and Mechatronics
Application deadline:	Applications are accepted between June 01, 2024 00:00 and June 30, 2024 23:59 (Europe/Zurich)

Description

As power electronics is being used ubiquitously across various applications, the range of possible application requirements is also getting wider. Conventional design approaches often cannot meet the requirements of niche applications. For example, high magnetic field limits the use of magnetic core materials, high radiation restricts the use of the majority of power and control semiconductor components available off the shelf. Moreover, in applications like point-of-load converters for particle accelerator experiments, even the size and weight of the converters are under scrutiny as they influence the outcomes of measurements.

Non-isolated DC-DC converters still provide the best efficiency and lowest cost in many applications, like point-of-load converters. Hence, the given work will concentrate on advanced implementation and packaging approaches of the existing topologies and their benchmarking and testing in relevant environments. This will include the use of wide bandgap semiconductors, PCB-integrated magnetic components, and radiation hard components, as well as the design of converters for extreme temperatures.

This work will contribute to the field of applied power electronics and control with high practical value in increasing the reliability of mission-critical applications.

Responsibilities and (foreseen) tasks

- Design optimization of non-isolated DC-DC converters with application-specific design constraints
- Design and implementation of PCB-integrated magnetic and radiation hard components
- Synthesis and verification of novel control methods resulting in efficiency optimization
- Stress-testing of minimum viable prototypes of developed technologies in relevant harsh environments
- Feasibility study and benchmarking of different semiconductor devices against application requirements
- Design of control systems based on small and large signal models
- Publishing research findings in top-tier journals and dissemination at the flagship conferences of the IEEE IES/PELS - 3 Journal and 4 Conference papers is the minimum expected level to qualify for defense.

Applicants should fulfill the following requirements:

- master's degree in power electronics;
- B2 English level certificate if English is not the native language and the language of instruction in MSc study was not English;
- practical experience in the design of power electronic converters;
- experience in the modeling of electronic circuits in PSIM or PLECS software;

- experience with PCB design (preferably using Altium Designer);
- experience with closed-loop control system design with analog/digital sensors and DSPs;
- good understanding of power semiconductor components, basics of their driving and packaging;
- excellent command of English and strong and demonstrable writing and analytical skills;
- capacity to work both as an independent researcher and as part of an international team;
- capacity and willingness to provide assistance in organizational tasks relevant to the project.

(The following experience is beneficial:)

- international publications will be valued;
- internship experience abroad will be considered a plus;
- industrial experience is preferable.

We offer:

- Early Stage Researcher position in one of the leading applied power electronics research centers in EU with a large portfolio of ongoing pan-European and national research and innovation projects
- The chance to do high-level applied research in collaboration with CERN
- Opportunities for conference visits, research stays, and networking with leading universities and research centers in the fields of power electronics and microgrids.

About the group

Research in the Power Electronics Group is focused on the development and experimental validation of new state-of-the-art power electronic converters for such demanding applications as rolling stock, automotive, telecom, and renewable energy systems. Key research directions include the synthesis of new converter topologies, development of special control and protection algorithms, implementation of new components, and elaboration of design guidelines to further improve the efficiency, power density, reliability, and flexibility of the on-market power electronic converters. Other research activities are concentrated on the development of power flow control algorithms and new supervision, fault detection, protection and communication methods for the electronic power distribution networks (Micro- and Smart-Grids).

Highlights:

- Well experienced and dynamic team of young researchers and engineers (1 Professor, 4 Senior Researchers, 1 Senior Lecturer, 4-6 PostDocs, and 8-12 full-time Ph.D. students)
- Long-lasting experience in applied design of power electronic converters for different power ranges and applications
- Since October 2011, the group is the European Competence Centre of Power Electronics and an active member of the European Centre for Power Electronics (ECPE)
- Strong record of scientific publications (over 60 annually published research papers)
- Project-based PhD studies with research-oriented theses
- Strong relations and cooperation with Estonian and Baltic industrial companies
- Strong relations with European universities and research institutions
- Modern laboratory facilities and infrastructure:
- Active participation in national and EU funding programs and joint research projects

(Additional information)

For further information, please contact Dr. Andrii Chub andrii.chub@taltech.ee

To get more information or to apply online, visit https://taltech.glowbase.com/positions/786 or scan the the code on the left with your smartphone.