Charlotte Bolding Andersen

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Dear Reader

After four years of successful project collaboration, the Danish-German Interreg project PE:Region has now reached its conclusion. In this final newsletter, you will find an overview of the latest achievements, activities and project results.

Announcement

We have the great pleasure to announce that the Interreg Committee has approved our application for a new Danish-German Interreg project with focus on power electronics. The project is entitled PE:Region Platform.

On top of development of technology and applications, PE:Region Platform will have particular focus on the establishment of a power electronics platform for the entire region and beyond. PE:Region Platform is a three-year project starting on 1 January 2020 and with the project partners of the original PE:Region project:

- University of Southern Denmark/Mads Clausen Institute (SDU-MCI – Leadpartner)
- Sønderborg Vækstråd (SV)
- Christian-Albrechts-Universität zu Kiel/Chair of Power Electronics (CAU)
- Fachhochschule Kiel/Institut für Mechatronik (FH Kiel)
- Forschungs- und Entwicklungszentrum Fachhochschule Kiel GmbH (FuE FH Kiel GmbH)

- Wirtschaftsförderung und Technologietransfer Schleswig-Holstein GmbH (WTSH)

An official kick-off event will be held early next year and we look forward to continuing the fruitful collaboration with well-known partners as well as new ones.

Conference/Workshop Participation

PE:Region Concluding Seminar and Interreg Caravan

SDU Odense

Wednesday 11 December 2019 at 11.00 - 15.00 in Odense

Demonstrator Development for Intelligent Grid Integration,

High Speed Drives and Battery Charging

The PE:Region concluding seminar took place at SDU Odense on 11 December along with the Interreg Caravan. This proved to be an ideal setting for dialogues and networking for members of the Interreg Committee, PE:Region project partners, and partners from other Interreg projects, and not least for presenting the final results of the 4-year project. At the Interreg Caravan, PE:Region was represented by 7 posters, hardware and video material of the three demonstrators:

#1 - Intelligent grid integration of wind and sun (CAU)
#2 - Energy efficient, reliable and compact high speed drive (CAU)
#3 - High power onboard bidirectional battery charger (SDU)

The seminar part included a review of the overall project results both as to the demonstrators and all other cross-border activities throughout the project period from January 2016 – December 2019.

When it comes to dissemination of PE:Region results, 50 articles/publications have been published for international conferences and journals, and more than 20 seminars/workshops have been hosted; including the international power electronics conference 'IEEE CPE-POWERENG 2019' held in Sønderborg in April 2019 counting 15 sessions, lectures etc.

(Please visit https://www.pe-region.eu/en_GB/arrangementer/ for further pictures.)

Finally, a database of relevant equipment among the academic PE:Region partners has been created and made accessible online: Thus, power electronics equipment can now be shared across the Danish-German border. So far, 400 items have been registered and the database is regularly updated.

332 Programmable AC Electronic Load	Chroma	63802
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334 Low-Noise Voltage Preamplifier	Princeton	SR560
335 Spectrum Analyzer	Anritsu	MS2601A
336 DC Power Supply	Regatron	TopCon Quadro
337 DC Power Supply	Regatron	TopCon Quadro

Demonstrator Status

Demonstrator #1: Intelligent grid integration of wind and sun energy

The prototype for demonstrator #1 has been assembled and tested with the circulated power reaching 400 kW.

Fig. 1.1 Hardware prototype for demonstrator #1

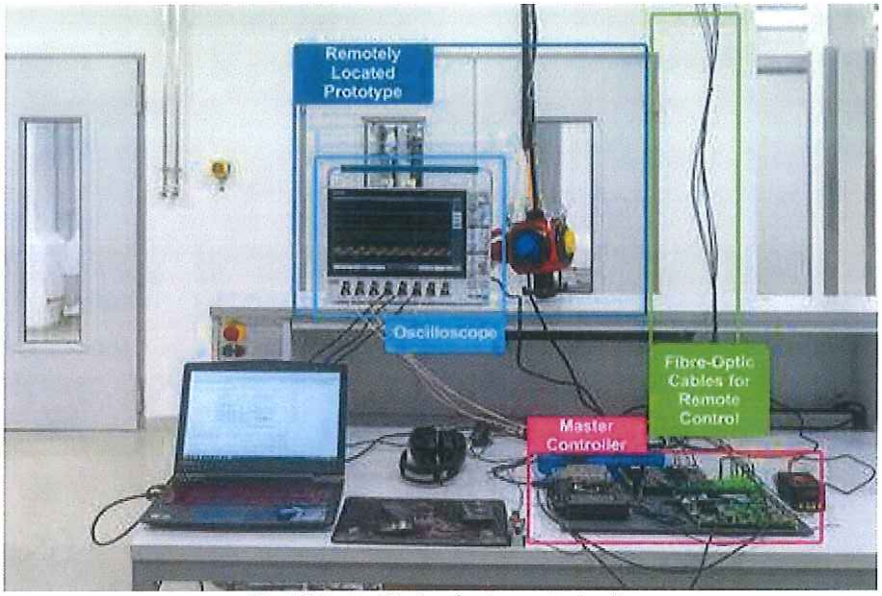
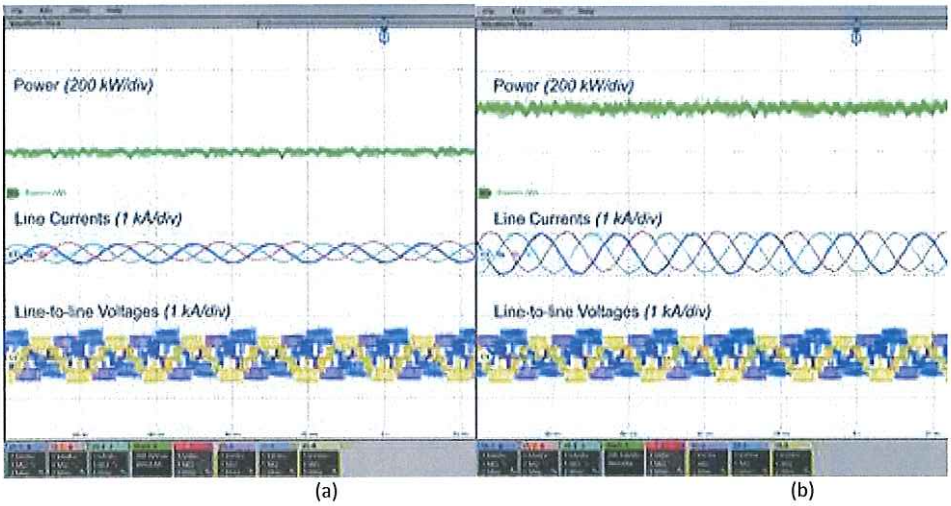


Fig. 1.2 Control System for demonstrator #1

For safety reasons, the system is to be operated remotely from a secured site. For the experiment the setup has been installed inside a safety cabinet while connected via 10 meters of Fibre-Optic cables to the master controller FPGA system outside of the cabinet. The final results of the demonstrator in operation are given in Fig. 3. Fig. 3(a) shows the results of the power circulated at approximately 200 kW. The current peak is set to 300 A, whereas the voltage is 600 Vrms. Fig. 3(b) depicts the results of the 400 kW operation. The current peak is controlled up to 550 A and the voltage is 600 Vrms.



(a) (b)

Fig. 1.3 Experimental results of demonstrator #1

The master controller can be operated via control software, which has been developed in C# language. It can be connected to any computer via standard USB cable and used for operating the system.

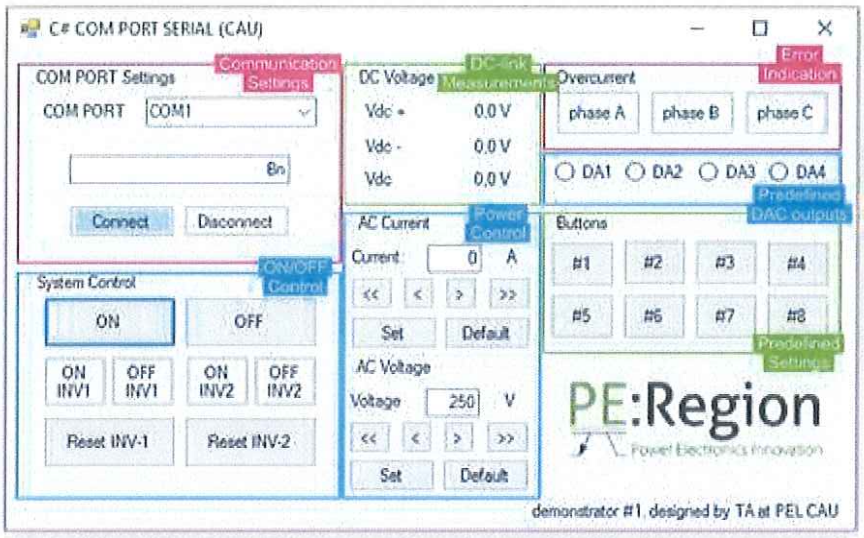


Fig. 1.4 Control Software for demonstrator #1

In the first version of the software, the ON/OFF control can be done to each of the two power stacks simultaneously or separately. The DC-link measurement section provides real-time update on the DC-voltage of the system. The Power Control section allows to set the AC current reference for one power stack and AC voltage reference for the second power stack.

The error indication window highlights the phase in the event of the overcurrent. The DAC section has 4 radio buttons which can be predefined to display up to 8 different signals, e.g. AC current/voltage, modulation index, DC-link voltage, controller outputs etc. Eight buttons are used for the configuration of settings which are not covered in the current version of the software; such as changing the operation mode, debugging, precharge, etc.

Demonstrator #2: High efficient, reliable and compact high speed drive

The laboratory test setup for demonstrator 2 was finished. With the installed sinewave motor filter, the control schemes for the model predictive control (MPC) as well as the PWM based control strategies have been adjusted. To maintain high efficiency as well as low current and voltage harmonics, an observer based active damping scheme was investigated and set up. Fig. 2 shows a schematic of the overall system in case of the hysteresis based model predictive control.

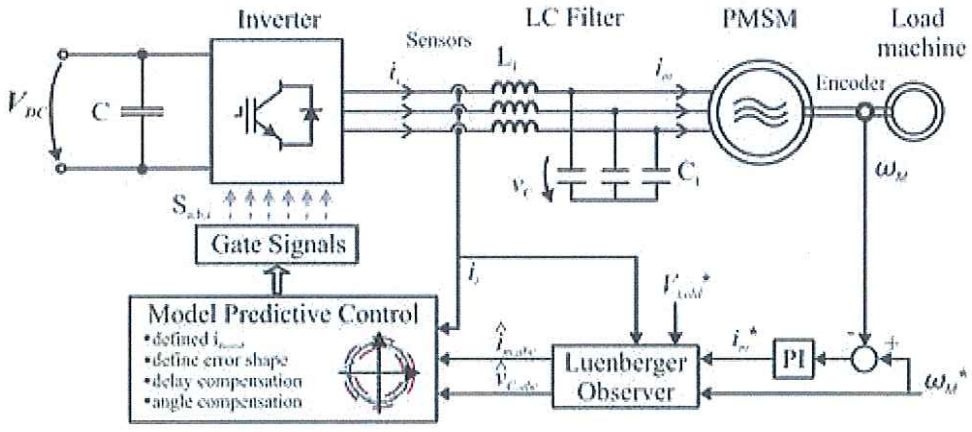


Fig. 2 Schematic of the overall system in case of the hysteresis based model predictive control

Demonstrator #3: High Power on-board bidirectional battery charger

For demonstrator #3, the hardware prototype of the 20kW two-level three-phase power factor correction has been modified and demonstrated. Fig 3.1 shows the prototype of the 20 kW two-level three-phase power factor correction. The filter part is modified to fulfill the considered EMI standard (CISPR11 class B). The converter side inductor is designed to reduce the current ripple to less than 20% of the peak of the current. The efficiency of the converter is calculated and expected to reach 99% at 60% of the full load.

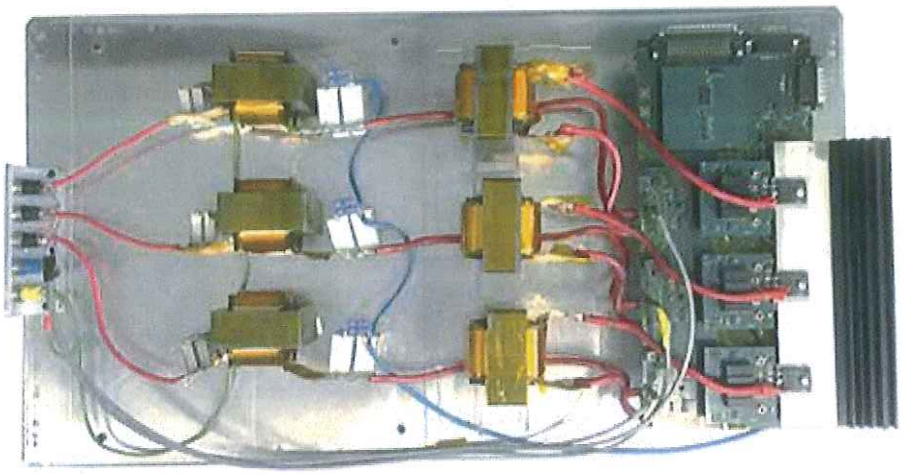


Fig. 3.1 Hardware prototype of the 20 kW two-level PFC

The 20 kW isolated dc-dc converter utilizes low-inductive SiC power modules from FH Kiel. Low profile, high efficiency transformer along with a planar inductor with power iron core is used to realize a high power density 20 kW isolated dc-dc converter. The power density of the proposed 20 kW isolated dc-dc converter is 13.3 kW/L excluding the heatsink. The converter has an estimated efficiency of 98% over a wide range of output load conditions.

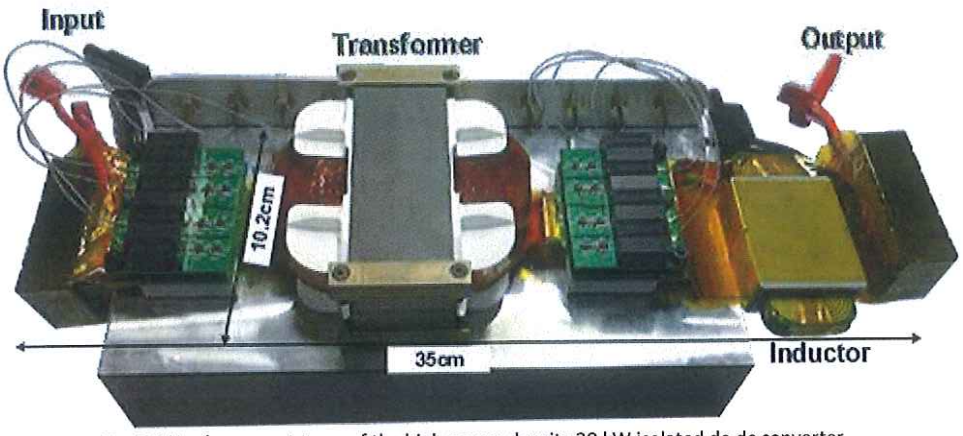
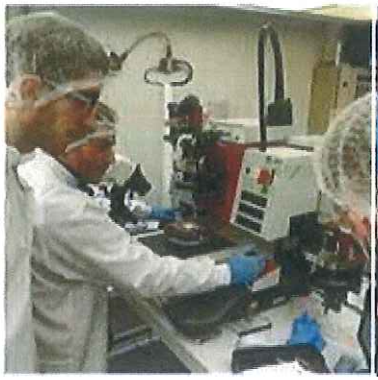


Fig. 3.2 Hardware prototype of the high power density 20 kW isolated dc-dc converter

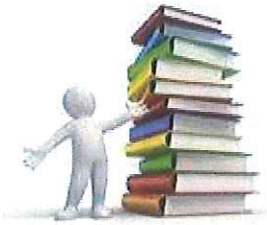
The measured heat dissipation with organic film archives an improvement of more than 40% compared to current conventionally produced DCB. Due to the high voltage of 700 V, the module has to be encapsulated against electrical flashovers. Corresponding tests resulted in a dielectric strength of the module of at least 1.7 kV. Thus, the required minimum dielectric strength of 1400 V is clearly exceeded.

Danish-German Crossborder Teaching

In December, Master and PhD students from SDU Sønderborg went to FH-Kiel and CAU, respectively, to join their teaching. At FH-Kiel, students attended a customized seminar on power modules allowing them to try out individual manufacturing procedures involved in the manufacture of power modules. At CAU, students took part in a lecture on control theory and EMC-filter design.




Publications



R. Ramachandran, J. Nielsen, M. Nymand, N. Nageler, R. Eisele, "A 20 kW High Power Density Isolated DC-DC Converter for an On-board Battery Charger utilizing Very-low Inductive SiC Power Modules", 2020 IEEE Applied Power Electronics Conference and Exposition (APEC), USA, 2020.

UPCOMING EVENTS 2020

Lecture on high-speed machines by Prof. Bernd Löhlein

Christian-Albrechts-Universität zu Kiel
Monday 20 January 2020 at 16:00

Professor Bernd Löhlein is giving a lecture on high-speed machines within the framework of the colloquium of the Technical Faculty of CAU. The lecture starts at 16:00 with the opportunity to meet the speaker prior to the event in a casual setting.

In October, Prof. Löhlein started in a position as professor at the University of Applied Sciences in Flensburg. His research focuses on electric traction drives, high speed permanent magnet machines, soft magnetic composite, multiphysics and system simulation (FEM).

Thank you for the good collaboration to PE:Region partners from academia and industry!

(Danish and German versions of this newsletter will be uploaded a.s.a.p. to our homepage).

www.pe-region.eu

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