DEPARTMENT OF ENERGY TECHNOLOGY
AALBORG UNIVERSITY

PhD Public Defence

Title: Improvement of Transient Power Sharing Performance in Parallel Converter Systems

Location: Pontoppidanstræde 111, auditorium

Time: Tuesday 3 December at 13.00

PhD defendant: Mohammed Alhasheem

Supervisor: Associate Professor Pooya Davari

Moderator: Associate Professor Amjad Anvari-Moghaddam

Opponents: Associate Professor Daniel Ioan Stroe, Dept. of Energy Technology, Aalborg University (Chairman)
Professor Jorma Kyrra, Aalto University, Finland
Team Manager Alireza Nami, ABB, Sweden

All are welcome. The defence will be in English.

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Abstract:

‘’MGs are one of the key technologies that will enable further penetration of renewable energy sources (RES) in the power system. By aggregating multiple RES with distributed adaptive loads results in achieving much higher flexibility than individual operation. In this context, MGs can be used to provide different types of ancillary services e.g. voltage support. Also, in the case of an outage or low power quality of utility mains, they can seamlessly disconnect and continue to supply the loads with high-quality power in stand-alone mode.

Among different power converters, voltage source converters (VSCs) will be intensively studied as it will serve as the interface/interlink to the MG. A challenge to be overcome in the MG technology is to realize the operation of parallel-connected converters with good load sharing ability in both steady-state and transient conditions. The conventional principle of controlling these converters is based on cascading linear control loops. However, such a structure has inherent limitations such as slow response and sensitivity to control parameter settings.

This Ph.D. thesis proposes an alternative way of designing the MG control structure. It takes advantage of the fast evolution of digital signal processors, which is a platform for the integration of control algorithms for power converters and drive applications. The key idea is to use that raw processing power to embed all the inner control loops within a single algorithm that takes into account the model of the converter and its associated filter. In that sense, the principle of using a discrete model of the voltage source converter with an associated filter to predict its future behaviour for all possible control inputs, and consequently applying the one that minimizes a programmed cost function (CF) at every sampling time will be deployed. This kind of control strategy is referred to as the finite control set (FCS) model predictive control (MPC). This method has not fully explored and investigated in parallel converters system and MG applications. Therefore, this thesis aims to fill this gap both by theoretical research and experimental demonstration and also by investigating the performance of the proposed control structure in parallel operation. The effects on power quality have been addressed and the feasibility of applying FCS-MPC control strategy is further studied through efficiency analysis. Based on that, improved control strategies have been proposed and presented in this thesis to ensure high quality and fast operation of the future MGs.’’