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Transient stability versus damping of electromechanical oscillations in power systems with embedded multi-terminal VSC-HVDC systems

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Abstract-

Multi-terminal high-voltage direct current technology based on voltage-source converter stations (VSC-MTDC) is expected to be one of the most important contributors to the future of electric power systems. In fact, among other features, it has already been shown how this technology can contribute to improve transient stability in power systems by the use of supplementary controllers. Along this line, this paper will investigate in detail how these supplementary controllers affect electromechanical oscillations, by means of small-signal stability analysis. The paper analyses two control strategies based on the modulation of active-power injections (P-WAF) and reactive-power injections (Q-WAF) in the VSC stations which were presented in previous work. Both control strategies use global signals of the frequencies of the VSC-MTDC system and they presented significant improvements on transient stability. The paper will provide guidelines for the design of these type of controllers to improve both large- and small-disturbance angle stability. Small-signal stability analysis (in Matlab) has been compared with non-linear time domain simulation (in PSS/E) to confirm the results using CIGRE Nordic32A benchmark test system with a VSC-MTDC system. The paper analyses the impact of the controller gains and communication latency on electromechanical-oscillation damping. The main conclusion of the paper is that transient-stability-tailored supplementary controllers in VSC-MTDC systems can be tuned to damp inter-area oscillations too, maintaining their effectiveness.

Index Terms-

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