Three-Phase 6-Pulse Thyristor Converter

Last updated in PLECS 4.5.1

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1 Overview

This example demonstrates a feedback-controlled three-phase grid-connected thyristor (SCR) rectifier. The control scheme first ramps up the output DC current from 0 to 10 A and then steps it up to 25 A.

![Figure 1: Feedback-controlled three-phase grid-connected thyristor (SCR) rectifier](image)

2 Model

2.1 Power circuit

This three-phase, 6-thyristor AC-DC converter rectifies a three-phase grid source on the AC-side to supply a desired current on the DC-side. A detailed description on the behavior of thyristors can be found in the demo model “Single-Phase 2-Pulse Thyristor Converter” in the PLECS demo models library.

A full-wave rectifier utilizes both the positive and negative pulses of the sinusoidal input waveform to produce a DC output. In reality the output will still contain a certain amount of ripple, but filtering can achieve a specific target of reduced high frequency distortion.

The output voltage of a three-phase rectifier can be estimated with this equation:

\[ V_{\text{out}} = \frac{3 \cdot \sqrt{3} \cdot V_{\text{peak}}}{\pi \cdot \cos(\alpha)} \]

Where \( V_{\text{peak}} \) is the amplitude of the AC input phase (to neutral) voltage and \( \alpha \) is the firing angle for the thyristors.

The thyristor firing angle is synchronized with the input voltage to achieve a maximum power factor. A demonstration of a single-phase full-wave diode rectifier with power factor correction is given in the demo model “Single-Phase Diode Rectifier with PFC” in the PLECS demo models library.

2.2 Control

A 6-Pulse Generator component is used to control the firing of the thyristors. A Phase-Locked Loop (PLL) detects the phase angle of the three-phase supply voltage. The low-frequency DC-side current is measured and fed into a current controller. This current is compared with a reference DC current and
the error is fed into a PI controller, which generates a firing-angle setpoint. The 6-Pulse generator produces the switching signals for the 6 thyristors based on the firing angle setpoint from the current controller and the phase angle information from the PLL.

### 3 Simulation

The DC-side reference current is initially set to zero. At $t = 10\, \text{ms}$, the reference current is ramped up to $10\, \text{A}$, and subsequently stepped to $25\, \text{A}$ at $t = 60\, \text{ms}$. Run the simulation and observe the DC current waveform in the scope. Notice the low-frequency AC-component of the current.

![Simulation result](https://www.plexim.com)
Revision History:
PLECS 4.3.1 First release
PLECS 4.5.1 Updating PLL component with new library block

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PLECS Demo Model
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