Voltage Sourced Converter Based HVDC Transmission Systems

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This tutorial will discuss the latest developments in control and circuit topologies of voltage sourced converters for HVDC applications, including their broader support roles to ac power systems during normal and abnormal conditions, and power grid decarbonisation. The topics will be covered and depth of the discussions will be tailored toward an holistic approach, which targets a wide range of audiences and supports a global effort to raise new generations of academics, researchers and engineers with good knowledge of power electronics and power systems in order to able to meet the contemporary and future energy challenges.

This tutorial will cover the following aspects:

1. General overview:
   - Brief reviews of voltage source converters for HVDC applications, with emphasis on their motivations, operating philosophies, and attributes and limitations.
   - The critical roles that the converter topologies in system design trade-offs, particularly, between return of investment and security of supply, extended control range for better system interoperability, and fault tolerant operation of HVDC transmission systems, including relaxation of the design requirements of the protection systems.
2. Modular multilevel converters:
   - Operating principle, modulation and capacitor voltage balancing.
   - Higher and lower level controllers for centralized and distributed control methods.
3. Customized mixed cells modular multilevel converter (MC-MMC) and its variants:
   - Operating principle and control methods, and customized features and control range.
4. Enhanced modular multilevel converter and its variants:
   - Operating principle and control methods, and customized features and control range.
5. Alternate arm converter (AAC) and its variants:
   - Operating philosophy, control methods and limitations
6. Selected simulation cases aims to illustrate the half-bridge MMC performance during:
   - Normal operation (mechanism of power transfer within the MMC).
   - Symmetrical and asymmetrical ac faults
   - Pole-to-ground (P2G) and pole-to-pole (P2P) dc faults.
7. Selected simulation cases aims to illustrate the full-bridge MMC performance during:
   - P2G and P2P dc faults.
   - Bipolar dc voltage operation
8. Selected simulation cases to illustrate the performance of MC-MMC with equal and unequal number of full and half bridge cells per arm during:
   - Normal operation over customized operating range (illustration of added features)
   - P2G and P2P dc faults.
9. Selected simulation cases aims to illustrate the performance of the enhanced MMC and its variants during:
   - Normal operation (synthesis of different voltages).
   - Symmetrical and asymmetrical ac faults
   - Pole-to-ground (P2G) and pole-to-pole (P2P) dc faults.
10. General discussions

All registered delegates to this tutorial will be given electronic copies of the most comprehensive reports to date on MMCs and MC-MMC and comprehensive libraries of PSCAD and RTDS models. The time needed for delivery of this tutorial is 2.5 hours.

Biography:

G.P. Adam (M'12) received a PhD in Power Electronics from University of Strathclyde in 2007. Since April 2008, Dr Adam is with Institute of Energy and Environment, University of Strathclyde in Glasgow, UK. Besides his academic research, Dr Adam is a leading contributor to several research and development projects on novel MVDC and HVDC converters with industry, and to major European Union research projects on energy such as TWENTIES of the Seventh Framework Programme (FP7) and PROMOTION of the Horizon 2020. His research interests include: fault tolerant voltage sourced converters for HVDC applications; modelling and control of point-to-point and multi-terminal HVDC transmission systems; voltage source converter based FACTS devices; and advanced control methods to facilitate continued operation of offshore multi-terminal HVDC grids using cost-effective partially selective protection schemes. Dr Adam has authored and co-authored three books in applications of power electronics in power systems and renewable energy, and over 100 journal and conference papers in the area of multilevel converters and HVDC systems, and grid integration of renewable power. Dr Adam is a member of IEEE and IEEE Power Electronics Society, and active contributor to scrutiny of academic literature in the areas of fundamentals and applications of power electronics for several IEEE and IET Transactions and Journals and conferences, and as an associate editor and guest editor to IEEE journal of emerging and selected topics in power electronics.