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# Externe Masterarbeit

# SIEMENS



TECHNISCHE  
UNIVERSITÄT  
DARMSTADT



Elektrische  
Energieversorgung  
unter Einsatz  
Erneuerbarer Energien

## Small-signal analyses for investigating slow control interactions between power electronic elements in modern electrical power systems

### Master Thesis with Siemens Energy Management - Transmission Solutions

For reliably integrating power electronic elements in modern power systems, the interoperability of the elements with the network and amongst each other needs to be ensured. The wide range of potential interaction phenomena can only be covered by a bundle of complementary approaches.

In a first step Siemens has proposed a methodology to investigate slow control interaction phenomena of a single VSC HVDC with the network in the linearized state space of complex systems based on small-signal analyses, i.e. modal analysis (eigenvalues and eigenvectors of the state matrix, etc.) and linear analysis tools (Bode, Nyquist, etc.).

For this thesis the proposed method shall be refined and extended to “multi-infeed” configurations addressing the interaction of multiple power electronic elements.

MATLAB and Simulink will be employed for the analyses of the linearized differential equations.

### General Requirements

- Excellent knowledge of the operation of electrical energy systems
- Strong mathematical foundations for analytical calculations
- Preference for candidates with very good knowledge of MATLAB and Simulink
- Preference for candidates with good knowledge of a network calculation program: (DigSILENT PowerFactory, PSS NETOMAC)

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