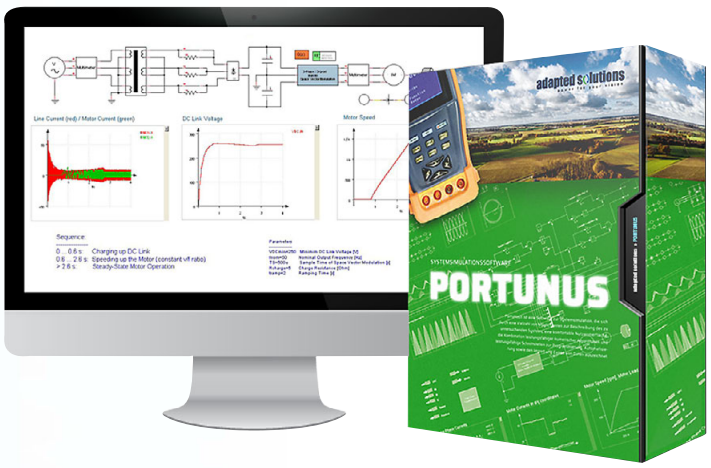
PORTUNUS



adapted solutions
power for your vision

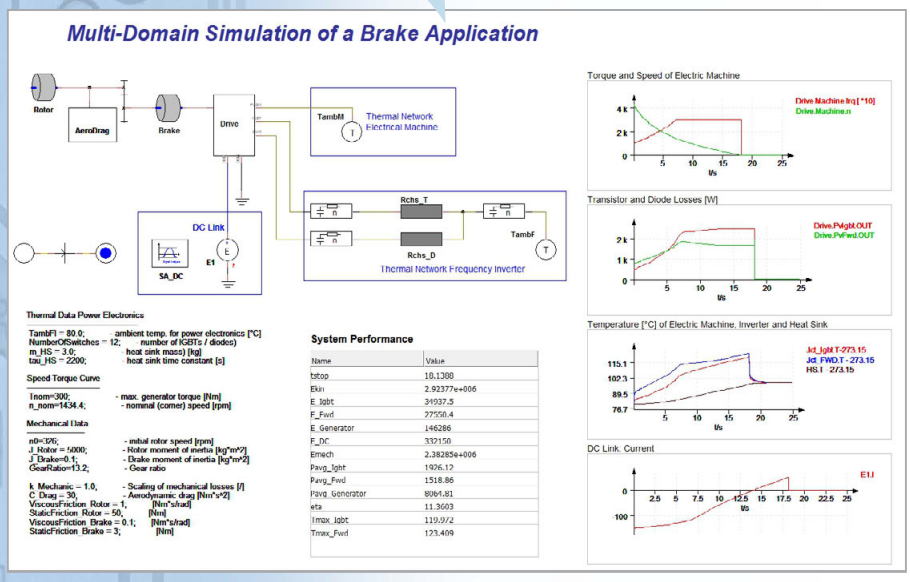
System simulation with Portunus – versatile, intuitive and fast

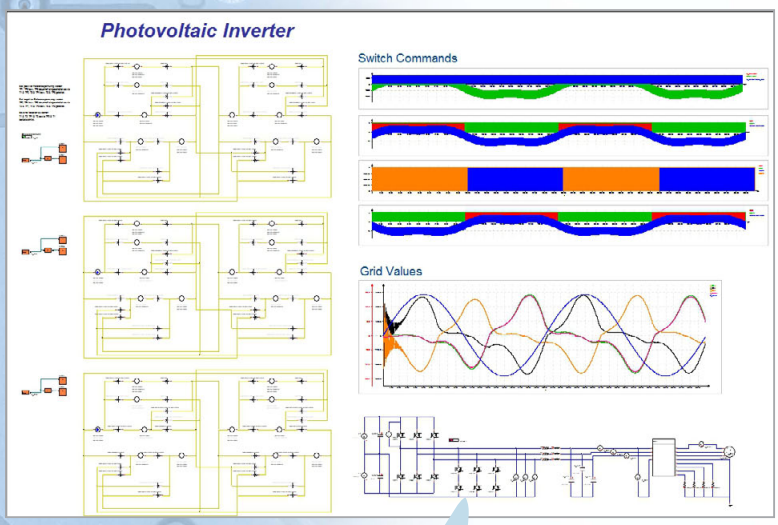
Via Portunus®, Adapted Solutions provides the engineer with a compact simulation tool which combines several modelling approaches, numerical methods and powerful interfaces that make it applicable to a variety of applications.

The model of an electric brake system allows for the simultaneous calculation of speed and torque values, currents, voltages and power dissipations as well as the determination of the resulting temperatures in the power semiconductors.

Modelling Physics

Quite often, the analysis of technical systems is not restricted to one physical domain. This is why Portunus® offers options for calculating electrical, mechanical, thermal, magnetic and hydraulic values; if necessary even combined in just one system model.
Couplings between component models allow for the analysis of physical interactions such as the heating of an electrical conductor caused by a current flow and the resulting increase of the resistance or the reduction of the current flow.



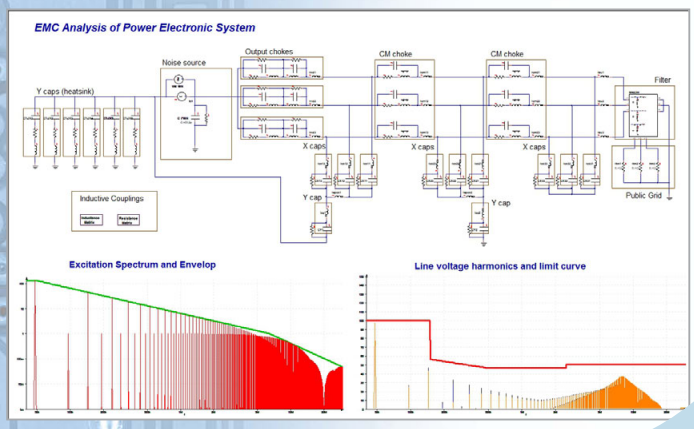


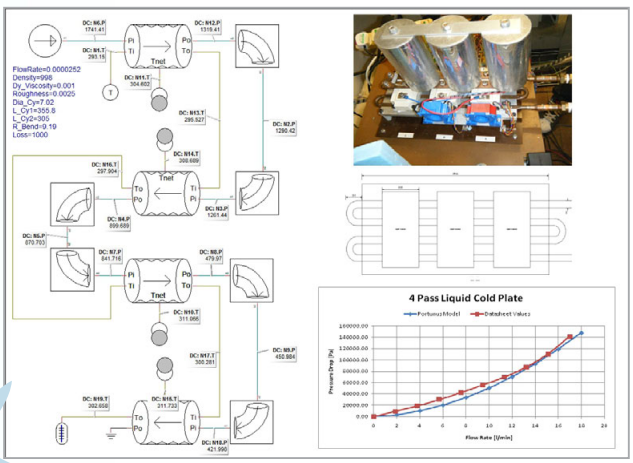
The control of a photo-voltaic inverter including the modulation of a third harmonic can be modelled by a combination of time functions, state machines and block diagrams.

The integration of the control algorithms is essential for simulating the system behavior. To ease this task, Portunus® offers a multitude of possibilities as state machines, block diagrams, the integration of source code and simulator couplings.

Analyses

Different applications lead to different requirements on the numerical methods and analyses. Even if in the majority of cases the time course of the quantities and the derived characteristic values are to be calculated, the simulation in the time domain (“transient simulation”) does not cover all requirements. Thermal calculations are often carried out with the aim of determining the steady-state conditions (“DC analysis”) and EMC investigations are typically done in the frequency domain (“AC analysis”). Portunus® supports all these analyses. Depending on the details of the application, it is also possible to apply different analyses or their combinations to the system model.

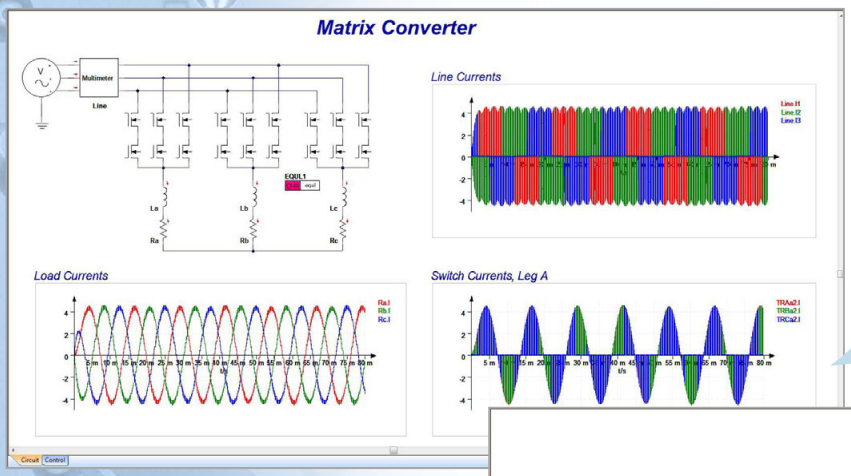




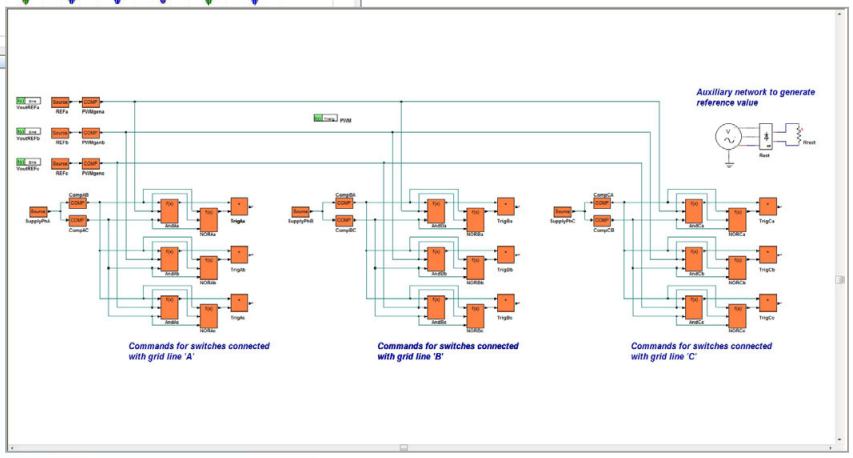
The EMC properties of an inverter (left) are calculated in the frequency domain (AC analysis). Temperature and pressure drops in a coolant system (right) are determined for steady-state conditions (DC analysis).

Graphical and Textual Modelling

The graphical description of the system behaviour can be very easily done in Portunus® by connecting models within networks, block diagrams and state machines. In addition, various time functions and multidimensional characteristic curves can be linked to models.

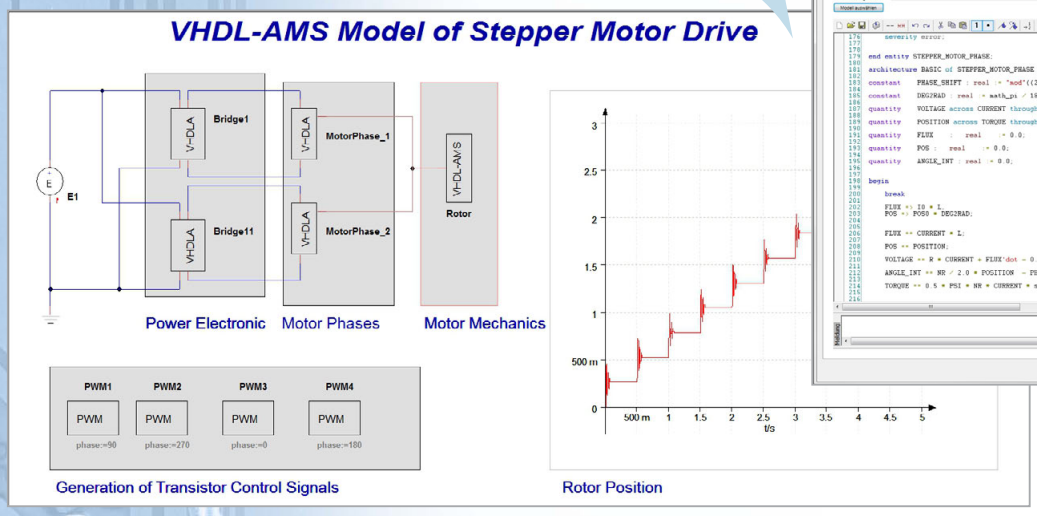


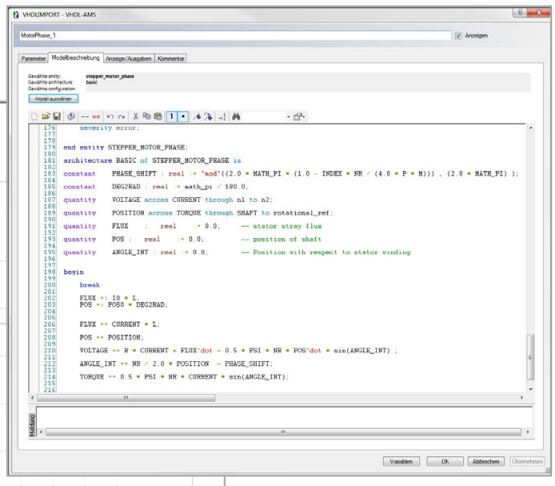
The model of a matrix converter consists of an electrical network and a block diagram for defining the control signals.



Alternatively, Portunus® offers the possibility of textual modelling using the model description language VHDL-AMS, the syntax of SPICE netlists or by coding with C ++. These options are especially useful if the complex model behaviour leads to cumbersome graphical modelling, component models are provided by manufacturers or source code can be integrated into the simulation.

A stepper motor drive is being modelled by means of VHDL-AMS models which reflect the differential equation system.





The integration of a component model into a simulation is independent of its implementation. Portunus® offers almost unlimited possibilities of exchanging values between the components of a system model. Using arbitrary mathematical expressions, the dependencies and interactions within the system can be expressed.

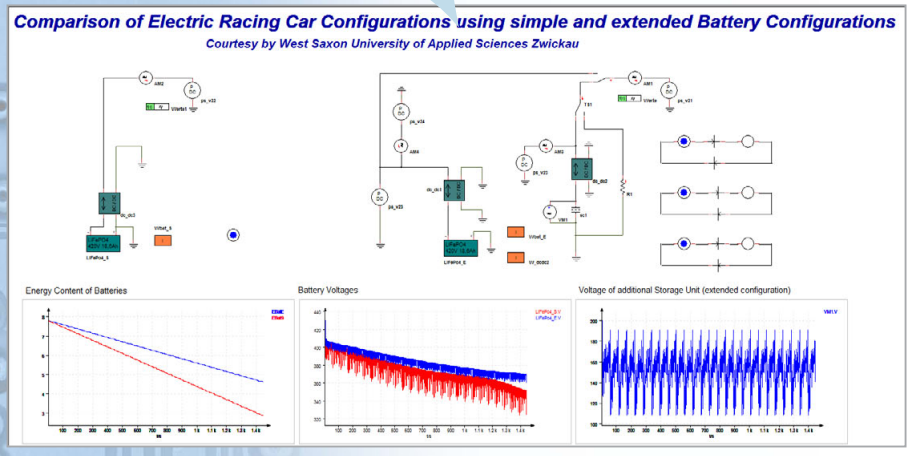
Graphical User Interface

Portunus® has a powerful, intuitive graphical user interface that provides a clear view of even large systems by means of the multi-page technology and the option to encapsulate subsystems.

The calculation results can already be displayed during the simulation run. An arbitrary number of display elements, showing the results as curves or tables, may be inserted into the schematic. These display elements provide post-processing functions and may show the results of several simulation runs (parameter sweep). A number of models support the visualization of operating states, so that, for example, a switching state can be recognized from the symbol in the circuit diagram. In combination with a "Replay-Mode" it is also possible to debug the model after the simulation has finished.

To compare two drive configurations, driving through a race track is simulated. The electrical values at the battery and the system control state are being visualized during the simulation run already.

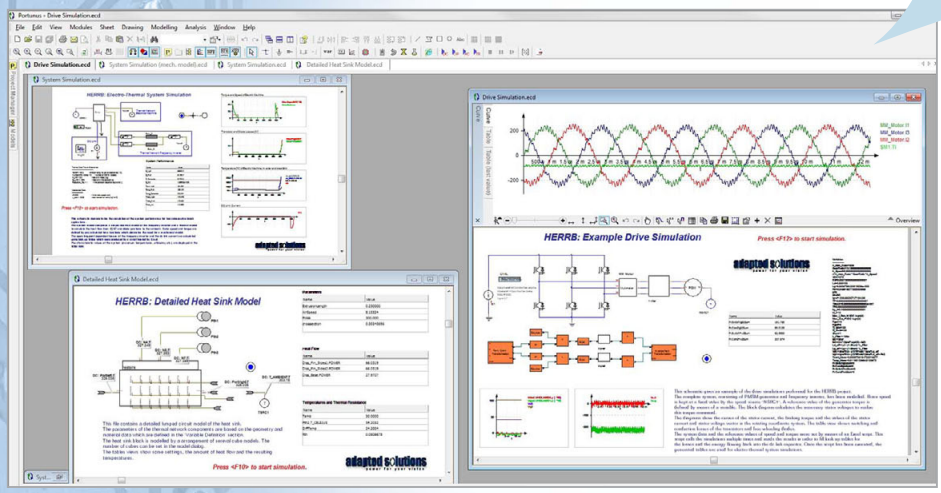
Modifying model parameters during a running simulation is possible using interactive elements.



Users can create libraries with their own models. These models can be defined graphically in the form of subsystems or textually defined as VHDL-AMS models, SPICE netlists and DLLs built from C++ code.

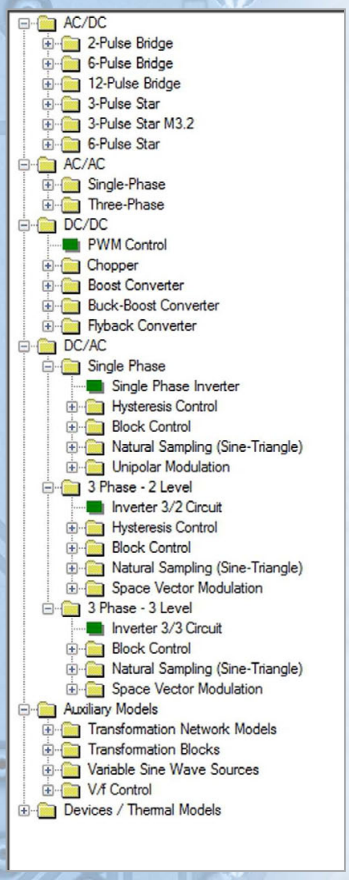
A system model can be exported into a "Stand-Alone Application", thus providing it to users who do not have a Portunus® license. The "Stand-Alone Application" contains functions of the graphical user interface as well as of the simulator and allows for the modification of model parameters and the run of simulations with the exported system model.

By means of a "Stand-Alone Application", pre-defined models ready for simulation can be provided to customers and development partners.



Model Libraries

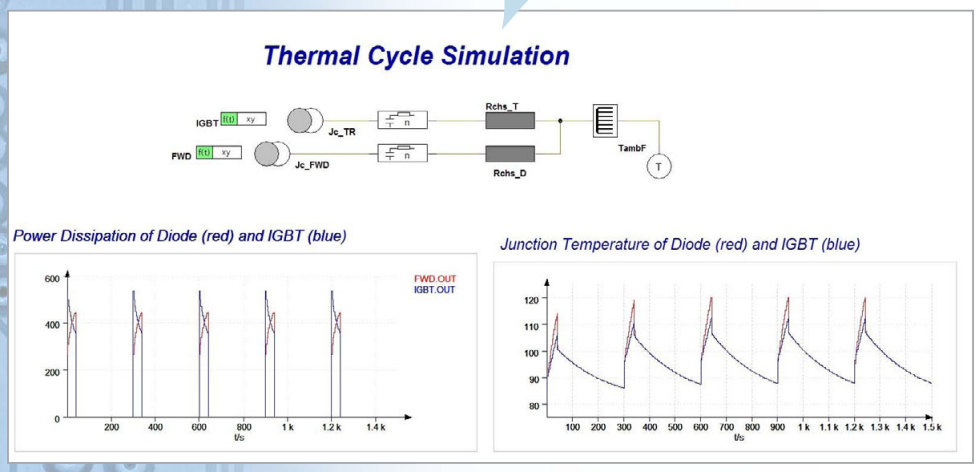
The basic version of Portunus® comes already with libraries containing more than 100 models for simulating electrical, mechanical or magnetic systems and for building block diagrams or state machines. Moreover, a library of components according to the SPICE standard is provided.



The additional module ***"Power Electronics Library"*** provides more than 80 models for the simulation of power electronic systems taking into account all forms of energy conversion (AC/DC ... DC/AC). Besides building of networks for typical topologies, emphasis was put on the modelling of the control algorithms as experience has shown a higher proportion of development time is needed for their implementation. A particularly powerful model is that of a power electronic switch with a free-wheeling diode for electro-thermal calculations. It is based on a special modelling approach ("average model") which enables a fast calculation of the temperatures in semiconductors. Parameter sets for a large number of modules manufactured by Infineon are integrated in this model. Frequently used algorithms such as Park-Clarke transformations, V-f control and sine wave time functions featuring variable frequencies and amplitudes complete the model set of the ***"Power Electronics Library".***

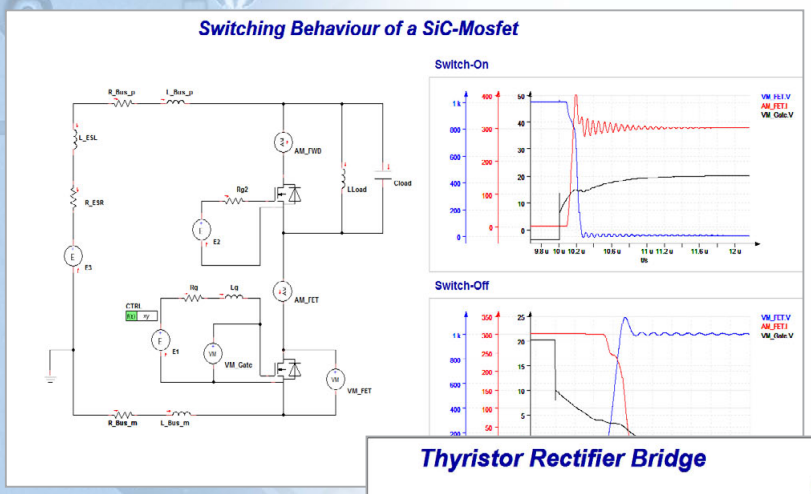
To model the heat flow in system simulations, the ***"Thermal Library"*** has been developed as a joint product of Motor Design Ltd. (UK) and Adapted Solutions. This additional library contains all necessary components for the simple realization of thermal simulations. The model set includes temperature and heat sources, linear and non-linear thermal resistances (heat conduction, convection and radiation), heat storage, often used topologies (e.g. "Foster Model" and "Cauer Model") as well as coupling elements for connection to electrical networks. The input dialogs of the models feature amongst others functions to automatically determine the heat flow determining equations and coefficients from geometry and material data. Thus, the task of the user is limited to the input of the geometry and material properties. The models of the ***"Thermal Library"*** can be used to calculate steady-state conditions and transients.

Temperature courses in a converter can be calculated by a simple thermal network model.



Teamwork of Simulators

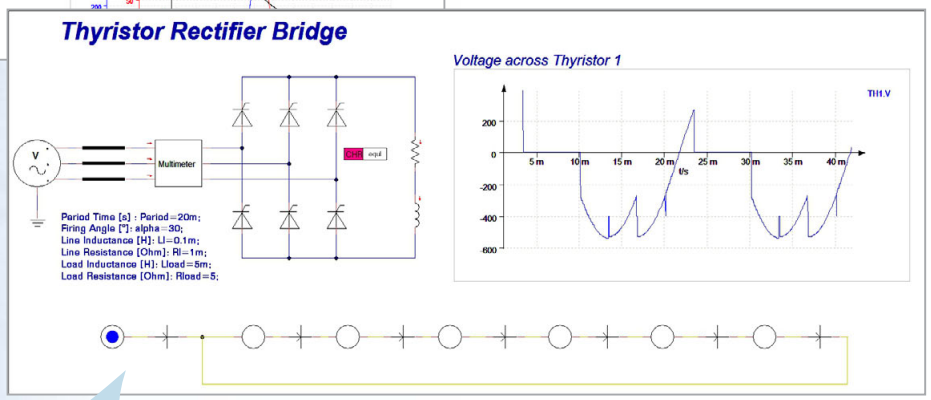
Portunus® combines a simulator for solving differential-algebraic equations with a "digital simulator" to handle event-driven systems. The numerical methods used for the "analogue system" correspond to those of a "real network simulator", so that any topologies and model approaches – from simple switch models to transistor networks that take into account the parasitic elements – can be used. Algebraic loops are resolved by the simulator without any time delay. An adaptive step size control and several integration methods ensure a fast and stable simulation.



Interfaces

In order to support the integration into a design flow, Portunus® features automation, simulator, model and data interfaces.

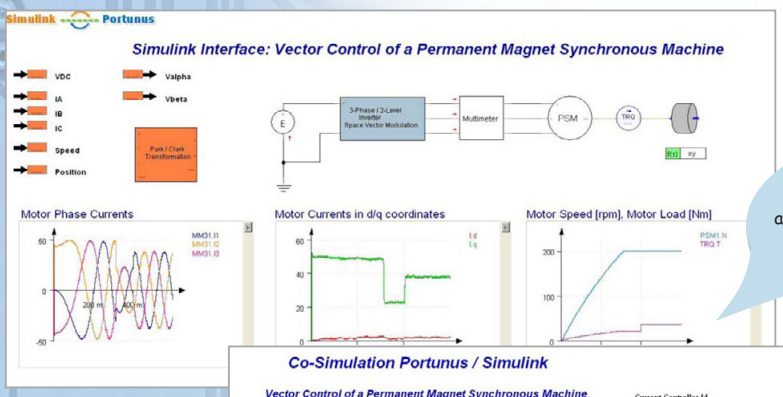
Based on the OLE or HTTP protocol, automated loading, modification and simulation of system models and access to the calculation results are possible.

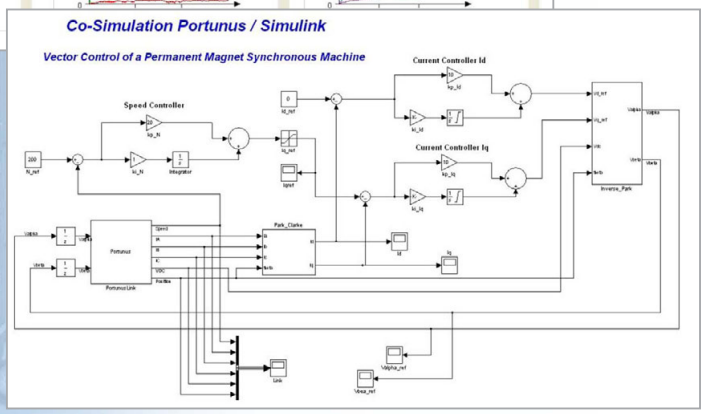


Current and voltage curves of power electronic circuits can be simulated in Portunus® using detailed models (left) as well as simple "switch models" (right).

Demanding optimization tasks can be addressed with the help of the "Optimization Workbench" (third-party product). This software analyzes the structure of system models in Portunus® and performs the optimization of model parameters. The quality criteria used for the optimization are derived from the model outputs.

Simulator couplings exist for Matlab® / Simulink® (Mathworks) and EasiMotor (EASITECH). Co-simulation with other simulation tools can also be realized by integrating models according to the FMI specification.





The co-simulation of Portunus® and Matlab®/Simulink® can be defined in the graphical editors of both software products.

Using an XML netlist import, other programs can create models for Portunus®. Importing model-specific data is possible from Motor-CAD®, SPEED and InCa3D.

Characteristics and time functions (tables) can be imported by Portunus® using XML and other formats.

Portunus in a Nutshell:

- Can be used on all Windows PCs (minimum Windows XP) with no special hardware requirements. Locale and network installation possible.

Graphical User Interface:

- Schematic editor using multiple pages and subsystem technology.
- Library management / Integration of user-defined models.
- Visualization and analysis of simulation results in schematic editor.
- Data export functions (Matlab®, Excel® and other formats).
- Automation possible via OLE and HTTP interface.
- Project management.
- “Optimization Workbench” (third-party product for optimization tasks).

Modelling

- Networks, block diagrams, state machines.
- Basic library comprising more than 100 models (electrical, mechanical, magnetic, blocks, state machine components, time functions, characteristics, signal processing).
- Library with models according to SPICE standard (version 3F5).
- Add-on libraries for simulation of power electronic and thermal systems.
- Model import functions:
  - SPICE netlists,
  - VHDL-AMS,
  - FMI (Co-Simulation, Model Exchange - Continuous Time Mode),
  - Motor-CAD®, Speed®,
  - Multi-dimensional characteristics (csv and xml format),
  - XML-netlist import.

Simulator Technology

- DAE solver (integration methods: Euler, Trapezoid, BDF).
- Adaptive step size control.
- Simulator couplings (Matlab®/Simulink®, EasiMotor etc.).
- C++ programming interface (C++).

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