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Creating a VHDL-AMS model of a claw-pole alternator

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The design of Switched Reluctance Motors (SRM) is a complex optimization problem involving a large number of geometrical and electrical parameters. In practice, this can be a challenging task involving a large number of iterations and a long design cycle.

The example presented here demonstrates how OptiNet searches for the improved design of a 8/6 SRM to maximize the torque generated while conforming to manufacturing and operating constraints.

Systemvision Circuit

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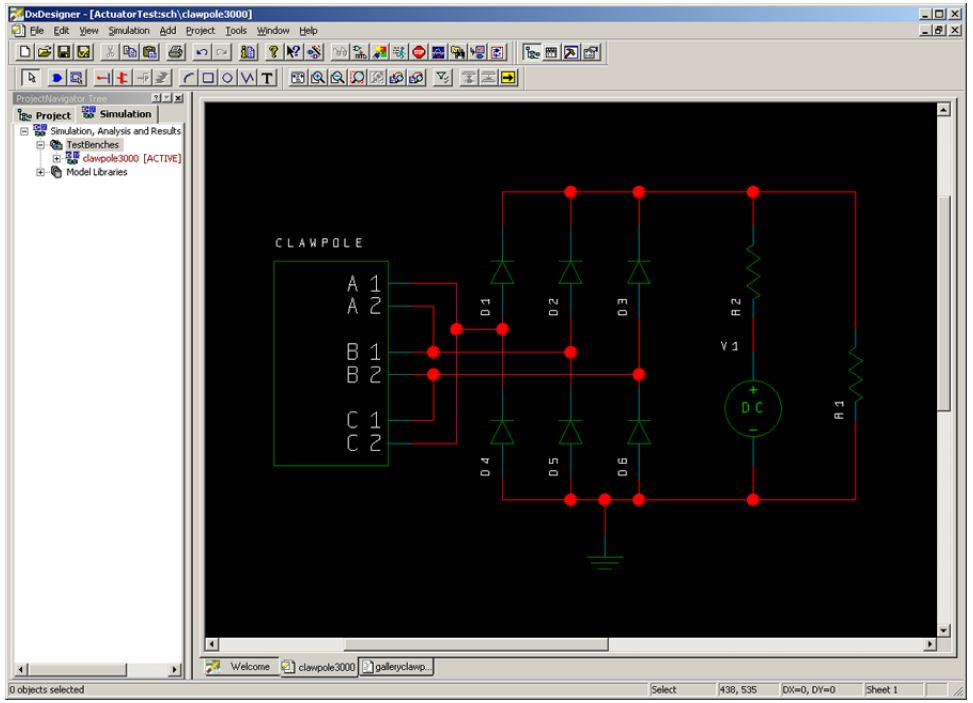
The claw-pole component is shown here in the SystemVision circuit. In SystemVision it is a simple matter to create this component from the VHDL-AMS file. The pins are automatically labeled from information in the file, and the model parameters, such as the number of turns in the windings, can be modified in a properties dialog.



Capturing Nonlinearities in the Rsm

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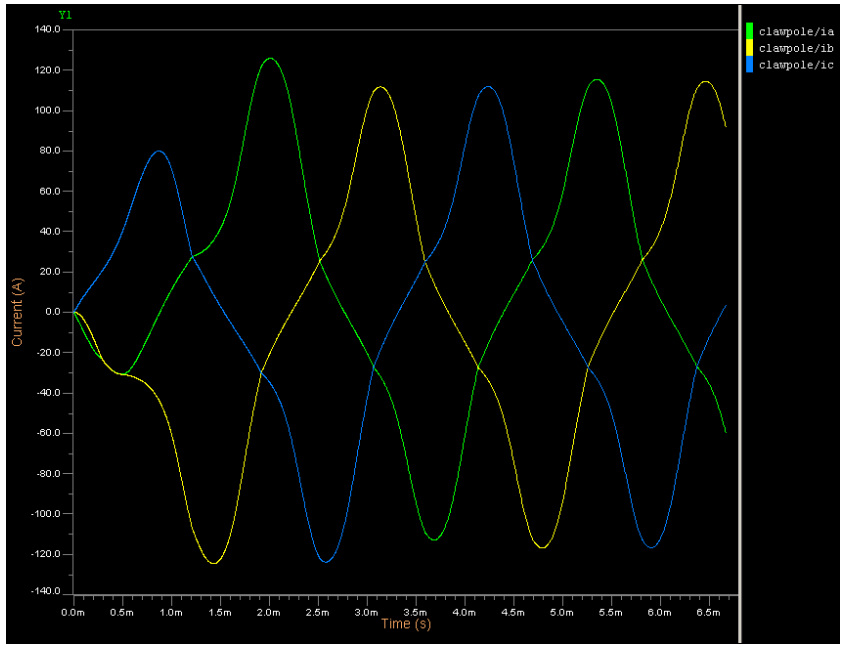
This example has already been solved using Infolytica's Transient 3d with Motion solver, and the results of that analysis are shown in the Application page Simulating a claw-pole alternator in an automobile electrical system environment. The current shown here compares well with that simulation, in particular, note that the third harmonic content is clearly evident, showing that the RSM is capturing one of the essential properties of these machines: nonlinearities.



Diode Switching Behaviour

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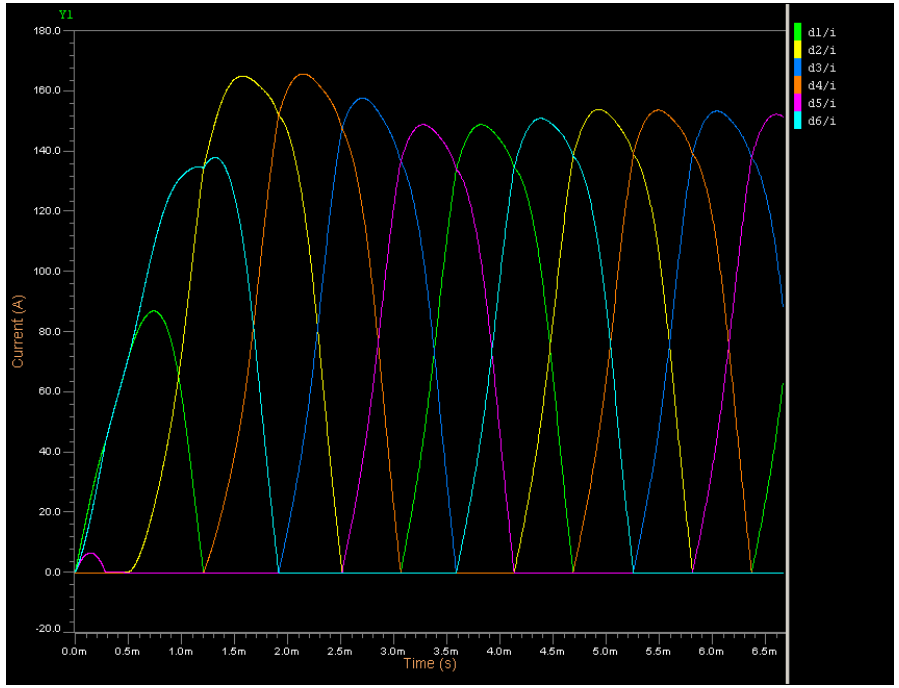
The diode currents shown here also compare well with the full transient solution. The diode switching behavior can be difficult to simulate, the fact the two simulations give identical results is as much a verification of the transient solution as of the system simulator.



Phase Voltages

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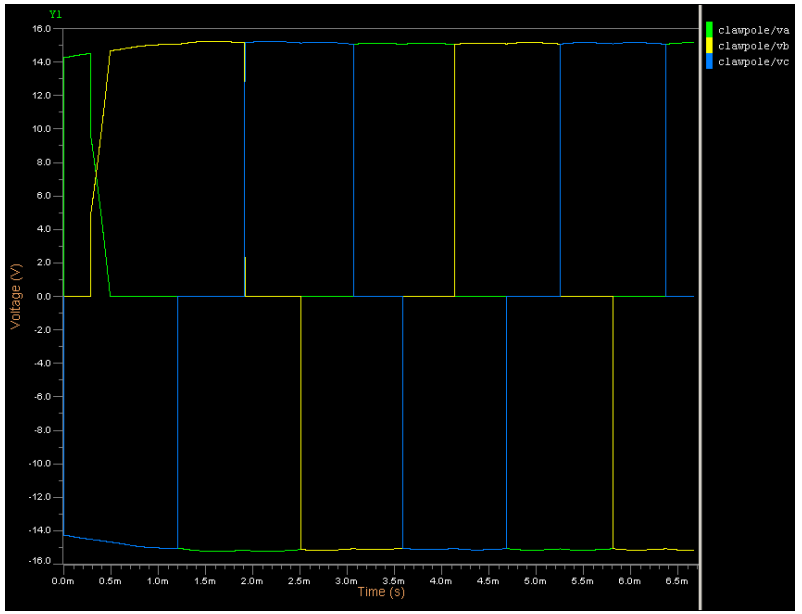
The phase voltages are shown here. They are much smoother than their counterparts from the MagNet transient simulation, since the circuit simulator can afford to take much smaller time steps. Simulating this transient takes a few seconds in SystemVision, compared to many hours for the MagNet transient simulation.



Battery Ripple Voltage

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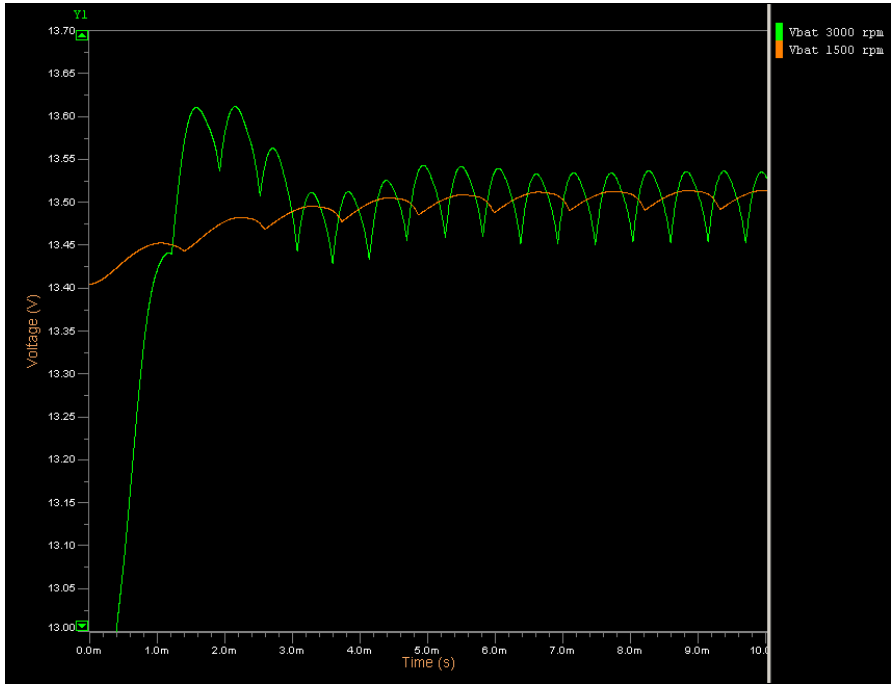
One of the benefits of the VHDL-AMS model is the ease with which different operating conditions can be simulated. Shown here is the battery ripple voltage at 1500 rpm and 3000 rpm. In both cases the resistive load has been adjusted such that the battery itself has approximately zero current through it.



Diode Bridge Behaviour

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At a lower speed (1500 rpm) the delta-connected diode bridge exhibits the behavior shown here. This result is obtained by simply editing the speed parameter in the claw-pole's property dialog. Another version of the claw-pole VHDL-AMS model has a separate mechanical terminal which allows an engine to drive the alternator at dynamically changing speeds.