Lab sessions:
Máster en Ingeniería Industrial

Lab session 1: Control of a three-phase inverter connected to the grid

Author

Ricard Lado Roigé

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1. Introduction

The first lab session has consisted in implementing in MATLAB-Simulink the block diagram corresponding to each part of the inverter. The following is a summary of the work carried out on the first session.

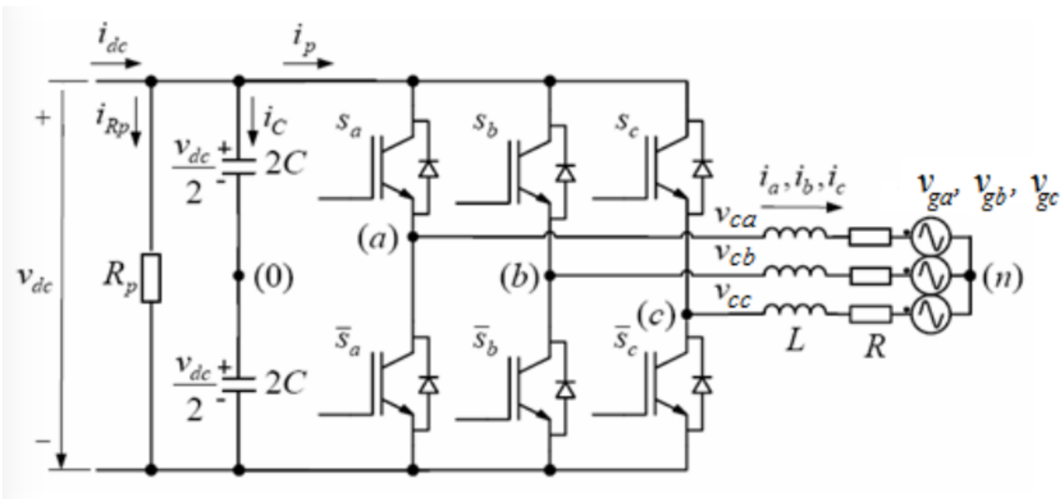


Figure 1.1: Three-phase inverter connected to the grid

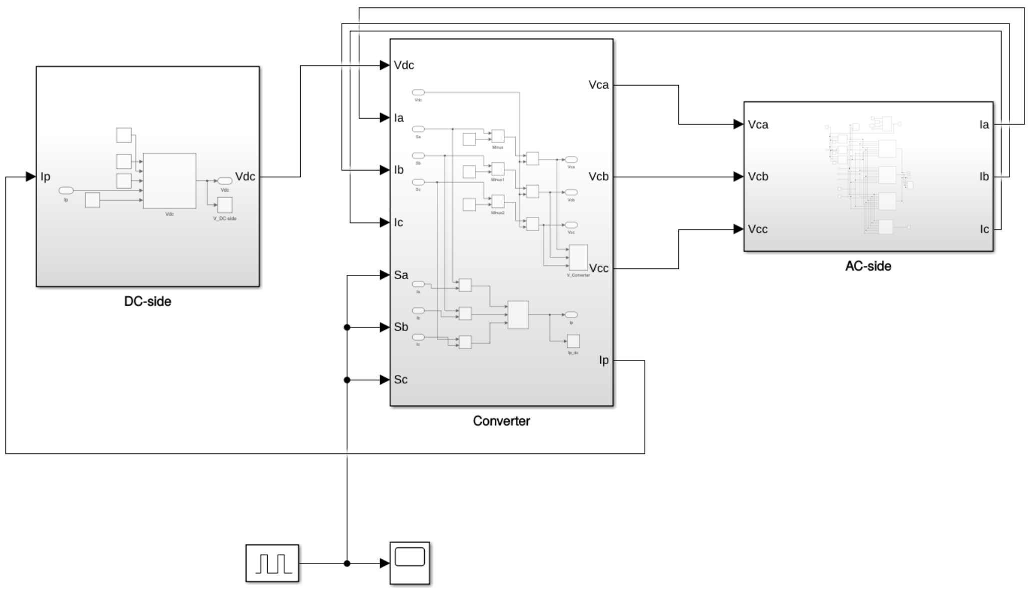


Figure 1.2: Final model after the first lab session

2. Modelling the AC side

The AC-side consists of a RL filter connected to an AC grid of 400V RMS 50Hz. The grid model includes a mechanism to drop the voltage for a certain amount of time in order to simulate a fault on the grid, the simulated fault is a three-phase fault with a 50% depth during 5.5 cycles (or 110ms).

The RL filter is used to filter out high frequencies generated by the power converter switching.

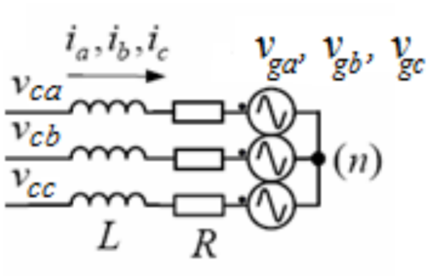


Figure 2.1: AC-side of a three-phase inverter (RL filter + grid)

$$i_a = \int \frac{1}{L}\left(v_{ca} - Ri_a - v_{ga} - v_{n0}\right)dt$$

$$i_b = \int \frac{1}{L}\left(v_{cb} - Ri_b - v_{gb} - v_{n0}\right)dt$$

$$i_c = \int \frac{1}{L}\left(v_{cc} - Ri_c - v_{gc} - v_{n0}\right)dt$$

$$v_{n0} = \frac{v_{ca} + v_{cb} + v_{cc} - \left(v_{ga} + v_{gb} + v_{gc}\right)}{3}$$

Figure 2.2: Mathematical model for the AC-side

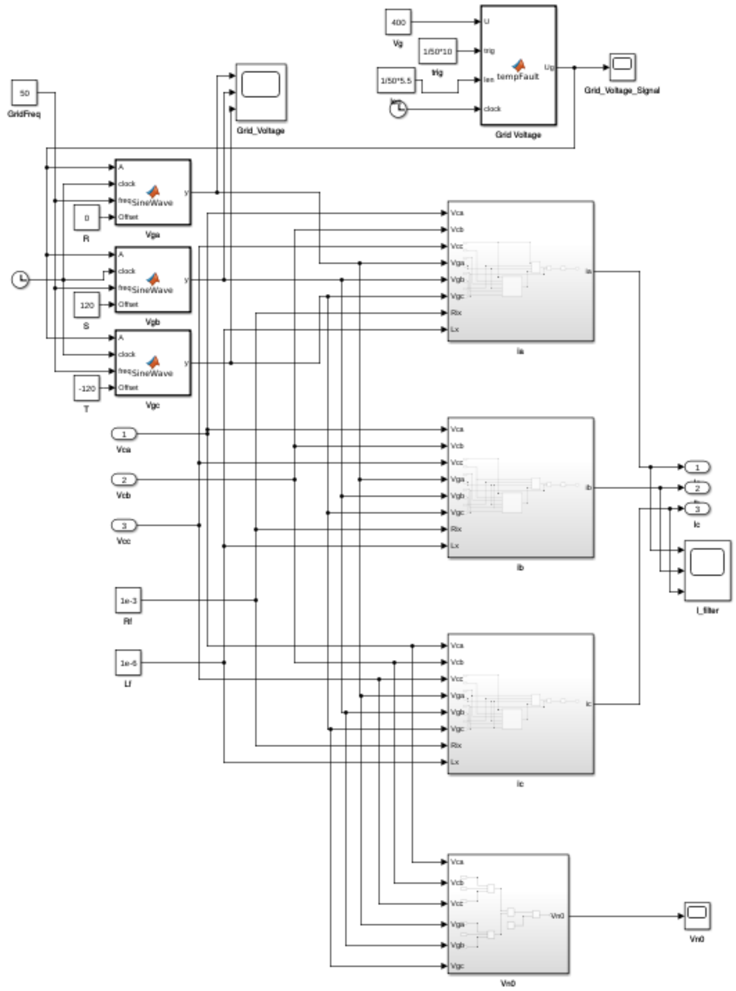
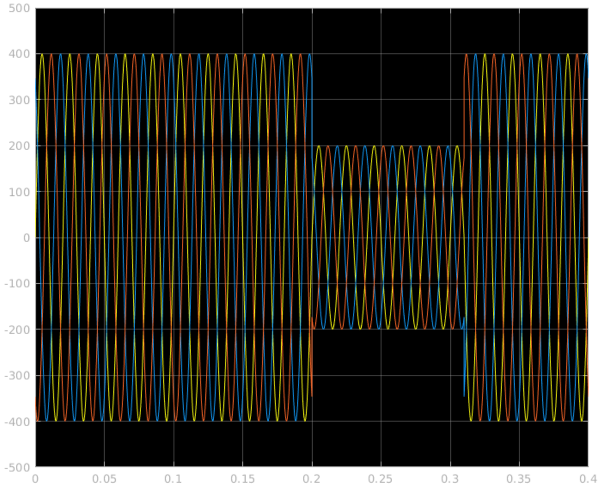
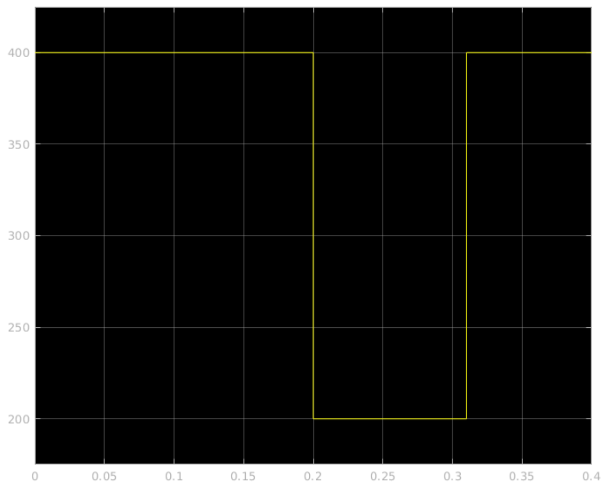


Figure 2.3: Mathematical model for the AC-side translated into Simulink



(a) Grid voltage simulated fault



(b) Voltage command signal drop

Figure 2.4: Three-phase grid fault

3. Modelling the DC side

The DC link of the power converter has also been modeled using a DC source in paralel with a resistor and a capacitor.

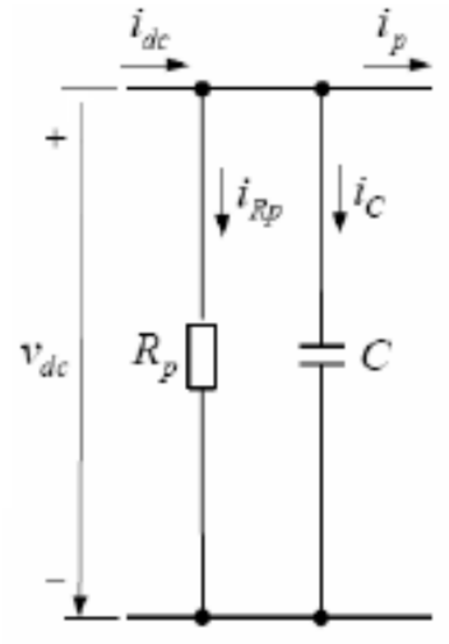


Figure 3.1: DC-link of a three-phase inverter

$$v_{dc} = \int \frac{1}{C}\left(i_{dc} - \frac{v_{dc}}{R_p} - i_p \right) dt$$

Figure 3.2: Mathematical model for the DC-side

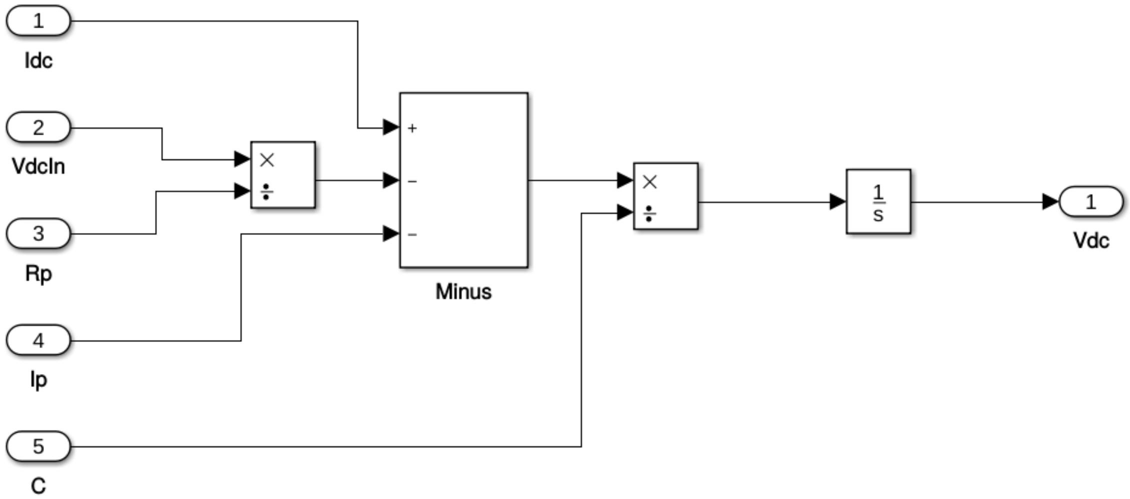


Figure 3.3: Mathematical model for the DC-side translated into Simulink

4. Modelling the converter

Finally, the power converter has also been modeled, but control will be implemented on the next session.

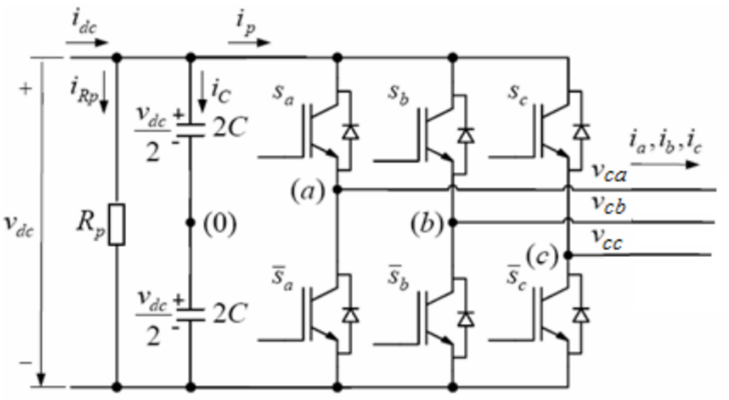


Figure 4.1: Three-phase inverter with IGBTs and diodes in anti-parallel

$$v_{ca} = \left(s_a - \frac{1}{2} \right) v_{dc}$$

$$v_{cb} = \left(s_b - \frac{1}{2} \right) v_{dc}$$

$$v_{cc} = \left(s_c - \frac{1}{2} \right) v_{dc}$$

$$i_p = s_a i_a + s_b i_b + s_c i_c$$

Figure 4.2: Mathematical model for converter

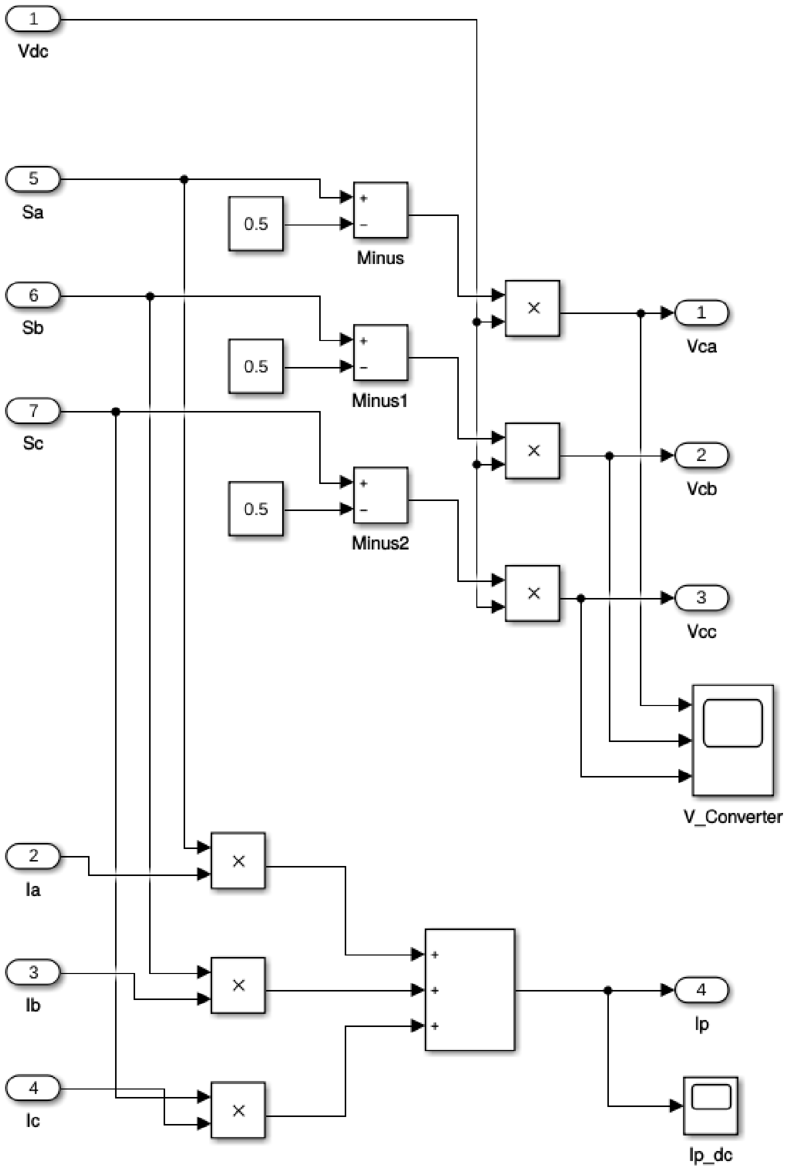


Figure 4.3: Mathematical model for the converter translated into Simulink