PE:Region Newsletter - May 2018

Upcoming Events 2018

SCAPE 2018

[International Wide-Bandgap Power Electronics Workshops]

Stockholm, 11-12 June 2018

Danish-German PE:Region Seminar

SDU Sonderborg - The Mads Clausen Institute

Wednesday 27 June 2018 at 11.30 - 15.00 at Alsion

Demonstrator Development for Intelligent Grid Integration, High Speed Drives and, Battery Charging

For further information and registration

Conference/Workshop Participation

EMC in Industrial Electronics

Danfoss Silicon Power , 27 February 2018

Danfoss Silicon Power GmbH in Flensburg was so kind as to host the PE:Region seminar "EMC in Industrial Electronics" on 27 February. Speakers from both industry and academia provided an overview of EMC/EMI technical knowledge, current regulation, test and measurement methods and experiences from different fields of application within industrial electronics.

So far, this was the largest event organised by the PE:Region project, since more than 120 persons wanted to attend. However, the number of seats was limited to 75 and priority was given to participants from industry. The seminar included a visit to the new 10 m EMC test facility as well as the production facilities at Danfoss Silicon Power.

The event was organized in close cooperation between Danfoss, WTSH, Sønderborg Vækstråd and SDU.

New Energy 2018

16 March 2018

The PE:Region team joined the FURGY CLEAN Innovation congress on New Energy 2018 in Husum. Around 250 participants came to learn about trends and technologies of the future energy world. The annual congress was dedicated to the challenges facing the energy transition of which power electronics is a big part. In this regard PE:Region presented the current stage of development in WideBandGap technology, thermal simulation and the progress in our demonstrator development and SiC technology as

- Intelligent integration of wind and sun to the grid
- Energy efficient, reliable and compact high speed drive
- Bidirectional battery charger of 20kW

CPE-POWERENG2018

10-12 April 2018, Doha-Quatar

Kasper Paasch presented the IEEE CPE-POWEREG2019 to be hosted in Sonderborg next spring. The presentation was well received and there was a rather large interest about the fact that the conference will be held in Scandinavia for the first time. Please find here call for paper.

SDU was additionally presenting two conference papers at the conference in Doha: “Simple Digital Model-Based Design and Implementation of Carrier-based PWM for High Frequency Hybrid 3-L Active NPC Inverter” by Giorgo Kapino and Alireza Kouchaki (SDU Odense) and “Modeling, Simulation and Electromagnetic Conducted Emission Reduction Techniques by Finite Element Method” by Wai Keung MO and Kasper M. Paasch (SDU Sønderborg).

European Power Electronics Conference (EPE2018)

17-21 September 2018, Riga, Latvia

Two papers are in preparation.

Staff News

Wulf-Toke Franke

In his new position as an Associate Professor at MCI, Wulf-Toke Franke will work within the Centre of Industrial Electronics (CIE) and supervise a PhD project within the PE:Region project entitled 'Beyond the limits of standard motor drive topologies – New approaches for high speed drives'. For high speed machines, standard motor drives come to their limitations: Either high cooling effort is needed or the drive has to be extremely overrated to handle the high switching losses.

The aim of the project is to investigate new approaches to overcome this issue by applying multilevel topologies and wide band gap materials. The project is supported by an industrial partner in the field of high-end compressors, but the results will be transferable to multi-purpose high-speed drives and the next generation of power trains for electrical vehicles.

Wulf-Toke Franke has a PhD in in the field of silicon carbide power devices for solar inverters. In 2014, he moved into the fields of power stacks and power semiconductor packaging at Danfoss Silicon Power. He developed a power stack for compressors and was part of a technology project in the field of electromobility. Moreover, he was local project manager of several funded research projects as IEPE, CORPE and DC-Industrie. The latter included the development of an intelligent power module (IPM) for motion drives powered by dc-grids.

Boyan Dinev

Boyan Dinev has been employed as a PhD student at MCI, SDU Sonderborg under the supervision of Associate Prof. Konstantin Kostov developing computer models of DC-DC power converters, emphasizing on low EMI emissions and high efficiency, and thus joining the PE:Region project.

The goal of the PhD project entitled 'Computer-aided Modelling and Design of Power Electronic Converters' is to develop models of power electronic converters and their components, which can accurately predict the operation of the converter, including undesired effects, such as electromagnetic emissions, and parasitic coupling effects that can adversely affect converter performance. Computer-based power converter design requires high confidence in the models and methods that will be developed. Therefore, practical implementation of the design, and its verification, are very important parts of the work.

The project will start with the modelling of inductors and passive filters. The focus will be on the accurate prediction of the electrical behavior of a power filter – the inductor parasitics and coupling between the components depending on the layout, the resulting insertion loss, etc. Subsequently, the project will move on to the modeling of active semiconductor power devices and looking for optimal layout arrangements that can be useful in the various power converter topologies.

Boyan Dinev received his Master's degree in Mechatronics at MCI in June 2016, specializing in Embedded Control Systems. In the past year he has worked as an Embedded Systems Engineer, developing wind energy vibration monitoring systems.

Demonstrator Status

Demonstrator #1: Increasing the renewable energy penetration by coordination of different voltage control devices

CAU is working on the comparison of different solutions (such as STATCOM and ST) to support the integration of renewable energy. Through previous research, all those power electronics based devices have the capability to increase the integration of renewable energy source. The comparison of solutions with respect to the economic effects and technical performance has been made. The economic effects include the cost of manufacture and cost of installation. The technical performance of different devices has been analysed.

Demonstrator #2: Controller design for energy efficient, reliable, and compact high speed drives

Model predictive control offers the possibility to reduce the effective switching frequency of the converter while maintaining fast dynamic response, and good steady-state performance, which is important assuming a cascaded control structure. The hysteresis based MPC is extended to multiple prediction steps. By using more than one prediction step, the algorithm can be improved to look for a solution that is not optimal in the first step, but

prepares for longer following trajectories.
A detailed analysis of this research carried out at CAU is accepted for publication at the upcoming IEEE Energy Conversion Congress & Exposition (ECCE 2018).

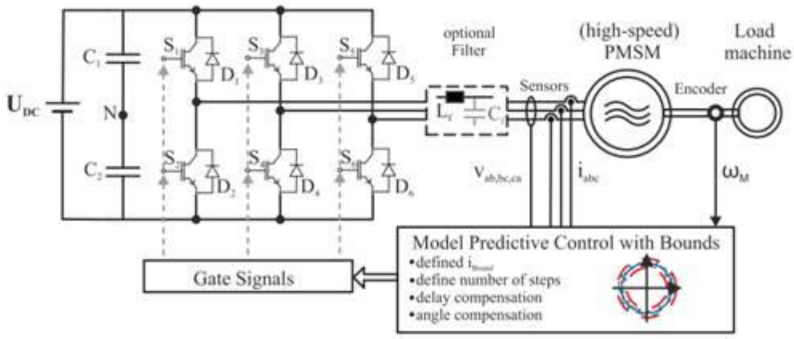

Figure 1: Schematic of 2-Level Voltage Source Converter with MPC

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

For the demonstrator #3, a 20 kW two-level three-phase power factor correction (PFC) rectifier has been designed with discrete SiC MOSFETs. The hardware prototype of the switchboard along with the measurement and the protection setup is shown in Fig. 3.1. The PFC rectifier including the filter inductor has a calculated efficiency of about 99.2% at full load and 99.3% at half the full load.

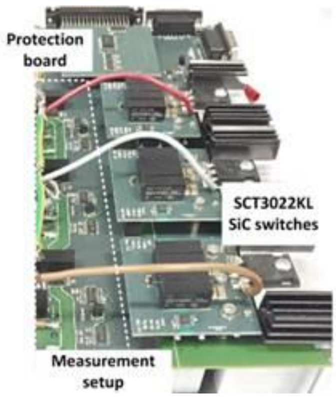

Fig. 3.1. Hardware prototype of a 20 kW PFC rectifier

For the dc-dc converter part, in order to reduce the magnetics size, the switching frequency has been increased from 35 kHz to 100 kHz. The hardware prototype of the 20 kW, 100 kHz transformer is shown in Fig. 3.2. The designed transformer has a measured leakage inductance of around 125nH and ac-resistance of 40mΩ referred to the primary at a switching frequency of 100 kHz.

Fig. 3.2. Hardware prototype fo the 20 kW, 100 kHz transformer

In connection with demonstrator #3, a novel power module has been designed by FH-Kiel that will be used in a later stage for the implementation of the dc-dc converter demonstrator.

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