DEPARTMENT OF ENERGY TECHNOLOGY
AALBORG UNIVERSITY

PhD Public Defence

Title: Protection of Multi-terminal VSC-HVDC Transmission Lines

Location: Online (find stream link on et.aau.dk) - PON 101 1.001

Time: Thursday 17 September 2020 at 13.00

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Opponents: Associate Professor Sanjay Chaudhary, Dept. of Energy Technology, Aalborg University (Chairman)
Professor Bertrand Raison, Grenoble Alpes University, G2ELab
Associate Professor Dirk Van Hertem, KU Leaven University, EnergyVille

All are welcome. The defence will be streamed live in English.

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Abstract:

High voltage direct current (HVDC) transmission plays a major role in transmitting power between generation and consumption regions worldwide. During recent decades, the evolution of voltage source converter-based HVDC (VSC-HVDC) links, has led to significant improvements in DC power transmission. However, there are still challenges in the protection and control of VSC-HVDC grids. These challenges are more important in multi-terminal VSC-HVDC (VSC-MTDC) grids, which need novel protection and control methods, along with the need for novel DC breaker topologies and converters with fault blocking abilities.

Regarding the protection algorithm design for VSC-MTDC grids, it is essential to have a selective fault detection method in order to detect the faulty section and separate it from the grid. The fault detection algorithm must be very fast and accurate, in order to have minimal damage to the converter switches. After detecting the faulty section, localizing the fault is of significant importance for a faster repair and maintenance processes. Due to the high rising rate of fault currents in HVDC transmission and the need for fast fault detection, traditional HVAC protection methods are not proper to keep converter switches safe. Accordingly, the designed protection algorithms must be significantly faster than the common protection algorithms.

I this thesis, novel strategies to detect the faulty section in multi-terminal HVDC grids, as well as new methods using fault traveling wave (TW)s in the modal domain are proposed. The signal-processing process is one of the most important stages in power system protection. In this thesis, most of the common signal-processing methods, which have been used in electrical power system fault analysis are analyzed. Additionally, novel combined morphological signal-processing methods, which give a more accurate initial peak detection for HVDC grids are designed and proposed. Combining the proposed TW analysis, faulty section detection strategies and the designed combined signal-processing method, new protection algorithms are developed, able to perform fault detection, localization and faulty pole detection for VSC-MTDC grids. Accordingly, in this thesis, novel fault detection and localization methods are designed, which give accurate and fast detection results suitable for VSC-MTDC grids. The proposed modal and morphological methods are tested with a variety of faults applied to standard HVDC benchmark models. The methodologies proposed in this thesis, namely modal and morphological techniques, give more accurate results to most of the literature works regarding the detection and localization of faults.