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Title

EXERCISE 7: CONTINUOUS-TIME GRID CURRENT CONTROL

Course Name
EE-465 Industrial Electronics I

1 INTRODUCTION

A skeleton model is available for download on Moodle. The inverter parameters are given in Table 1. All system parameters are set in the *Simulation parameters → Initialization tab*. The *3ph grid* blocks embeds grid voltage magnitude disturbance (low voltage ride through) for controller testing. The grid angle is available as output (*theta*). The *Reference calculation* outputs the grid current reference in *abc* frame $i^{\star}_{g,abc}$ in order to match a specified P/Q profile. The *Power calculation* block computes P and Q for a given set of measured grid currents in *abc* frame.

V_{DC}	750 V	V_g	400 $V_{\text{l-l,rms}}$	f_g	50 Hz	f_{sw}	10 kHz
S_{nom}	20 kVA	L_g	10 mH	R_g	20 mΩ	T_s	$1/2/f_{sw}$

Table 1 Parameters set for the model.

2 TASKS DESCRIPTION

1. Implement the PI controller in *dq* frame (subsystem) as grid current controller. Perform the required coordinate transformations, knowing that the grid angle is provided from the *3ph grid* block. Include reference limitation and anti-windup with back calculation.Show your block implementation in your report.
   Notes:
   - You can use "ctrl+u" to look under the mask of a subsystem and modify them.
   - A saturation block is provided, use it to implement back-calculation anti-windup.
   - Suggestions for PI tuning are given in the next task
   - We using 'Goto' and 'Signal From' blocks in PLECS be careful both to the *Tag name* and the *Scope* of the variable.

2. Tune the controller according to the criterion of your choice (Magnitude Optimum or target Phase Margin for a given ω_c). Consider double-update PWM (implying $T_d = 0.75/f_{sw}$).

   Test the closed-loop control response with the provided reference profile. Are you satisfied with the control performance? If not compare it with another criterion of your choice, in case some performance improvement is achieved.

   Show a scope capture of the response in ABC domain and in the DQ frame (use the scopes of the template showing, P,Q, grid voltages, converter voltages, grid currents and their references).

3. Implement the PR controller in $\alpha\beta$ frame (subsystem) as grid current controller. Perform the required coordinate transformations. Ideal PR implementation should be sufficient.
   Notes: You can use back calculation to avoid winding up the resonant part of your controller when the output saturates. It is applied in the same way as for the integral part of a PI controller.
   Show your block implementation in your report.

4. Tune the resonant controller. Consider double-update PWM (implying $T_d = 0.75/f_{sw}$). Test it in the same way as the PI controllers in DQ frame. Show a capture of the same scopes as before.

5. Are there any major differences between a PI controller in *dq* frame and a PR controller in $\alpha\beta$ frame in terms of controller response and performance, such as disturbance rejection ?