





Laboratory test environment for wind turbine prototype connected to grid based on RTDS simulation

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Introduction

Purpose of the study is to create laboratory test setup which takes into account

- The impact of network phenomena to the wind turbine operation
- The impact of the wind turbine operation to the network operation

Network model in RTDS



DC-motor, controlled using thyristor rectifier, is used to emulate the behaviour of wind turbine rotor

The wind turbine consists of permanent magnet synchronous generator, three-level generator side and grid side converters

• Nominal power of both converters are 10 kW and the converters are controlled using dSPACE

Network is modelled in RTDS and simulated point of common coupling (PCC) voltages are realized after scaling to the PCC of the wind turbine prototype using grid emulator

- Grid emulator is controlled using dSPACE
- Active grid side converter enable bidirectional power flow \bullet

Wind turbine PCC currents are measured and after scaling fed to RTDS

Wind turbine prototype is scaled to have nominal power of 500 kW when connected to RTDS network \bullet





Conclusion

- Wind turbine prototype is connected successfully to the artificial network which is controlled using RTDS
- If PCC voltages simulated by RTDS are used as grid emulator voltage references
 - Emulator performance is decent in frequency range up to 300-600 Hz depending of the load type
 - Emulator does not take the operation point of wind turbine (or other load/source) into account
 - PCC voltages in different operation points are determined by the emulator filter components rather than network parameters
- The operation point of wind turbine can be taken into account by using feedback control for the PCC voltages
- The bandwidth of the feedback control limited by
 - Resonances of the passive components
 - Saturation of the transformer
- The positive sequence bandwidth using controller with voltage feedback loop is 170 Hz (V-control)
- The positive sequence bandwidth using controller with voltage and current feedback loop is 185 Hz (VC-control)

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Future work

- Verification of simulation model of the laboratory environment with measurements in transient simulations
 - Symmetrical fault
 - Unsymmetrical fault
- Utilization of grid emulator in other applications
 - Solar power grid connection
 - Connection and control of renewable energy sources and/or energy storages in microgrid
 - LVDC
 - Charging / discharging of electric vehicle in different networks
 - Etc.