Stable network bridge control immune to system impedance

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Background

Grid side converter controller stability is strongly affected by the system impedance. Considering the turbine's electrical interconnection within a wind farm, this reactive component is typically associated to the MV and HV collectors' cable capacitance. This causes electrical resonances that have to be taking into account for a proper analysis of the stability performance of vector control strategy: in order to avoid unstable conditions, an enhanced controller design in needed, with stability margins ideally non-dependant on the system cable impedance. A solution to the problem has been proposed in the literature and it is the introduction of a filtering stage in the current feedback path [1]. However, tuning of this filter is strongly dependant on the wind farm cabling layout.

Objective

This work aims to identifying an innovative current vector control design able to provide an improved and portable solution to the grid resonance issue above discussed. Experimental tests will be conducted on a laboratory based test rig in order to confirm the findings of the work.

Project steps

Wind farm grid interconnection models in both time and frequency domains → Model validation with a laboratory test rig → Stability analysis and suggestions for enhanced control strategies → Validation of the proposed solutions with the laboratory test rig

System model

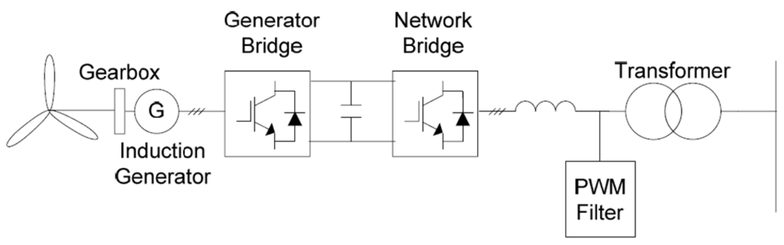

Figure 1. Wind turbine grid interface (a). Wind farm interconnecting layout (b) [1].

Controller structure and analysis

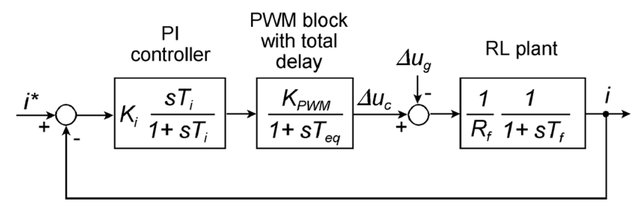

Figure 2. System model in the frequency domain [2].

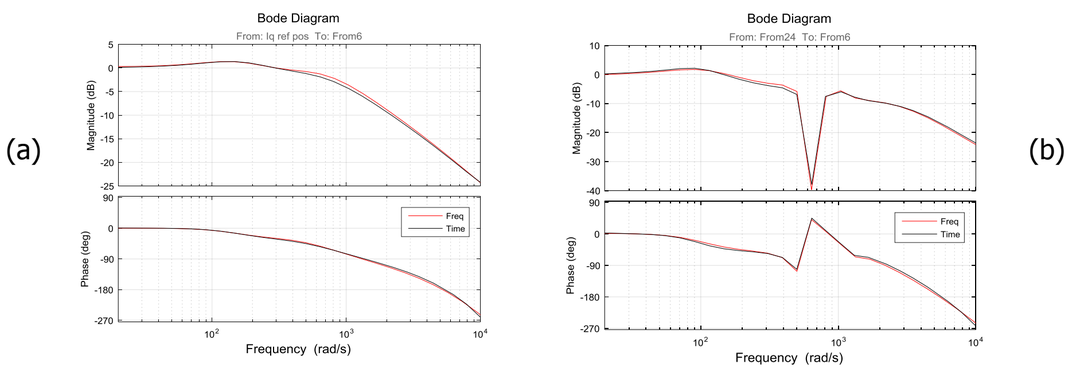

Figure 3. Simulated results: comparison of the current loop transfer functions based on a time and on a frequency domain model of the system. (a) only positive sequence. (b) positive and negative sequence.

References:

[1] Paul Brogan – Siemens Wind Power - The stability of multiple, high power, active front end voltage source converters when connected to wind farm collector systems.

[2] Alojz Slutej et. al. –Stability analysis of three phase PWM converter with LCL by means of nonlinear model. Document number: 621.314.5:621.376.6 - Automatika 51 (2010), 3., pages 221-232.

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