IEEE DACH PhD Lectures

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Recent advances in PV and EV charging technology, power quality conditioning and resilience-oriented control

Date: Tuesday, February 28th, 2023, Time: 4:00 PM – 6:10 PM (Time Zone: Vienna)
Location: ONLINE

Registration: To register for the event (FREE) please visit the IEEE registration page https://events.vtools.ieee.org/event/register/344318 or contact markus.makoschitz@ait.ac.at.
Login information for joining the online event will be provided right before the event starts!

Agenda

16:00 – 16:05: Welcome

16:05 – 16:10: **Opening**
(DI Dr. Markus Makoschitz – Chair of the IEEE IAS/PELS/IES Joint Chapter Austria)

16:10 – 16:40: **Fast Dynamic Control – for the Applications of Power Quality Conditioning**
(Dr. Carl Ho – Professor and Canada Research Chair, University of Manitoba, Canada)

16:40 – 17:10: **Optimized Control of a bi-directional on-board Charger**
(DI Thomas Langbauer – Silicon Austria Labs)

17:10 – 17:40: **Advanced Resilience-Oriented Control of Multi-Microgrids**
(DI Dr. Michael Spiegel – Technische Universität Wien/Austrian Institute of Technology)

17:40 – 18:10: **Inductive Power Transfer for Photovoltaic Modules**
(Dr.-Ing. Fabian Carigiet – ZHAW School of Engineering)

18:10: End of Online Event

Organizers:

This event is jointly organized by the **IEEE IAS/PELS/IES Joint Chapter Austria**, the **IEEE PES Chapter Austria**, **IEEE IES/IAS/PELS Joint Chapter Germany**, **IEEE PELS Swiss Chapter**.

This event is jointly supported by the **AIT Austrian Institute of Technology GmbH** and **Graz University of Technology**.
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For **further information** please contact **JC chair** markus.makoschitz@ait.ac.at or **vice-chair** s.leitner@tugraz.at

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Speaker Information:

Title: Fast Dynamic Control – for the Applications of Power Quality Conditioning

Abstract: Fast dynamic response is one of key features which are required in modern power electronics applications. Conventionally, control bandwidth of Proportional–Integral (PI) controllers is limited by the process of “integral”, therefore dynamic response is also limited. Boundary control techniques with nonlinear switching surface have been proposed to be alternatives to pulse-width-modulated (PWM) control strategies in power electronics converters. It addresses the complete operation of a converter and does not differentiate startup, transient, and steady-state periods. The controller is based on operating model of converter, in order words: switching trajectory, to make switching decisions to guide the converter operating around the desired operating point. Ideally, a system with boundary controller can return to steady-state within two switching actions after a transient. The control strategy is promising for modern power system applications to deal with disturbance. This presentation gives the fundamental concept of Boundary Control with second-order switching surface. And one practical application, Power Quality (PQ) Conditioning, of the control strategy will be provided. By using the control strategy, fast dynamic response Unified Power Quality Conditioners (UPQC) are designed and implemented to deal with the PQ issues, including voltage sags, swells, harmonics, flickers and input voltage regulation. Performance of PQ conditioners have been experimentally evaluated. The measured transient times were within the range of micro-second and most of common PQ issues have been tackled. The results will be shown and discussed in the seminar. And other applications using the fast dynamic control, Photovoltaic (PV) Maximum Power Point (MPP) Tracking, Grid-forming and LCL filter damping, will also be introduced in the seminar.

Speaker: Dr. Carl Ho received his BEng and MEng double degrees and PhD degree in electronic engineering at the City University of Hong Kong in 2002 and 2007, respectively. He was involved in research on the development of dynamic power quality conditioning technology during his Ph.D degree. In 2007, he joined ABB Switzerland. He has been appointed as R&D Principal Engineer for PV Inverter and UPS products. In 2014, he joined University of Manitoba, currently he is Professor and Canada Research Chair in Efficient Utilization of Electric Power. In July 2021, he was appointed as Associate Head (Electrical Engineering) of the Department of Electrical and Computer Engineering at University of Manitoba. He established the Renewable-energy Interface and Grid Automation Lab (RIGA Lab) at the University of Manitoba and takes up the challenge of research into Microgrid technologies, Photovoltaic Inverters, Power Hardware-in-the-loop, and WBG Power Semiconductor applications.

Dr. Ho is currently an IEEE Senior Member and serves as an Associate Editor-in-Chief of the IEEE Journal of Emerging and Selected Topics in Circuits and Systems (JETCAS), an Associate Editor of the IEEE Transactions on Power Electronics (TPEL) and IEEE Journal of Emerging and Selected Topics in Power Electronics (JESTPE). He received the Second Place Winner for 2018 Prize Paper Awards of TPEL and he was the recipient of the Associate Editor Awards of JESTPE in 2018, 2019 and 2021. And his leading project team Winnie the Power received Best Student Team Regional Award of the IEEE Empower a Billion Lives 2019 competition in the Americas region.

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Title: Optimized Control of a bi-directional on-board Charger

Abstract: Within the Tiny Power Box project, we were aiming for highest power density for an automotive (one phase, 7kW, water cooled) and industrial (three phase, 11kW, forced air cooling) bi-directional on-board charger. In the presentation I will explain why the chosen topology was selected and how the control and modulation scheme support the power dense design and high efficiency. A comparison to the state-of-the-art will be provided and the implemented power pulsation concept will be explained in detail. The proposed frequency and phase shift control of the subsequent DC-DC converter provides high efficiency despite the galvanic isolation needed between the vehicle battery and the grid.

Speaker: DI. Thomas Langbauer earned his Bachelor's degree in 2015 and his Master's degree in 2018 from Graz University of Technology. Since 2018, he has been a member of the Division Power Electronics at Silicon Austria Labs, where he has worked on the Tiny Power Box project, a bidirectional onboard charger for electric cars which has earned the OVE Innovation award 2022.
In addition to his work with Silicon Austria Labs, Thomas spent six months as an academic guest at the Power Electronic Systems Laboratory at ETH Zurich. He is currently working on completing his PhD thesis at Graz University of Technology, under the supervision of the Electric Drives and Machines Institute. His main research interests include power dense converters, modulation schemes, and control design, with a focus on developing new solutions in the field of power electronics.

Title: Advanced Resilience-Oriented Control of Multi-Microgrids

Abstract: Microgrids and multi-microgrids are commonly presented as a measure to increase the power system resilience and to tightly integrate renewable energy sources alike. One lever in such systems are proactive scheduling algorithms that optimize the multi-microgrid operation in advance. A novel hybrid optimization algorithm that enables the inclusion of complex grid constraints in resilient scheduling is presented. To further address the value and need of proactive scheduling formulations, an extensive evaluation method is proposed and applied. It is shown that the novel algorithm overcomes limits in scalability and in considering low-level controls at scheduling time, even when a state-of-the-art reference fails to deliver any feasible solution. The extensive evaluation of various scheduling formulations further demonstrates that even on the specifically designed test system, a large share of 87% to 99% of the incident duration can already be handled without considering resilience at scheduling-time. Nevertheless, when it comes to the remaining unsupplied energy, a considerable reduction by up to 41% can be reached by proactive scheduling. The results demonstrate that in some cases, it can be well justified to focus on economic aspects without considering system resilience in day-ahead scheduling. However, in critical applications, such algorithms including the novel hybrid optimization technique can add further value.

Speaker: DI Dr. Michael Spiegel received the B.Sc. and Dipl.-Ing. (master's) degrees (Hons.) in computer engineering from Technische Universität Wien (TU Wien), Vienna, Austria, in 2015 and 2018, respectively. In 2022, he successfully defended his Ph.D. thesis focusing on the efficient and resilient control of microgrids and multi-microgrids at the Faculty of Mechanical and Industrial Engineering, TU Wien.

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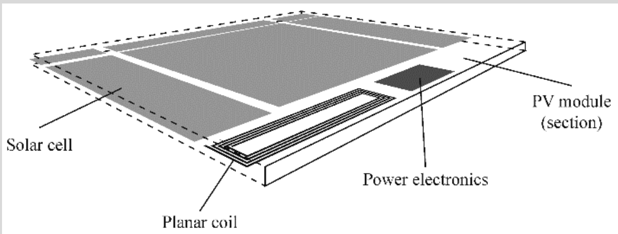
In parallel to his bachelor's and master's studies, he held various positions at AIT Austrian Institute of Technology, including two employments as a Research Fellow, where he studied the integration of event-based control and continuous physical models based on open standards. Additionally, for six terms, he worked at TU Wien supporting various courses held at the Faculty of Informatics. In continuation of his position as a Doctoral Fellow, he is currently working as a Research Engineer at the AIT Austrian Institute of Technology.
His research interests include power system optimization, multi-domain modeling and simulation of cyber-physical systems, and future sustainable power systems, in general.

Title: Inductive Power Transfer for Photovoltaic Modules

Abstract: The inductive power transfer was applied in the field of PV in order to develop a completely new and innovative PV system, which does not require a large number of traditional electrical connectors. Thus, the direct current of the solar cells is converted into an alternating current using a resonant converter and fed through a primary coil placed inside the PV module, which then induces a voltage to the secondary coil placed outside the PV module. The measured power transmission efficiency over the coils was 97.9% ±0.83% (k=1) and the modelled European efficiency of the whole wireless PV module including power electronics was 94.3%.



Speaker: Dr.-Ing. Fabian Carigiet was born in 1988 in the Swiss Alps. In 2008, he finished his four-year technical apprenticeship as an automation engineer with a hydroelectric power plant operator. Afterwards, he started studying electrical engineering at the Zurich University of Applied Sciences (ZHAW). After graduating with a Bachelor's degree, he was employed at the ZHAW and has been working with Prof. Dr. Franz Baumgartner in the innovative field of PV system technology to this day. In addition to his work, he competed his Master's degree in the field of photovoltaics. From 2016 to 2022, he did his doctoral thesis under Prof. Dr. Christoph Brabec at the Friedrich-Alexander-Universität Erlangen-Nürnberg (FAU) on the topic of "Inductive Power Transfer for Photovoltaic Modules".

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