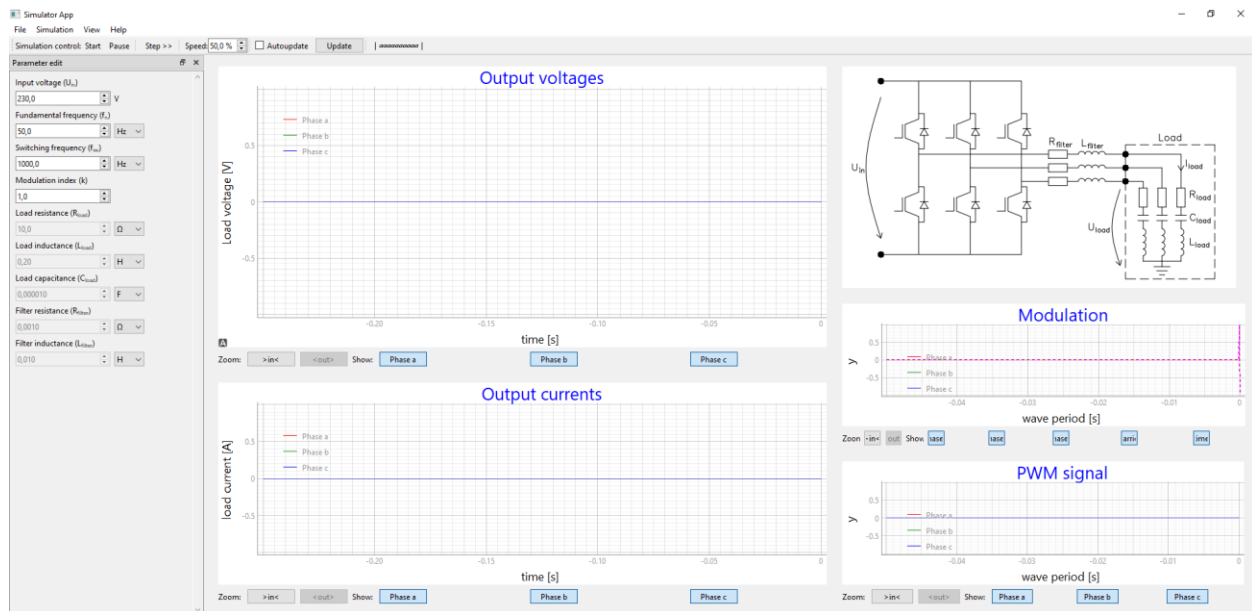# Frequency converter simulator

Frequency converter simulation is a part of the Introduction to Electrical Drives course. The goal of this simulation is to demonstrate PWM modulation of three phase frequency converters. The converter takes DC voltage as input and outputs 3-phase AC voltage. The ability to change frequency of electricity supplied to motors is an integral part of electrical drive systems, and PWM modulation-based converter is the simplest way of doing so.

The simulation can be opened from the simulator's startup menu and the opening view is similar to figure 1. The basic controls of the simulation are explained in the user manual.

Figure 1. Simulation view of the frequency converter simulation.

The simulation view consists of four time-domain graphs and a circuit diagram. The circuit diagram shows the converter bridge, filter and load simulated in the simulation. The output phase voltages and phase currents, where the voltages are measured over the load. The modulation and PWM signal graphs show a one wave period of time. The modulation graph shows the waveforms used to create the modulation signals. The triangle wave acts as the carrier wave of the modulation and has the frequency of switching frequency. The sinusoidal waves are the reference waves for all three phases in 120° phase shift to each other. Additionally, there is a vertical line showing the current time of the wave period. The PWM

signal graph shows the signals for each phase, where the phase is either connected to positive or negative voltage.

When the simulation is started the modulation and PWM graphs are set according to the given input variables and the converter is set to follow this modulation. Since the simulation is dynamic, it takes some time, usually at least a few wave cycles, to reach a steady state. The fundamental frequency variable can be changed to modify the wanted output voltage frequency and the switching frequency variable changes the carrier wave frequency affecting the smoothness of the output current and voltage. The modulation index sets the amplitude of the reference waves and can be used to adjust the amplitude of the output voltage. The load supplied by the converter is RLC series load, which can be set using the load resistance, capacitance and inductance variables. Additionally, the converter has a simple L-filter. Filters are commonly used to smooth the output voltage of a converter. The editable parameters are expanded on table 1.

Table 1. Parameter edit parameters, symbols, units and definitions.

Parameter	Symbol	Unit	Definition
Input voltage	U_{in}	V	Converter DC input voltage
Fundamental frequency	f_n	Hz	Reference frequency of the modulator and the output frequency of the converter.
Switching frequency	f_{sw}	Hz	Carrier wave frequency of the modulator and switching frequency of the converter.
Modulation index	k	-	Modulation index of the modulator, amplitude of the reference wave
Load resistance	R_{load}	Ω	Resistance of the load
Load inductance	L_{load}	H	Inductance of the load
Load capacitance	C_{load}	F	Capacitance of the load
Filter resistance	R_{filter}	Ω	Resistance of the filter inductor
Filter inductance	L_{filter}	H	Inductance of the filter inductor