

Exercise 8: Control Design for PFC Rectifier

In this exercise a cascaded voltage controller for a PFC rectifier has to be designed. For this purpose the current controlled boost converter from exercise 4 should be used.

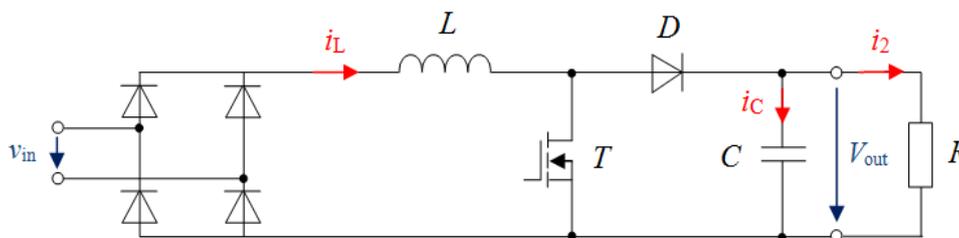


Figure 1: PFC rectifier consisting of full diode bridge and boost converter

The specification of the PFC rectifier is given below:

| | | | |
|-------------------------|----------------------------------|------------------------|---------------------------------------|
| Nominal output voltage: | $V_{\text{out}} = 400 \text{ V}$ | Boost inductance: | $L = 1 \text{ mH}$ |
| Nominal output power: | $P_{\text{out}} = 500 \text{ W}$ | Output voltage ripple: | $\Delta v_{\text{out}} = 4 \text{ V}$ |
| Grid voltage: | $V_{\text{in}} = 230 \text{ V}$ | Switching frequency: | $f_s = 100 \text{ kHz}$ |
| Grid frequency: | $f = 50 \text{ Hz}$ | | |

Download the provided and zipped file *Ex08_PFC.rar*, extract it and copy the Simulink model and the initialization m-file to a new folder. Start MATLAB, open the Simulink model and initialize it.

1. How have the circuit and control structure to be expanded to receive a mains-friendly converter?
2. Draw qualitatively the graph of the inductor current over one half of the mains fundamental period.
3. Determine the capacitor value in order to not exceed the demanded output voltage ripple.
4. The current controller can be taken from exercise 4. The voltage controller has to be redesigned for the PFC rectifier. The cutoff frequency should be 10 Hz. Find an appropriate parameter for the proportional gain in order to ensure a phase reserve of at least 40 degrees.
5. Expand the controlled boost converter model in MATLAB/Simulink to a PFC rectifier. Use your calculated parameters for the voltage controller and the output capacitor to complete the model.
6. Analyze the behavior of the PFC rectifier for steady-state and dynamic processes. Optimize your controller parameters if necessary.