

OPERATING MODES AND THEIR REGULATIONS OF VOLTAGE-SOURCED CONVERTER BASED FACTS CONTROLLERS

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ABSTRACT

In most published literature, a shunt VSC such as a Static Synchronous Compensator (STATCOM) is set to control the bus voltage and a series VSC such as a Static Synchronous Series Compensator (SSSC) is set to control the line power flow. In practical operations, however, there are other operating modes that are more appropriate, such as the reactive power setpoint control for a shunt converter and the fixed injected voltage control for a series converter.

In this thesis work, we investigate the modeling, simulation, and control of various operating modes and their regulations of VSC-based FACTS controllers embedded in transmission networks. An efficient control mode implementation is proposed to implement steady-state dispatch of various operating modes of FACTS controllers, using an approach of separate models for shunt VSCs and for series VSCs and functional coupling by the circulating active power between them. Because the maximum dispatch benefit of a FACTS controller often occurs when it operates at its rated capacity, dispatch strategies to optimize power transfer are proposed when one or both VSCs of a FACTS controller are loaded to their rated capacity.

Following the steady-state dispatch, dynamic regulator models of FACTS controllers, which take into consideration the dynamics of DC Links, are developed and implemented to evaluate their impact on transient stability during system faults and lightly damped inter-area oscillations. Based on the dynamic models, linearized models of FACTS controllers in multi-machine systems are derived using small-signal perturbations.

FACTS controllers can be utilized to improve small-signal stability by providing damping control supplemental to their regulation controls. To study the damping control effects of FACTS controllers, a new modal decomposition approach, which fully decouples all the modes in the system and considers the interaction of the other modes to the mode of interest, is proposed to quantify levels of controllability, observability, and inner-loop gains of the linearized models. A comprehensive process that examines the damping controller gain design and the selection of damping controller input signals is developed.