Efficient Modeling of Modular Multi-Level HVDC Converters (MMC) on Electromagnetic Transient Simulation Programs

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The recent introduction of a new converter topology, the modular multi-level converter (MMC) is a major step forward in voltage sourced converter (VSC) technology for high voltage, high power applications. To obtain a multilevel ac output waveform, a large number of semiconductor switches has to be used in the converter. The number of switches in MMC for HVDC transmission is typically two orders of magnitudes larger than that in a two or three level VSC. The large number of device count creates a computational challenge for electromagnetic transients (EMT) simulation programs, as it significantly increases the simulation time.

The purpose of this research is to develop an efficient, time-varying Thévenin's equivalent model for the MMC converter based on partitioning the system’s admittance matrix. Therefore, a computationally efficient yet mathematically exact model of the MMC converter was developed and implemented to simulate the MMC based HVDC transmission.The PSCAD/EMTDC simulation results shown that the model can drastically reduce the computational time without loss of accuracy. This approach enables what was hitherto not practical; the modeling of large MMC based HVDC systems on personal computers. Therefore, the use of the proposed method is demonstrated by simulating a point to point MMC based HVDC transmission system successfully with more than 100 levels. Control algorithms and other modelling aspects of MMC applications are also developed in this research.

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