

PLECS

*DEMO MODEL*

## Single-Phase 2-Pulse Thyristor Converter

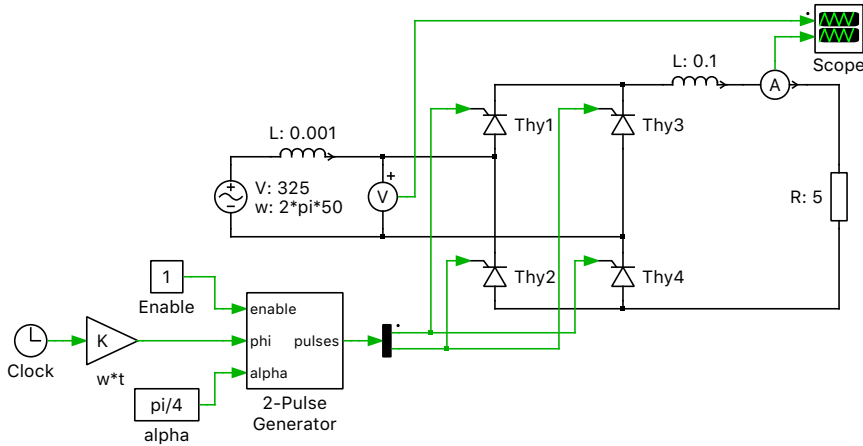
Last updated in PLECS 4.3.1

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# 1 Overview

This demonstration shows a single-phase full-wave thyristor (SCR) rectifier. The rectifier uses a 2-Pulse Generator component to control the firing of the thyristors (SCRs).



**Figure 1: 2-pulse 1-phase thyristor converter with RL load**

## 2 Model

This 4-thyristor AC-DC converter rectifies a single-phase source on the AC-side to supply a desired current on the DC-side. A description of a single-phase full-wave rectifier using diodes is given in the demo model “Diode Rectifier” in the PLECS demo models library. Similar to a diode, a thyristor can conduct current only in one direction. But unlike the diode, its turn-on is controlled by an external gate signal. The thyristor is modeled by an ideal switch that closes if the voltage between anode and cathode is positive and a non-zero gate signal is applied. The switch remains closed until the current passes through zero, at which point the device naturally commutates to open. Contrary to a transistor, a thyristor cannot be switched off via the gate. A basic example of how a thyristor can chop an AC voltage is found in the demo model “Thyristor Chopper Circuit” in the PLECS demo models library.

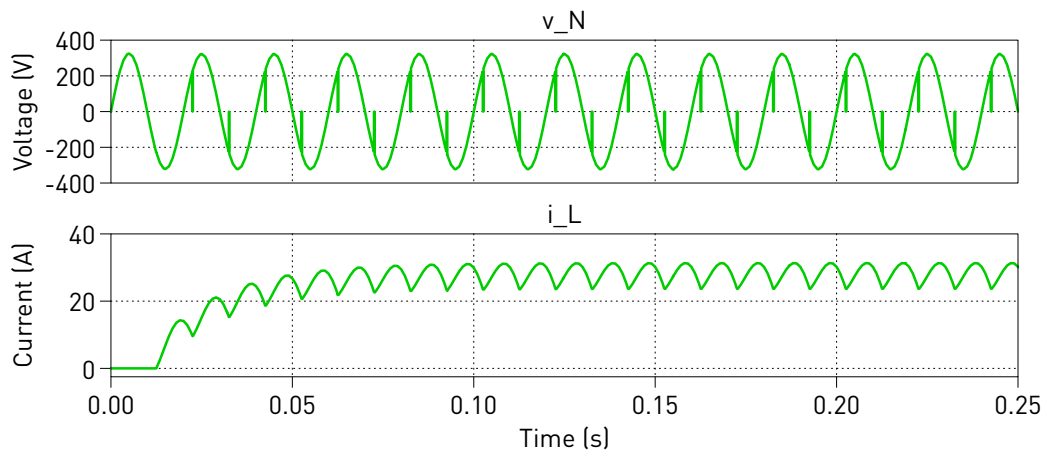
In this model, a 325 V, 50 Hz AC voltage is rectified and applied to an RL load. A 2-Pulse Generator component generates the pulses for firing the thyristors. A ramp signal and a firing angle are provided to the block as inputs. The firing angle controls the amplitude of the output current, while the firing events are aligned with the input voltage by means of the ramp signal to maximize the power factor. In an actual application, the ramp signal would be generated by a Phase-Locked Loop (PLL).

The output voltage can be approximated with this equation:

$V_{out} = (2 \cdot V_{peak}) / \pi \cdot \cos(\alpha)$ , where  $V_{peak}$  is the amplitude of the AC voltage and  $\alpha$  is the firing angle for the thyristors.

## 3 Simulation

Run the simulation to view the voltage and current waveforms shown in Fig. 2. Verify that the average load current is approximately 29 A. This can be calculated by dividing the output voltage by the RL load impedance. The voltage  $V_{out} = (2 \cdot V_{peak}) / \pi \cdot \cos(\alpha) = 650 \text{ V} / \pi \cdot \cos(\pi/4)$ , or approximately 146 VDC. With a load impedance of  $5 \Omega + 0.1 \Omega \approx 5 \Omega$ , the DC current is  $146/5 \text{ A} \approx 29 \text{ A}$ . This can be confirmed in the Scope by enabling the cursors and selecting the Mean function. Change the value of the firing angle to  $\pi/3$  and re-run the simulation. Verify that the current has been reduced, which, when recalculating for this new firing angle, should be  $\approx 20 \text{ A}$ .



**Figure 2: Simulation result of input voltage before thyristor converter and load current**

## Revision History:

PLECS 4.3.1      First release

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