Dynamic Model, Control and Stability Analysis of MMC in HVDC Transmission Systems

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A control technique is proposed in this paper for control of modular multilevel converters (MMC) in high-voltage direct current (HVDC) transmission systems. Six independent dynamical state variables are considered in the proposed control technique, including two ac currents, three circulating currents, and the dc-link voltage, for effectively attaining the switching state functions of MMCs, as well as for an accurate control of the circulating currents. Several analytical expressions are derived based on the reference values of the state variables for obtaining the MMC switching functions under steady state operating conditions. In addition, dynamic parts of the switching functions are accomplished by the direct Lyapunov method to guarantee stable operation of the proposed technique for control of MMCs in HVDC systems. Moreover, the capability curve of MMC is developed to validate maximum power injection from MMCs into the power grid and/or loads. The impacts of the variations of MMC output and dc-link currents on the stability of dc-link voltage are also evaluated in detail by small-signal analysis.

Full paper DOI: 10.1109/TPWRD.2016.2604295