EPE'25 – Call for Tutorials

System Level Modelling and Simulation of MVDC Distribution Grids featuring Solid State Transformers

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Tutorial Objectives:

The rapid development of Solid-State Transformers (SST) enables a future for microgrids that features the connection of various sources, loads, and storage elements to a common MVDC bus. The simulation of such systems present various challenges due to their growing complexity caused by the large amount of connected power converters and diversification of sources and loads. Quick benchmarking in booming MVDC areas require simulation models that feature superior speed with a dynamic response that fits real hardware. Within this context and objective in mind, a simulation tool has been developed with system level average models of elementary SST cells for DC grids. The implemented models are built with controlled current/voltage sources which embody dynamic behaviors of real SST systems. They may be arranged in various modular configurations, and they feature a basic failure mechanism that allows bypass of failed cells to study their impact on the full power system.

This tutorial aims to give both intuitive and practical understanding on the issues related to the control MVDC grids featuring modular SST with various loads and storage elements. The implementation of dedicated control on the power converter side together with a careful identification of possible perturbations is subject to design and simulation examples supported by industrial experience and academic approach.

The Tutorial will be composed half/half with traditional slides and practical demonstrations that the audience can follow and redo on their own computers. Both aspects will allow interactive discussions and parameter modelling. The models are built and demonstrated with Simba, a simple and powerful simulation environment that is free for academics and that allows Python automated scripting and a so-called pseudo-real time simulation approach.

Target Audience:

The audience should have some basic knowledge in control of power electronics converters and grid connected power systems. The topics will first cover introductory aspects suiting the non-specialists, followed by some advanced features suiting the specialists.

The audience should have a computer and possibly an installation of the modelling software that can be found on Simba.io (free for academics, trail version for industrials). To all programming enthusiasts, welcome!

Topical Outline:

Introduction: (Estimated time: 30 minutes)

- DC grids basics (grid modelling, strength, disturbances, and standards)
- control of power converters (control basics, handling of DC systems)

System level modelling of MVDC related comments (Estimated time: 60 minutes)

- System level model of an elementary SST cell
- Paralleling of modular SSTs
- System level model of the DC-BUS
- All other elements

Execution of a running model (Estimated time: 60 minutes)

- Full model of a typical MVDC for renewable systems
- Presentation of Python scripts for running the model
- Continuous execution of final model

Conclusions (Estimated time: 30 minutes)

- Prospects and open discussion

Provisional Schedule of the Tutorial:

Schedule:

09:30 - 11:00 : DC grids basics / Component models
11:00 - 11:30 : Coffee break
11:30 - 13:00 : Microgrid models / Conclusions

About the Lecturer:

Daniel Siemaszko received the M.Sc. degree from EPFL, Lausanne, Switzerland in 2005 and the PhD. degree at the Industrial Electronics Laboratory (EPFL-LEI) in 2009, under the supervision of Prof. Alfred Rufer. He came to Royal Institute of Technology (KTH-EME), Stockholm, as a Post-Doc working on MMC with Prof. Hans-Peter Nee. Then he joined CERN, Geneva, Switzerland, as a fellow researcher working on the powering strategies of a future linear collider. He also worked on control of AFE with ABB MV-Drives, Switzerland. In 2014 he founded PESC-CH, a consultancy company in power electronics in Geneva, specialized in DC substation energy recovery and modular BESS solutions for the medium voltage range. He also took Power Electronics teaching activities at the University of Applied Sciences of Western Switzerland in Yverdon (HEIG-VD) and collaborated on research with Prof. Mauro Carpita. In 2020, he joined Hitachi Energy as a senior R&D engineer working on SST for MVDC and E-mobility.