Externe Masterarbeit

SIEMENS

TECHNISCHE
UNIVERSITÄT
DARMSTADT

Elektrische
Energieversorgung
unter Einsatz
Erneuerbarer Energien

Multi-terminal RMS-type model for Modular Multi-level Converter based HVDC

<u>Master Thesis with Siemens Energy Management - Transmission Solutions</u>

This master thesis aims to expand an existing point-to-point RMS (Root Mean Square)-type MMC-HVDC model to a multi-terminal configuration. The existing RMS model mimics the main controllability features of the detailed Electromagnetic Transient (EMT) model through modelling both the AC and DC-Circuits of each converter using separate AC and DC controlled voltage sources. The AC-DC coupling is realized through the control part. The existing RMS-model is developed in the software tool DIgSILENT PowerFactory.

A key issue for RMS-type simulations is the initialization of the whole network including dynamic controllers under study. The input for initialization of the existing state variables in the network model is the resulting load flow solution. Due to the methodology of using controlled DC voltage sources in the DC Grid in DIgSILENT, the DC load flow cannot be automatically solved by the software tool but must be provided by the model developer by giving the resulting DC voltage level for each converter terminal. Adding more converter terminals to the overall DC network increases the complexity of the DC load flow solution algorithm. In this thesis work, the point-to-point model expansion will be done in the first stage, followed by developing a DC load flow algorithm that can be generalized for multi-terminal DC grid. Once the load flow solution is established a dynamic grid controller based on droop characteristics will be implemented and verified through simulation results.

<u>Thesis objectives - Summary:</u>

- Expand existing point-to-point MMC-HVDC RMS-type model to a multi-terminal configuration
- Develop and verify a DC load flow solution algorithm that can be generalized for a multiple number of DC converter terminals.
- Develop the dynamic grid controller based on droop characteristics for multi-terminal configu-ration.
- Verify the dynamic performance of the developed three-terminal MMC-HVDC connection.

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