Simulating Power Electronics Converters Using Simscape Power Systems (Formerly SimPowerSystems) - The Right Balance between Performance and Fidelity

Audience

Electrical engineers, researchers and academics involved in designing, modeling and validating power electronics based equipment used in renewables power conversion and energy transmission.

Objectives

- Present various modeling and simulation techniques used to design and validate power electronics based equipment.
- Demonstrate the importance of selecting the appropriate simulation technique for a given study objective.
- Share knowledge on several engineering topics related to power electronics modeling and simulation.

Outline

Power system engineers simulating power electronics converter-based systems are often required to use special modeling techniques to speed-up simulation. These techniques may have drawbacks that will impair simulation results, hence the need to find the right compromise between performance and fidelity.

The tutorial presents four different levels of abstraction (switching devices, switching function, average model, and phasor) for modeling power electronics converters in Simscape Power Systems. These modeling techniques are applied to the case of a HVDC- Modular Multi-Level Converter (MMC) link. MMC technology is becoming the preferred means for power exchange between countries and transmission of power from renewables (hydroelectric plants, off-shore wind power and solar farms) to power grids. In the model, the MMC converter is implemented using four modeling techniques to simulate 36 power modules per arm.

A comparison of the methods and a description of their respective domains of validity are presented along with the simulation results. The most appropriate method for a given phenomenon under study is also proposed. Live real-time simulation of the case study is performed. Methods to extend real-time simulation of a 512-level MMC converter are also introduced.

Tutorial schedule

13:00 Registration

14:00 Introduction to Simscape Power Systems (formerly SimPowerSystems)

14:15 Levels of abstraction in modeling power electronic converters

- Presentation and illustration of various levels of abstraction to simulate power electronics based system.
- Case study description

15:30 Break

16:00 Performance and fidelity

- Detailed comparison between modeling methods.
- Performance vs fidelity metrics
- Finding the adequate simulation method for a given task

16:30 Real-time demonstration

- Live demonstration of the real-time HVDC-MMC model
- Demonstration of real-time simulation of a 512-Level HVDC-MMC model

17:00 Discussion and questions

17:30 End of Tutorial

The authors

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Pierre Giroux has been working for over 25 years as a senior engineer at IREQ real-time simulator. His work includes design, real-time simulation, and testing of controllers for HVDC systems, FACTS controllers, and power quality devices. He also performs the design, implementation, and testing of several MATLAB/SPS models.
He has a wide experience in the preparation and presentation

of technical seminars and training on Power and Control Systems.
Professional Interests: Power electronics & utility grid modeling, Real-time simulation

Gilbert Sybille obtained his electrical engineering degree in France in 1970 and
his M.Sc. from Université Laval (Québec) in 1978. In 1978 he joined the Laboratoire Simulation de réseaux of Institut de Recherche d'Hydro-Québec (IREQ) as a research engineer. He has been project leader in many simulation studies where he developed an expertise in real time testing of FACTS controllers. He is the chief architect of SimPowerSystems which is jointly developed by The Mathworks and Hydro-Québec.

Patrice Brunelle is responsible of the SimPowerSystems development team at Hydro-Québec (IREQ). In 2008 he joined the Laboratoire Simulation de réseaux of Institut de Recherche d'Hydro-Québec (IREQ) as a research engineer. He received the B.Sc.degree in Genie Unifié in 1992 from the Université du Québec a Chicoutimi, Chicoutimi, Canada, and the M.Sc. degree in electrical engineering in 1994 from University Laval, Ste-Foy

Christian Dufour received his Ph.D. degree from Laval University, Quebec, Canada in 2000. He is with Opal-RT Technologies since 1999 where he is now the lead researcher in power systems and motor drive simulation software. He is the main developer of the ARTEMiS-SSN solver.
Before joining Opal-RT, he also worked on the development of Hydro-Quebec's HYPERSIM real-time simulator, as well as MathWorks' SimPowerSystems blockset.
His current research interests are related to algorithmic solutions for the real-time simulation of power systems and motor drives, and their implementation on micro-processors and FPGAs.