Universal Soft-Switching PV Converter Based on GaN Transistors and Planar Magnetics

Summary

The PhD candidate will develop novel topologies of galvanically isolated dc-dc converters and corresponding hardware and digital control methods optimizing the converter operating mode.

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, 2022 00:00 and June 30, 2022 23:59 (Europe/Zurich)

Description

The growing market for residential renewable energy generation and storage systems facilitates the development of new types of photovoltaic modules, fuel cells, batteries, micro wind turbines, etc. Operating voltage and power ratings of these emerging residential energy sources vary in a wide range. As a result, each type requires a different interface converter due to the limitations of conventional power electronics.

This project aims to a new technology enabling wide input voltage regulation range in galvanically isolated dc-dc converters. The main outcome will be in the development of high step-up dc-dc interface converters for dc micro-grids, which will feature universal input capable of operation with different low-voltage sources and storages. The developed hybrid switching cells will be based on integral design combining wide bandgap semiconductor structures and integrated magnetic structures capable of changing their gain. This new technology will decrease the price of residential power systems due to lower capital costs resulting from mass production, lower staff training and supply chain expenses for installers.

PhD candidate will develop novel topologies of galvanically isolated dc-dc converters and corresponding hardware and digital control methods optimizing the converter operating mode.

Supervisors:

Main supervisor: Dr. Dmitri Vinnikov
Co-supervisor: Dr. Andrii Chub

Responsibilities and (foreseen) tasks

- Development and implementation of PCB-integrated planar magnetic components
- Synthesis of switching cells utilizing low-cost PCB-integrated matrix/planar transformer
- Synthesis and verification of topology morphing control methods resulting in efficiency optimization
- Applicability study of GaN semiconductor devices and their benchmarking versus generic Si devices
- Design of control systems based on small and large signal models
- Development and verification of outer control needed for converter operation in a dc microgrid
- Optimization of lifecycle cost using FIDES handbook recommendations and yearly mission profiles
- Publishing of research findings in top-tier (Q1) journals and dissemination at the flagship conferences of the IEEE IES and PELS

Applicants should fulfil the following requirements:

- Experience in FE modeling of magnetic components and co-simulation with power electronics
- Practical experience in the design of power electronic converters

- Experience in design of control systems and their implementation in microcontrollers and DSPs
- 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 systems comprising analog and digital sensors
- Good understanding of power semiconductor components and their driving

The following experience is beneficial:

- Experience in designing minimum viable prototype of power converter
- Working knowledge of electromagnetic compatibility
- Industrial experience
- Working knowledge of planar magnetics

The candidate should submit a research plan for the topic, including the overall research and data collection strategy. The candidate can expand on the listed research questions and tasks, and propose theoretical lenses to be used.

We offer:

- 4-year PhD position in one of the leading power electronics groups in EU
- Access to state-of-the-art lab facilities
- Collaboration with the world-leading supplier of power electronics components – Infineon Austria – with possibility of regular visits paid by the company.
- Opportunities for conference visits, research stays and networking with globally leading universities and research centers in the fields of power electronics

About the department and group

Department of Electrical Power Engineering and Mechatronics was established on 1 January 2017 within the framework of the structural reform of Tallinn University of Technology (TalTech) based on the departments of Electrical Power Engineering, Fundamentals of Electrical Engineering and Mechatronics.

We are an academic structural unit that belongs to the TalTech School of Engineering.

The department conducts teaching at the bachelor, master, and PhD levels, as well as research in the field.

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 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 SmartGrids).

Highlights:

- Well experienced and dynamic team of young researchers and engineers (1 Professor, 4 Senior Researchers, 1 Senior Lecturer, 3 PostDocs, and 9 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 European Centre for Power Electronics (ECPE)
- Strong record of scientific publications (over 60 annually published research papers)
- Project-based PhD programs 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 EU funded programs and joint research projects

Additional information

For further information, please contact Prof. Dmitri Vinnikov (dmitri.vinnikov@taltech.ee) or Dr. Andrii Chub (andrii.chub@taltech.ee).

To get more information or to apply online, visit https://taltech.glowbase.com/positions/530 or scan the the code on the left with your smartphone.