Reference frame simulation

Reference frame simulation is an example simulation and not explicitly a part of any course. The simulation shows how reference frames commonly used in electrical engineering are related to each other. These reference frames being the abc-frame, alpha-beta frame and dq-frame. This simulation was originally created as a testing tool for the graphing capabilities of the simulator program, but was left into the program for its potential as a learning tool.

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.

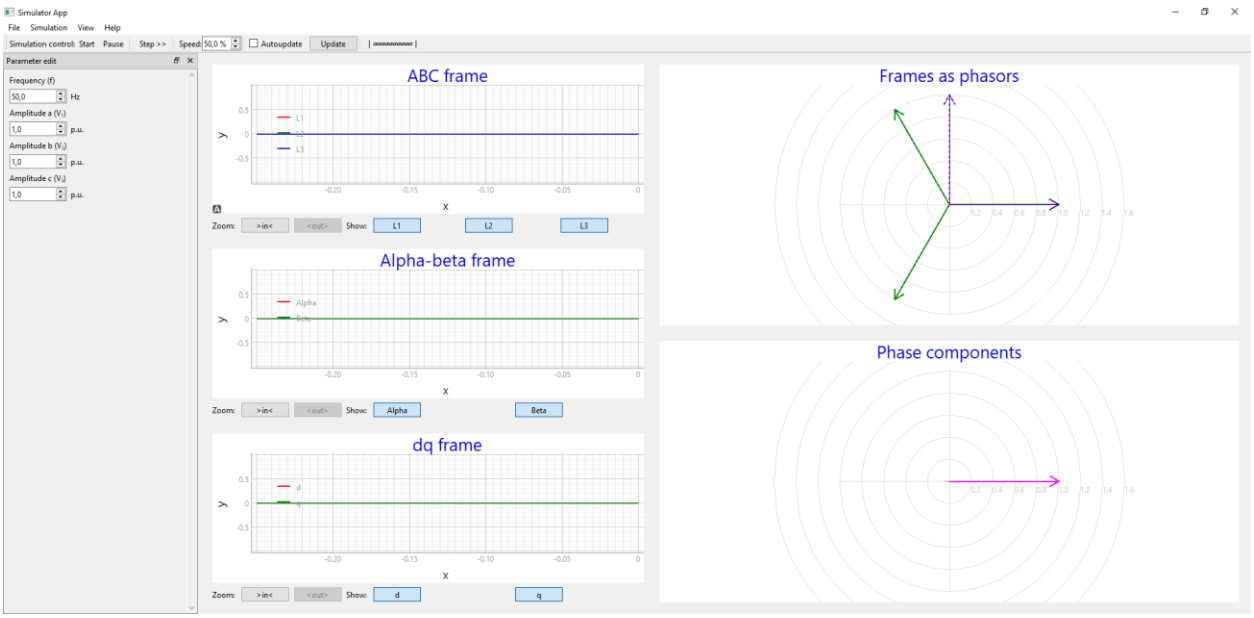

Figure 1. Simulation view of the reference frame simulation.

The simulator view consists of three-time domain graphs and two phasor domain graphs. The ABC-graph shows all three phases of a three-phase system. Alpha-beta graph shows the quadrature "phases" of alpha-beta frame. And dq-graph shows the quadrature phases in the dq-frame. In the *frames as phasors* graph, all three frames are shown in phasor representation, abc-frame in green, alpha-beta frame in dashed red and dq-frame in blue. In the phase components graph shows how a rotating phasor is formed by the three-phase system, where the phases abc are in represented by red, green and blue in corresponding order and the magenta phasor is the resulting rotating phasor known as state vector. Dashed

phasors are the origo oriented phasors and the non-dashed are the same phasors, just in different representation.

Reference frames are an integral part of space vector theory, which is used especially in the field of electrical machines and power electronics. In these systems, there are rotating parts, for example rotor in an electric motor, and the coordinates of these parts are therefore also changing. Using transformations can the coordinate system be changed to an invariant system making computations less complex and therefore faster. In sinusoidally varying systems the abc-frame represents the normal three-phase system and its state vector representation. Using abc to alpha-beta transformation, also known as Clarke transformation, can the reference frame be changed to alpha-beta frame. Similarly, abc to dq transformation, also known as park transformation, can be used to change reference frame to dq-frame. The theory is based on the idea that three phase system can be simplified to have only two components using space vectors. In the simulation these transformations are done and results represented in different graphs. The frequency and phase amplitudes can be changed to see the effects of these changes to the system in different reference frames. The editable simulation parameters are expanded on table 1.

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

Parameter	Symbol	Unit	Definition
Frequency	f	Hz	Frequency of the system
Amplitude a	V_1	-	Amplitude of the phase a
Amplitude b	V_2	-	Amplitude of the phase b
Amplitude c	V_3	-	Amplitude of the phase c