Control of VSFPWM-Operated LCL Filter in GCC

Master thesis project

Summary:

Research on the control strategies of grid-connected converters (GCC) employing LCL filter with Variable switching frequency PWM (VSFPWM) applied.

Problem definition:
VSFPWM (e.g. S-TCM) has gained ever increasing research attention because its potential to improve switching loss, reduce ripple, and optimize EMI filter design. Therefore, in order to evaluate the actual practicability of VSFPWM, it is worthwhile to look into the control strategies of grid-connected converters (GCC) employing LCL filters with VSFPWM applied. There have already been plenty of research conducted on the control issue of GCC employing LCL with conventional PWM methods that have a constant switching frequency, e.g. SPWM and SVPWM. This master thesis project differentiates by focusing on the control issues specifically related to VSFPWM, especially S-TCM.

Method:
This project starts with literature review on two aspects: VSFPWM (with a specific focus on S-TCM), and control issues of GCC employing LCL with conventional PWM methods. Then the project moves on to looking into the control issues related to GCC employing LCL with VSFPWM (specifically S-TCM). Finally, a closed-loop control algorithm for VSFPWM is to be implemented on the actual hardware (a two-level voltage source converter) to validate the theoretical analysis.

Research objectives:

1) Derive the mathematical model of S-TCM-modulated GCC with LCL filter in frequency domain.
2) Derive the stability criterion of closed-loop control for the aforementioned system, where a cascaded structure is considered here (one PI controller for voltage regulation and one PI controller for current regulation).
3) Implement the closed-loop control (cascaded PI controllers) both in simulation and on the actual hardware (a two-level voltage source converter) operated with S-TCM to validate the theoretical analysis.
4) If time allows, look into the possibility of implementing some advanced non-linear controllers, e.g. sliding mode, MPC, ANN etc. and compare with the traditional PI control.

Courses and supervision:
Knowledge on power electronics and classic control theory (frequency domain analysis) is a must;
C programming ability is a plus;
Knowledge on non-linear control algorithm is a bonus.

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