

# Power Quality and Stability Improvement of More-Electronics Power Systems

## Abstract

Primary drivers behind the widespread integration of renewable energies comprise a marriage of the ever-increasing energy demand and a desire for the reduction of carbon footprints. Since renewables, are normally coupled to power grids through power electronic converters, power systems gradually evolve into more-electronics power systems. Despite clear efficiency and control benefits, power electronics bring in concerns to power systems. For one hand, it is difficult to ensure high-quality power supplies. For the other hand, power electronics may introduce instability issues. this thesis aims to investigate and address several power quality and stability challenges in the hope of smoothing the transformation towards future smart grids.

First of all, the fundamentals of more-electronics power systems including system configuration, operating principles, and modelling and control of power converters are described. A prominent power quality issue introduced by power electronics refers to harmonics, which can be eased with the adoption of the proposed novel passive filters. These instability issues should be blamed not only for the improper control of a single power converter but also for the undesirable operation of the entire power system. For individual power converters, the interaction between converter control and grid impedance may introduce converter-level instability issues. As solutions, the impedance reshaping technique is proposed. In addition, power converters with virtual inertia or operated as virtual synchronous generators (VSGs) can contribute to system-level frequency stability improvement. Through the proposed method, improvements of the frequency nadir and rate-of-change-of-frequency can be expected.

As the trend of renewable integration continues, new challenges and opportunities will emerge in more-electronics power systems. Speaking of power quality, grid supports by power converters under unbalanced grid and fault conditions will become a challenge. Regarding the system stability, there is a great opportunity to explore the inertia emulation capabilities of other potential energy sources, such as batteries and flywheels.