



PLECS

*DEMO MODEL*

## Voltage Source Inverter with Pre-Charge

Last updated in PLECS 4.3.1

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# 1 Overview

This demonstration shows a closed-loop controlled 3-phase voltage source inverter with a DC-link pre-charge.

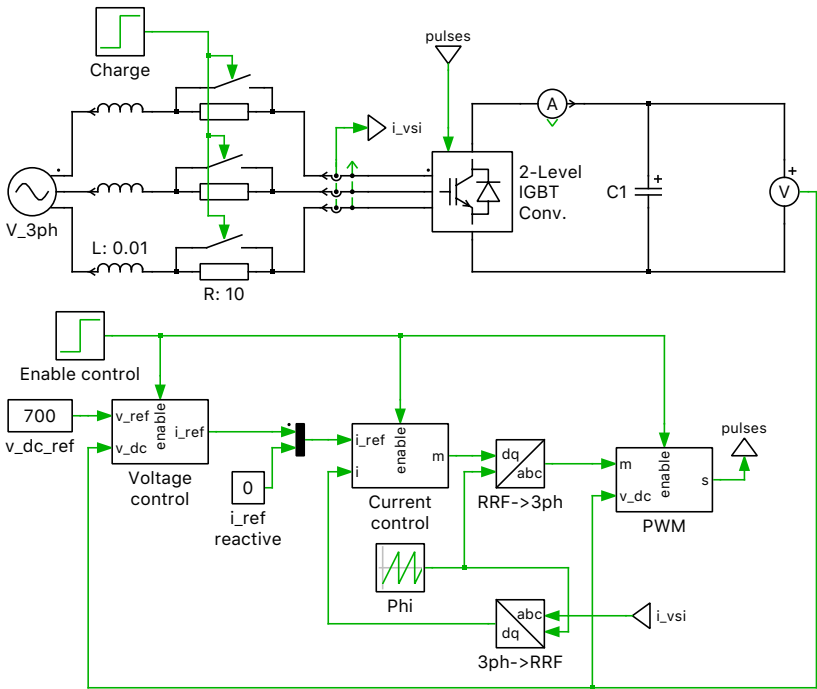


Figure 1: Feedback-controlled three-phase grid-connected thyristor (SCR) rectifier

## 2 Model

### 2.1 Power circuit

A stiff three-phase voltage source with line inductance is connected to the AC-side of 2-level IGBT converter. This model extends the “Voltage Source Inverter” demo model by including pre-charging resistors connected to the three-phase source. These resistors are used to limit the inrush current during the initial charging of the DC-link capacitor.

### 2.2 Control

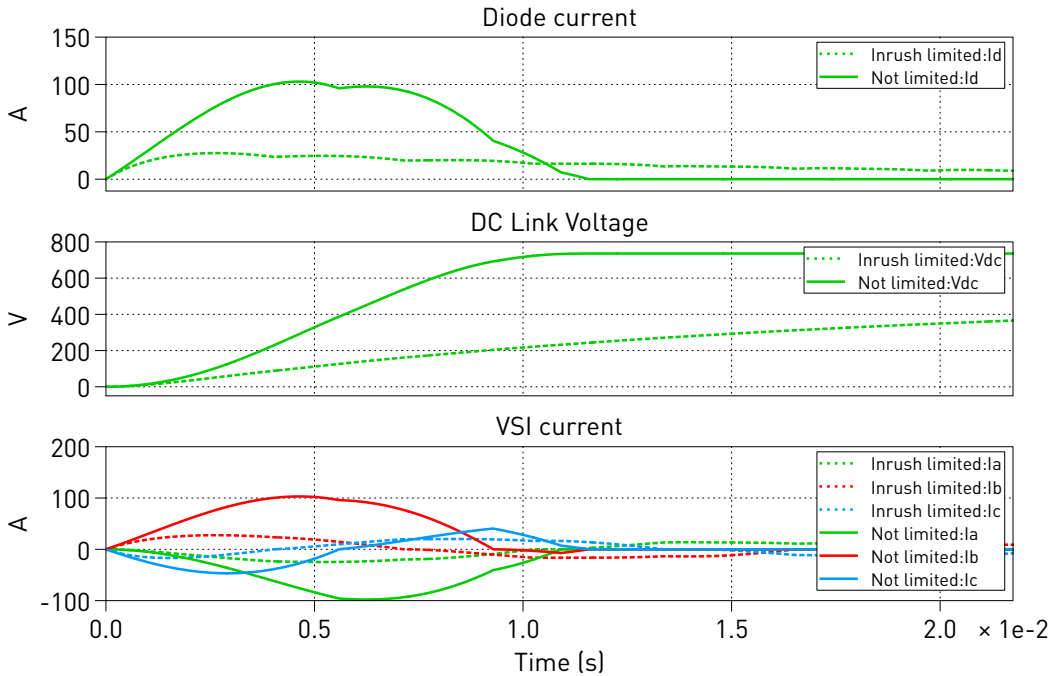
The inverter is controlled with an outer voltage control loop and an inner current control loop. The DC-link voltage is measured and compared against a voltage setpoint. The error signal is converted to a d-axis current setpoint via a PI regulator. The circuit is controlled to achieve unity power factor by setting the d-axis current setpoint to zero. The dq-current setpoints are then fed to a current controller.

The three-phase currents are measured and transformed to the dq-axis. A PI regulator with a feed-forward term is used to convert the current error signal into a corresponding modulation signal. The modulation signal is scaled with the DC-link voltage and fed into a PWM modulator to generate the gating signals for the IGBT converter.

### 3 Simulation

Initially all the controls are disabled and the 2-level IGBT converter acts as a passive rectifier. The rectified three-phase voltage initially charges the DC-link capacitor to the rectified three-phase voltage and the charge current is limited by the pre-charge resistors. After  $t = 30 \text{ ms}$  the pre-charge resistors are switched out of the power line. This causes a rise in the input current. At  $t = 50 \text{ ms}$  the controls are enabled and the capacitor voltage is increased to the desired 700 VDC operating point.

In the PLECS scope labelled with “i\_d, v\_d, i\_vsi”, save the trace and label it “Inrush limited”. Simulate the model again, without using the “pre-charge resistors”, by setting the “Step time” of the “Charge” step function to  $t = 0 \text{ s}$ . Compare the diode current waveform to observe the effect of pre-charging on this circuit.



**Figure 2: Simulation result**

## Revision History:

PLECS 4.3.1      First release

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### *PLECS Demo Model*

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