POWERSIM

PSIM®

Simulation environment for

POWER ELECTRONICS AND MOTOR DRIVES

Exceptional Performance

- Fast simulation speed
- Intuitive and easy to use
- Comprehensive motor drive library
- Flexible control simulation
- Custom C code
- Automatic code generation for DSP hardware
- Link to 3rd-party software
- Design solutions for motor drive and HEV systems

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powersys solutions

POWERSYS - Exclusive Distributor of PSIM Software

POWERSIM

PSIM

Simulation environment for power electronics and motor drives

With fast simulation and friendly user interface, PSIM provides a powerful and efficient environment for all your power electronics and motor drive simulation needs.

FRIENDLY USER INTERFACE

PSIM's graphic user interface is intuitive and very easy to use. A circuit can be set up and edited quickly. Simulation results can be analyzed using various post-processing functions in the waveform display program Simview. In addition, PSIM is interactive. It allows users to monitor simulation waveforms and change parameters on-the-fly. This makes it extremely easy to fine tune a system until desired performance is achieved.

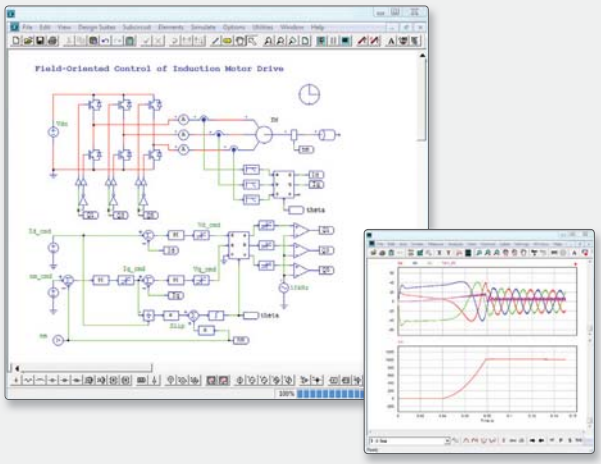
FAST SPEED AND ROBUST ENGINE

PSIM is one of the fastest simulators for power electronics. It is capable of simulating large and complex power converter and control systems in a short time. Besides, PSIM's simulation engine is very robust, and it does not have the convergence problem that many other simulation software suffer.

FLEXIBLE CONTROL SIMULATION

APPLICATIONS

- Switchmode power supplies
- Electric motor drives
- Industrial and consumer electronics
- Power management
- Renewable energy
- Automotive and transportation
- Aerospace and defense



Motor Drive System: The example above shows an induction motor drive system with field-oriented control. With built-in blocks such as abc-dqo transformation blocks, PI controllers, and low-pass filters, the setup of a motor drive system in PSIM is very simple and the schematic layout is easy to follow.

One of PSIM's key strengths is its ability to simulate complex control circuitry. A control circuit can be represented in various forms: analog op. amp. circuit, s-domain or z-domain transfer function block diagram, C code, or in Simulink®. The control library provides a comprehensive list of function blocks, making it possible to build any control circuit quickly and conveniently.

AC SWEEP ANALYSIS

AC sweep analysis (or frequency response analysis) is an important tool in designing control loops. While many simulation software require a circuit to be represented by average models first before performing ac sweep, PSIM is capable of performing ac sweep with the circuit as it is in switchmode. This makes it particularly convenient to determine circuit impedances, open-loop frequency response, and closed-loop bandwidth and stability.

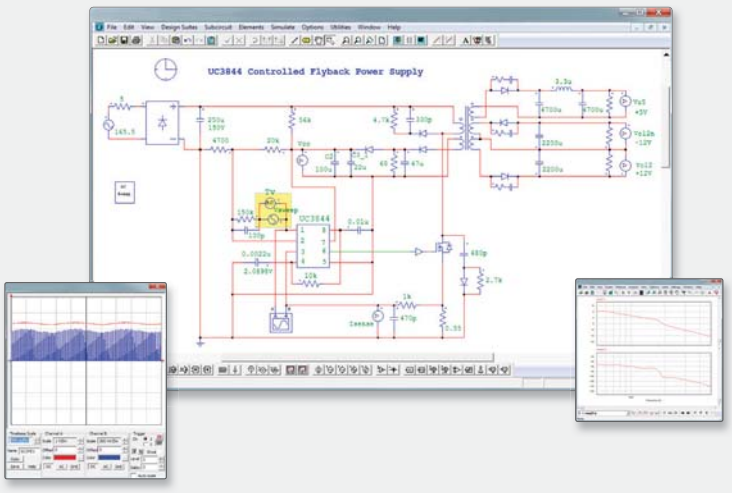
CUSTOM C CODE

PSIM supports custom C code through a built-in C interpreter and external DLL blocks. This allows users to implement virtually any model or control circuitry in C code, and significantly expands PSIM's flexibility.

ADD-ON MODULES

PSIM provides a list of add-on Modules to address specific needs in various applications, such as motor drives, digital control, renewable energy, DSP and FPGA support, and controller design. These Modules give users the flexibility to tailor PSIM for ones' own needs, and significantly enhance PSIM's capability.

AC Sweep: The example below shows the measurement of the voltage loop bandwidth of a multi-output flyback converter, with the ac perturbation source highlighted in yellow. The ability to determine the control loop performance in switchmode circuit is a powerful tool for controller design and stability analysis.



ADD-ON MODULES

Motor Drive: For adjustable speed drives and motion control

Digital Control: For digital control systems in z-domain

SimCoupler: For co-simulation with Matlab/Simulink®

Thermal: For quick power loss calculation

Renewable Energy: For solar power, wind power, and battery storage systems

HEV Design Suite: For designing hybrid electric vehicle powertrain systems

Motor Control Design Suite: For design of ac motor controllers

SimCoder: For automatic code generation

F2833x and F2803x Targets: For code generation for Texas Instruments' F2833x and F2803x series DSP

MagCoupler and MagCoupler-RT: For co-simulation with JMAG® and link to JMAG-RT files for finite element analysis

ModCoupler-VHDL and ModCoupler-Verilog: For co-simulation with ModelSim® for VHDL and Verilog support

PsimBook Exercise: Unified documentation and simulation environment

ADDITIONAL SOFTWARE

SmartCtrl and SmartCtrl Pro: For analog and digital controller design

PSIM®

HEV DESIGN SUITE

For hybrid electric vehicle powertrain design

Design solution for HEV powertrain systems

HEV Design Suite provides a quick solution to design and simulate a complete hybrid electric vehicle (HEV) powertrain system from scratch.

A HEV powertrain system is highly complex, and designing such a system is a non-trivial task. A series/parallel HEV powertrain system, for example, consists of PMSM generator and converter, PMSM traction motor and converter, bi-directional dc/dc converter, lithium-ion battery, internal combustion engine, and vehicle load with clutch. Furthermore, a generator controller and traction motor controller may include multiple control blocks, such as Maximum-Torque-Per-Ampere control, field weakening control, torque control, speed control, and voltage control.

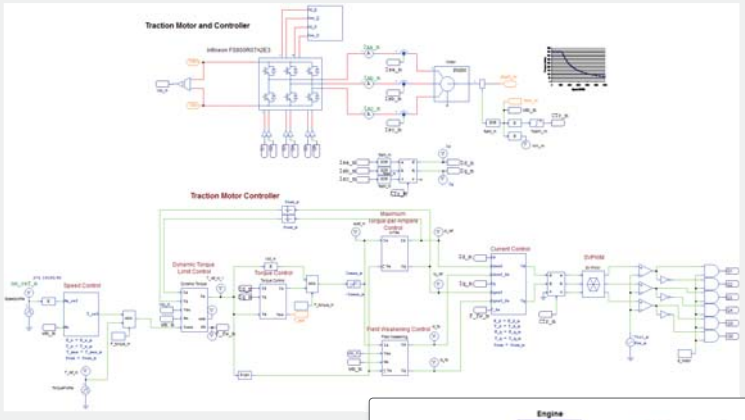
One major advantage of the HEV Design Suite is that, based on input system specifications, it will design all the controllers automatically with minimum user intervention and effort. In a very short time, users will have a functional HEV powertrain system set up and ready to simulate.

The HEV Design Suite can handle multi-mode operations of a HEV powertrain system, such as charging mode, battery drive mode, engine and motor drive mode, engine drive with charging mode, engine and motor drive with charging mode, full power mode, and regeneration braking mode.

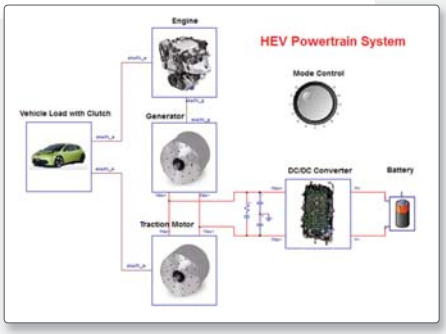
The HEV Design Suite helps significantly shorten the development of a HEV powertrain system.

FEATURES AND BENEFITS

- Complete powertrain system design and simulation
- Controllers for generator and traction motor
- Controller for bi-directional dc/dc converter
- Dynamic battery model for charging and discharging
- Multi-mode operations



Above: Traction motor and controller



Right: HEV powertrain system in Design Suite interface

RENEWABLE ENERGY MODULE

For solar power, wind power, and battery storage systems

For all your simulation needs for renewable energy applications

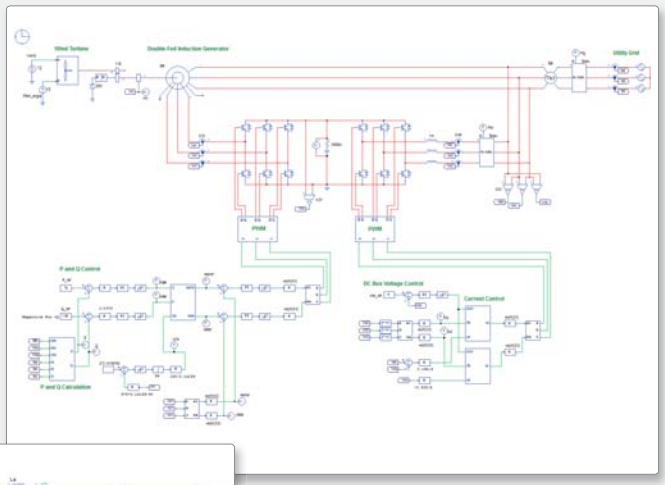
The Renewable Energy Module provides the necessary models and function blocks for renewable energy applications. It includes solar module models, sample MPPT (Maximum Power Point Tracking) blocks, and tools that allow users to extract solar module parameters directly from a manufacturer datasheet. This makes it very easy to model a real-world photovoltaic system with little effort.

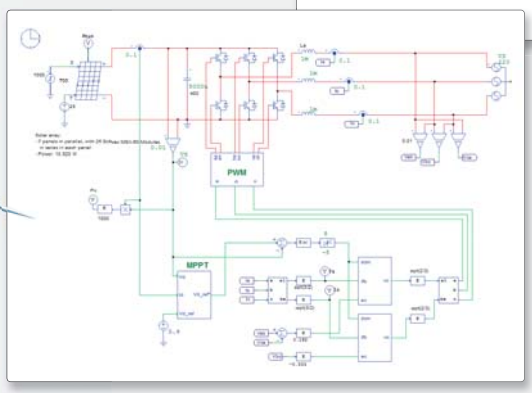
In addition, it provides the wind turbine model, and together with the Motor Drive Module, the capability to simulate wind power systems. Three complete sample wind power systems, based on double-fed induction generator, permanent-magnet synchronous generator, and squirrel-cage induction generator, are provided. These examples provide an excellent starting point to build and design your own wind power systems.

Furthermore, battery models are provided, allowing users to simulate battery charging and discharging process and energy storage systems.

FEATURES

- Lithium-Ion battery model
- Solar module with temperature and light intensity effect
- Parameter extraction directly from solar module datasheet
- MPPT blocks
- Wind turbine model and complete wind power system examples





Above: Wind power system with double-fed induction generator

Left: 3-phase grid-connected PV inverter with MPPT

PSIM®

MOTOR DRIVE MODULE

For adjustable speed drives and motion control

Simulating motor drive systems made easy

The Motor Drive Module provides an easy and effective way of modeling and simulating motor drive systems.

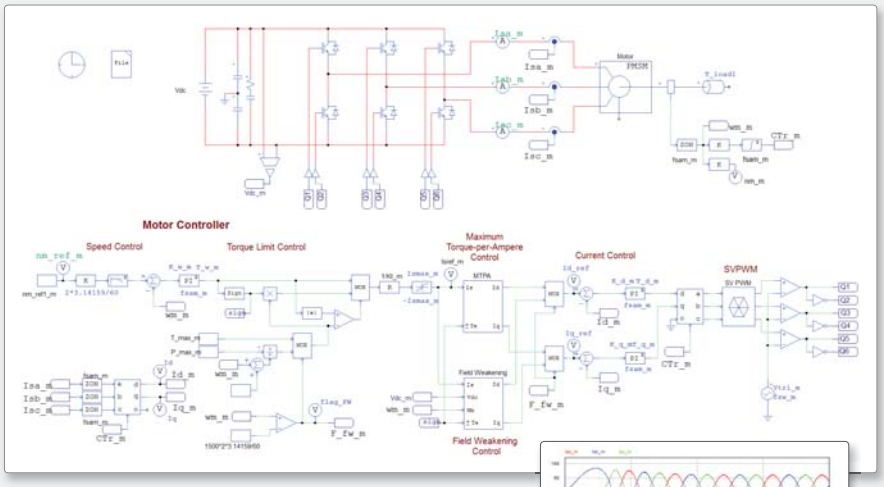
Analysis and design of a motor drive system is often a challenging task, due to the complexity in machine modeling and controller design. Such a task becomes considerably easier with the Motor Drive Module. Commonly used electric machine models, mechanical load models, and control blocks (such as Maximum-Torque-Per-Ampere Control and Field Weakening Control blocks) are provided. Using Motor Drive Module elements and other library elements, one can set up a motor drive system quickly and conveniently.

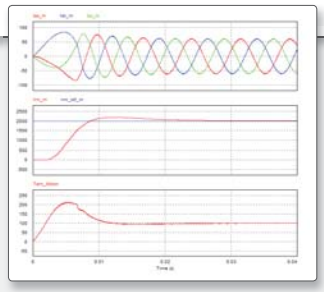
In addition, provision is given so that one can connect custom-built machine or load models to the models in PSIM, providing great flexibility.

The example below illustrates PSIM's capability to simulate motor drive systems. The system consists of a PMSM drive with current and speed control. Maximum-Torque-Per-Ampere control is implemented to achieve the maximum torque possible. Also, for this system, field weakening control must be used at high rotor speed as the dc bus voltage would not be high enough to maintain a normal operation.

FEATURES AND BENEFITS

- Comprehensive electric machine library and mechanical load library
- Easy setup of motor drive systems
- Commonly used power and control blocks available
- Motor control loop stability analysis





Above: PMSM drive system with maximum-torque-per-ampere control and field weakening control

Right: Simulation waveforms of the motor currents, rotor speed, and motor developed torque.

MOTOR CONTROL DESIGN SUITE

For controller design of motor drive systems

Designing a motor control system effortlessly

The Motor Control Design Suite provides a very quick way of designing a motor drive system from user specifications.

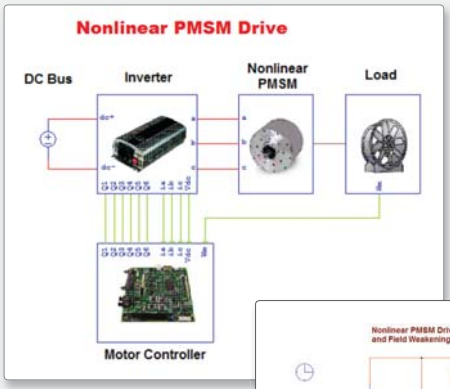
The Motor Control Design Suite includes a number of design templates for induction motors and linear and nonlinear PMSM. The nonlinear PMSM design template, for example, is for a nonlinear PMSM drive system that includes space vector PWM, current control, maximum-torque-per-ampere (MTPA) control, field weakening control, dynamic torque limit control, and speed control. Such a system includes multiple control loops (current loops and speed loop). In addition, the motor parameters are changing as a function of the current. All these factors combined make it very challenging to design the controllers of the motor drive system.

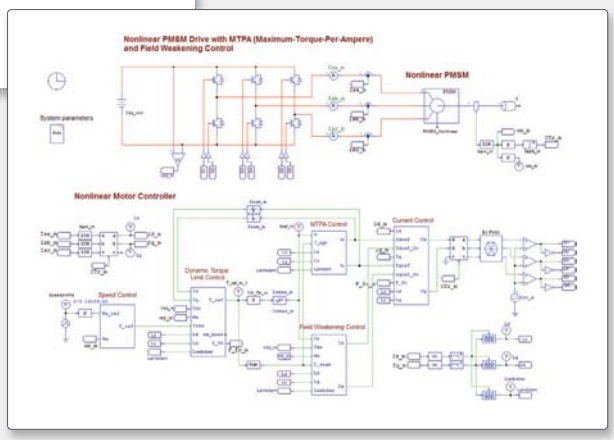
The task of designing the controllers of the motor drive system is made very easy with the Motor Control Design Suite. Given high-level system input specifications, the Motor Control Design Suite will design all the controllers automatically. In no time, users will have a complete and functional motor drive system that is ready to simulate for further analysis.

The Motor Control Design Suite is an indispensable tool for motor drive system development.

FEATURES AND BENEFITS:

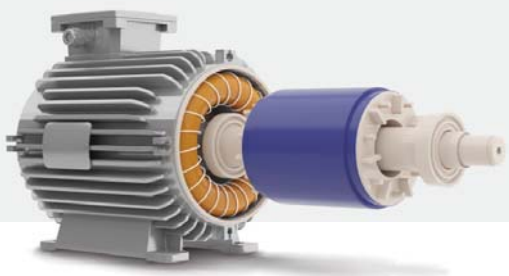
- Design template for linear and nonlinear PMSM with MTPA and field weakening control
- Design template for induction motor with vector control and field weakening control
- Designing motor controllers from input specifications in one easy step





Left: Nonlinear PMSM Drive template in Design Suite interface

Below: Nonlinear PMSM



PSIM®

THERMAL MODULE

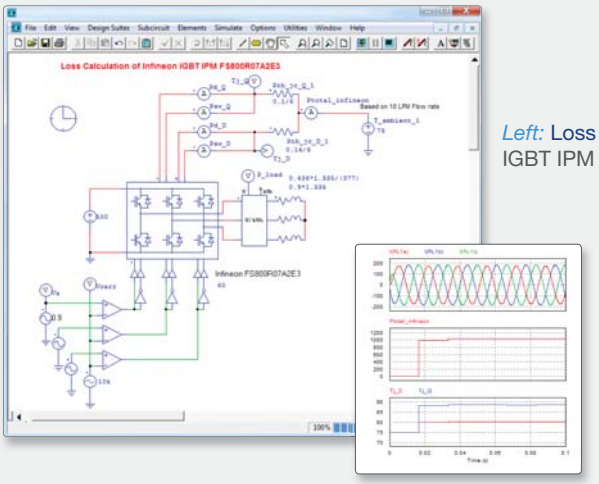
For quick power loss calculation

Quick power loss calculation from manufacturer datasheet

Power loss calculation is an important aspect in power converter design. Traditionally, users rely on detailed physical device models from device manufacturers or software vendors. But the model of a particular device of interest may not be available. Even if such a model is available, the complexity of the model often slows down simulation and results in a long simulation time.

With the Thermal Module, users can add devices of any manufacturer into a database in minutes using an easy-to-use Device Database Editor. These devices can then be used in the PSIM schematic and their power losses calculated in the simulation.

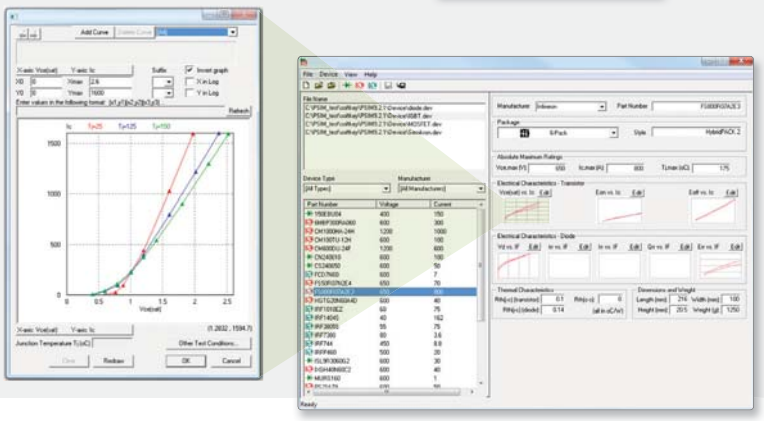
The Thermal Module provides a very quick way of estimating conduction and switching losses of semiconductor devices (diodes, IGBT, and MOSFET). One major advantage of the Thermal Module is that the loss calculation is done in such a way that it does not slow down the simulation. Also, the Database Editor provides a convenient way to add new devices and manage existing devices. In addition, utility tools are provided to capture device characteristics curves directly from device datasheet images.



Left: Loss calculation of IGBT IPM based inverter

FEATURES AND BENEFITS

- Easy-to-use Database Editor
- New devices easily added to database
- Quick power loss calculation with no impact on simulation speed



Left: Device Database Editor interface

DIGITAL CONTROL MODULE

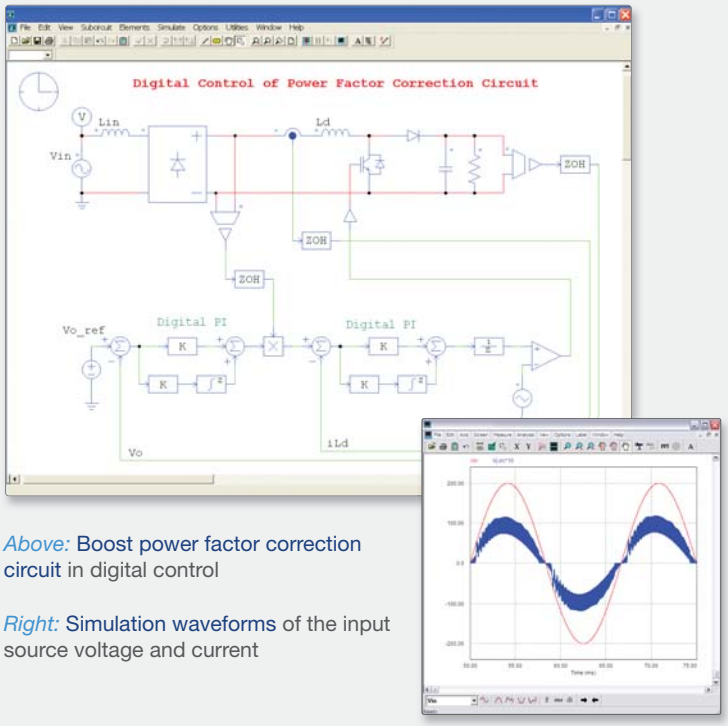
For analysis of digital control systems

Validating digital controllers quickly for microcontroller/DSP implementation

With higher performance and lower cost, microcontrollers/DSPs have been increasingly used in converter control in power supply and motor drive applications, requiring control algorithms to be implemented in digital control in discrete z-domain.

Unlike analog control, there are unique issues in digital control loop design, such as the effect of sampling and delay inherent in digital control, and errors due to A/D resolution and quantization. As a result, a controller that works in analog control may not work in digital control. Using the Digital Control Module, one can implement the digital control algorithm in z-domain block diagram, making it easy to check the performance and stability of the digital control loop, and debug the circuit thoroughly in a simulation environment rather than in the hardware which is much more difficult and time consuming.

To facilitate digital controller design, a utility tool is provided to convert an analog controller to a digital controller. After the controller is designed in analog s-domain taking into account the digital delay, the controller can be converted to a digital controller in

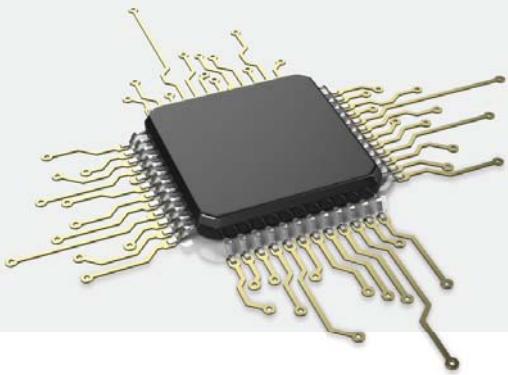


Above: Boost power factor correction circuit in digital control

Right: Simulation waveforms of the input source voltage and current

FEATURES AND BENEFITS

- Easy to use
- Commonly used digital control blocks provided, such as digital filters and PI controller
- Utility tool available to convert an analog controller to a digital controller



PSIM

SIMCODER MODULE

For automatic code generation

Generating C code from control schematic with the click of a button

The SimCoder Module provides the capability to generate C code automatically from the control schematic.

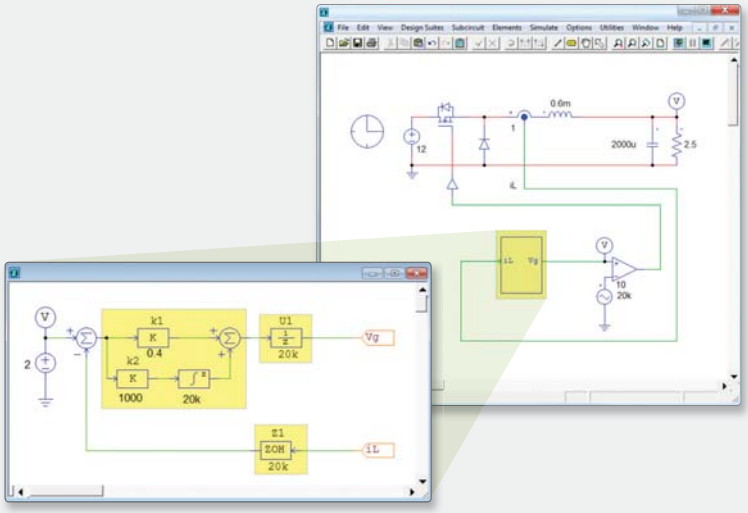
In many applications, control algorithms are implemented in microcontrollers/DSPs. Engineers are faced with the task of translating a control schematic into C code. This requires engineers with good programming skills. Also, since hand written code is prone to bugs and human errors, extensive testing is required.

Automatic code generation, on the other hand, offers significant advantages over hand code writing. After the control algorithm is verified in a simulation, the C code is generated automatically with the click of a button, greatly reducing the time of code development. Also, since the code is generated automatically, it is consistent in quality, and is less prone to errors.

Furthermore, together with one of PSIM's hardware targets (such as F2833x Target or F2803x Target), SimCoder can generate code that is ready to run on the specific target DSP hardware. The ability to go from control schematic to hardware code generation provides a seamless integration between simulation and hardware implementation, and greatly speeds up the development and design process.

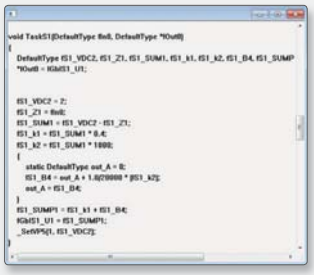
FEATURES AND BENEFITS

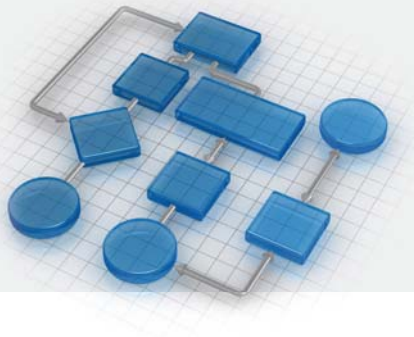
- Automatic code generation; no programming skills needed
- High-quality and consistent code with no human errors
- Hardware code generation together with hardware targets



Above: Control circuit in a subcircuit

Right: Automatically generated C code for the subcircuit





HARDWARE TARGET MODULES

Automatic code generation for microcontroller/DSP hardware

One-stop solution from simulation to hardware implementation

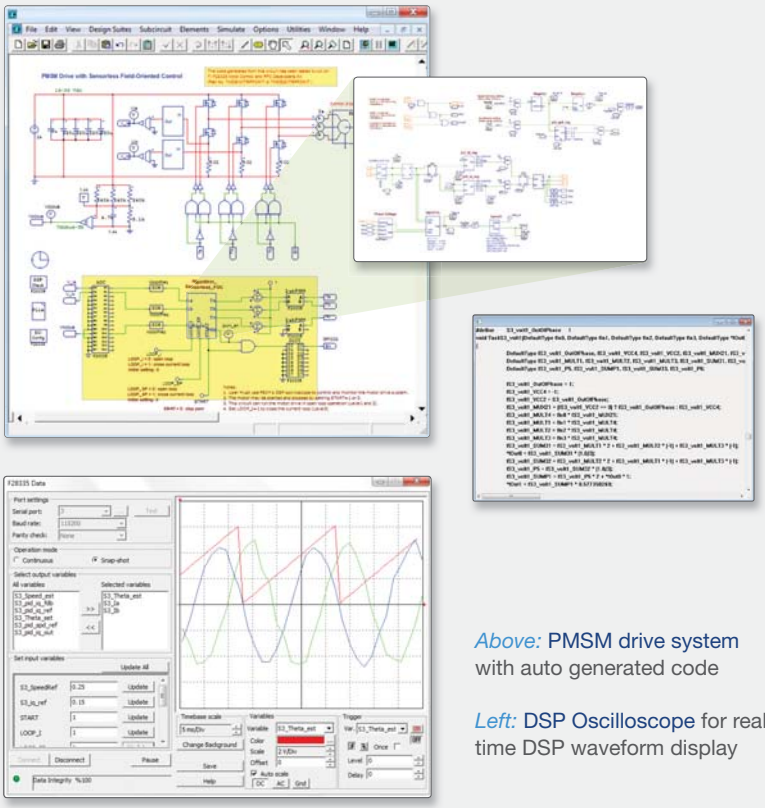
PSIM's Hardware Target Modules, together with the SimCoder Module, provide the capability to automatically generate C code that is ready to run on specific target DSP hardware.

Digital control implementation in a microcontroller/DSP is a time-consuming process due to the fact that the learning curve to write hardware control code is very steep. Also, debugging the control code is not easy as intermediate quantities are inside DSP and are not readily available. This often results in long development time and high development cost.

With the Hardware Target Modules one can simulate a system in PSIM at the schematic level, then generate the hardware code from the control circuit automatically. This offers significant advantages over manual code writing in that the control algorithm can be validated thoroughly in simulation. Also, engineers can concentrate on control algorithm development and performance enhancement rather than on learning the details of the hardware.

Automatic hardware code generation offers additional benefit that, for fixed-point programming, factors such as scaling and overflow, which are difficult to deal with in the hardware implementation, can be easily handled in simulation.

In addition, PSIM offers the DSP Oscilloscope function that allows DSP waveforms and parameters to be displayed and changed in real



Above: PMSM drive system with auto generated code

Left: DSP Oscilloscope for real time DSP waveform display

FEATURES AND BENEFITS

- Hardware code generation directly from control schematic
- Support of both floating-point and fixed-point DSP
- DSP Oscilloscope for real-time control and waveform display

HARDWARE TARGETS CURRENTLY OFFERED:

- F2833x Target: For TI F2833x series DSP
- F2803x Target: For TI F2803x series DSP
- PE-Pro/F28335 Target: For Myway's PE-Pro/F28335 board
- PE-Expert3 Target: For Myway's PE-Expert3 development

PSIM®

SMARTCTRL SOFTWARE

General-purpose power electronics controller design software

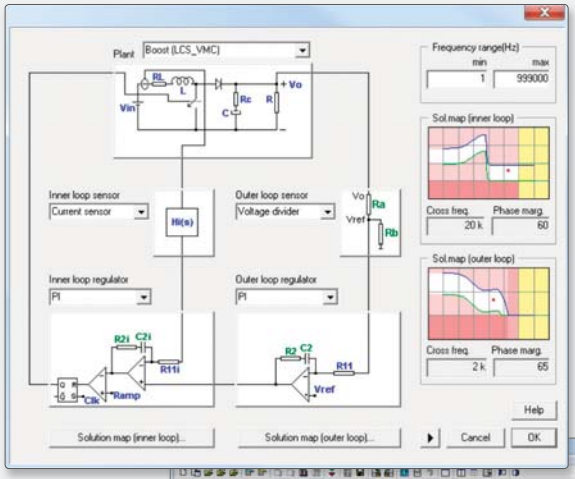
Designing a controller in minutes

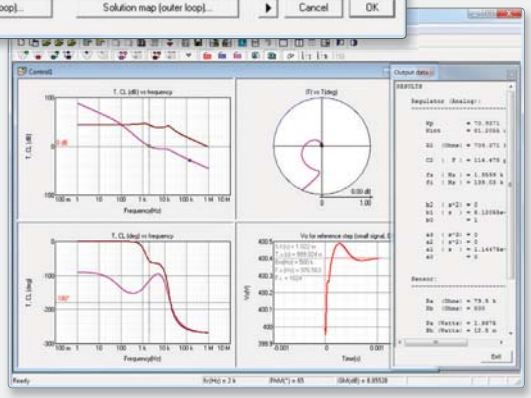
SmartCtrl is a controller design software specifically for power electronics applications. It features a friendly interface, simple workflow, and easy-to-understand display of control loop stability and performance. Using SmartCtrl, one can design controllers of various power converters easily and very quickly.

SmartCtrl offers predefined topologies for buck, boost, buck-boost, flyback, forward, and power-factor-correction converters. In addition, it provides the capability to import ac sweep response externally or define a s-domain transfer function for the plant, allowing it to support converters of any topologies.

SmartCtrl can handle continuous mode and discontinuous mode operation automatically. Based on specific operating conditions, SmartCtrl generates a Solution Map that defines the safe region for the controller. The Solution Map makes it very easy for users to design the controller.

In addition, SmartCtrl provides the digital controller design capability (through SmartCtrl Pro). With this option, one can design a controller in analog s-domain, define digital delay, and check the control loop stability with the digital delay taken into account. Once the controller is designed, digital controller coefficients for z-domain implementation can be generated.



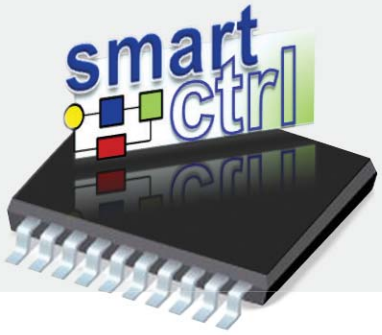


Left: Boost converter with inner current loop and outer voltage loop designed in SmartCtrl

Below: Control loop Bode plot,

FEATURES AND BENEFITS

- Friendly user interface
- Solution Map for easy controller design
- Capability to design digital controllers
- Multi-loop control structure
- Easy visualization of control loop performance
- Sensitivity analysis
- Automatic controller and converter circuit generation and seamless integration with PSIM



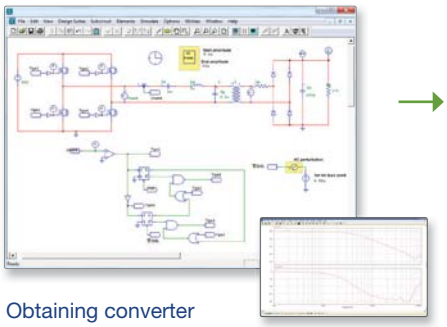
SMARTCTRL SOFTWARE

General-purpose power electronics controller design software

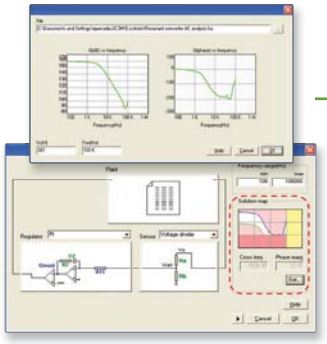
SmartCtrl Example: Resonant Converter Control Loop Design

SmartCtrl is capable of designing controllers of any power converters. To illustrate this, the example below shows a resonant converter, known for its difficulty in controller design. To design the controller, first perform ac sweep in PSIM; then import the ac sweep result into SmartCtrl, and design the controller in SmartCtrl using the Solution Map.

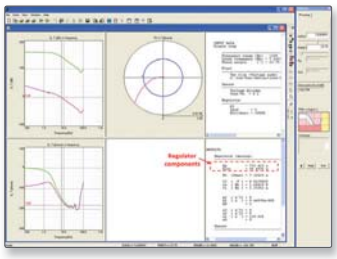
A difficult controller design task is made considerably easier with SmartCtrl!



Obtaining converter ac sweep result



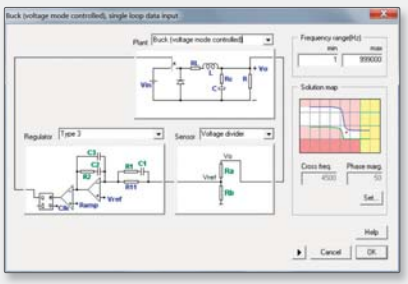
Importing ac sweep result into SmartCtrl and performing



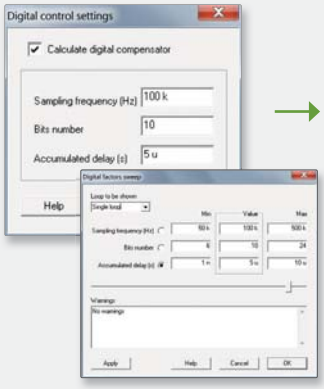
Displaying Bode Plot and controller parameters

SmartCtrl Example: Digital Control Loop Design

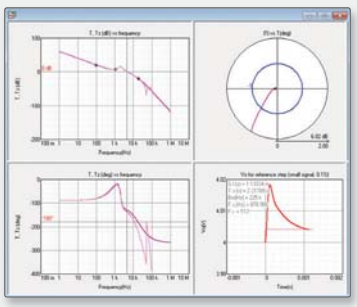
A digital controller can be easily designed using SmartCtrl Pro. In the buck converter example below, the analog controller is first designed. Then the controller is redesigned with the digital control delay taken into account. The difference without and with the digital control delay can be clearly seen in the phase Bode plot of the loop transfer function. The analog controller is then discretized for digital implementation.



Designing the analog controller



Defining the digital delay and redesigning the controller



Comparing the design without and with the digital delay

PSIM

MAGCOUPLER MODULE

For co-simulation with JMAG for finite element analysis

Linking FEA motor design to circuit simulation

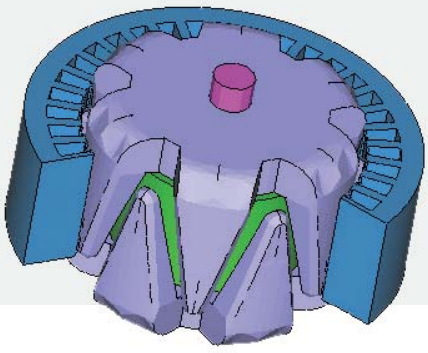
The MagCoupler Module provides the dynamic link for co-simulation between PSIM and JMAG. With the link, the power converter and control portion of a system can be implemented and simulated in PSIM, while electric machines and other magnetic devices can be implemented and solved in JMAG. The MagCoupler Module is very easy to use, and the link can be easily set up with minimum user effort.

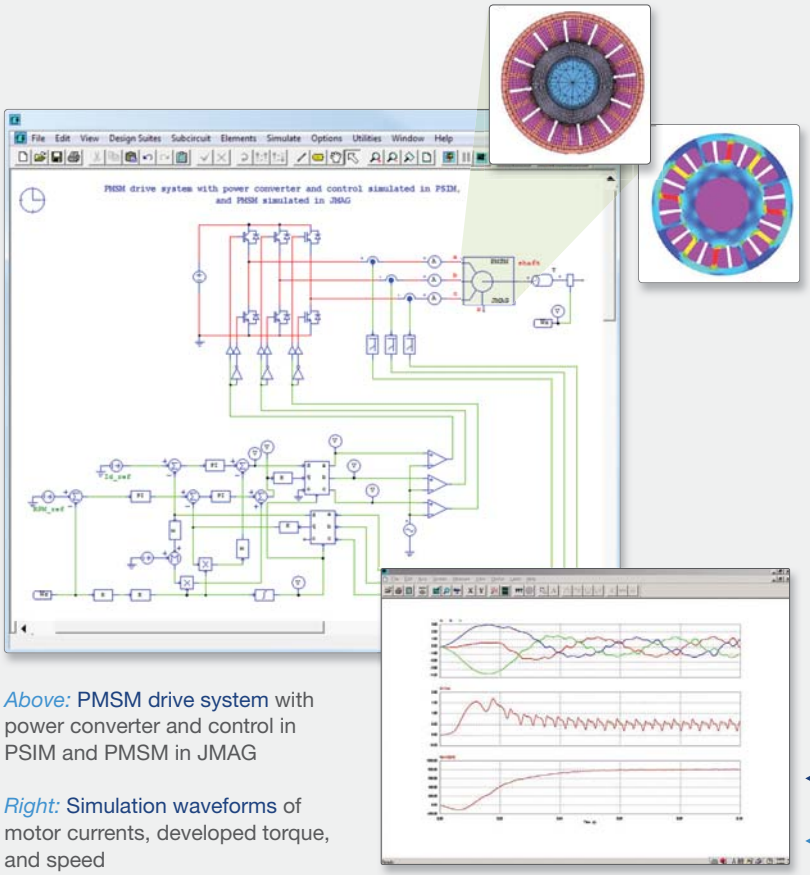
JMAG is a leading finite element analysis (FEA) software for electromagnetic field analysis. It supports the development and design of electrical and magnetic devices such as motors, actuators, and circuit components. JMAG features friendly user interface, powerful mesh generation and editing capability, robust and accurate solver, and comprehensive material database. It is particularly suitable for rotating devices such as electric machines.

With the MagCoupler Module, motor designers can interface and test their motor design with the intended power converters and control schemes, and optimize the design based on performance, size, and cost. At the same time, the MagCoupler Module expands PSIM's capability to finite element analysis. One can simulate electric machines based on machine dimension, structure, and materials, thus eliminating the need to extract or derive machine parameters. This gives more accurate results that take into account magnetic saturation and losses, time harmonics and space harmonics, and other nonlinear effects that would be difficult to consider otherwise.

FEATURES AND BENEFITS

- Easy to set up; minimum user input
- Complete system simulation with power electronics, control, and electric machines
- Accurate machine modeling in finite element analysis





Above: PMSM drive system with power converter and control in PSIM and PMSM in JMAG

Right: Simulation waveforms of motor currents, developed torque, and speed

MAGCOUPLER-RT MODULE

For link with JMAG-RT files

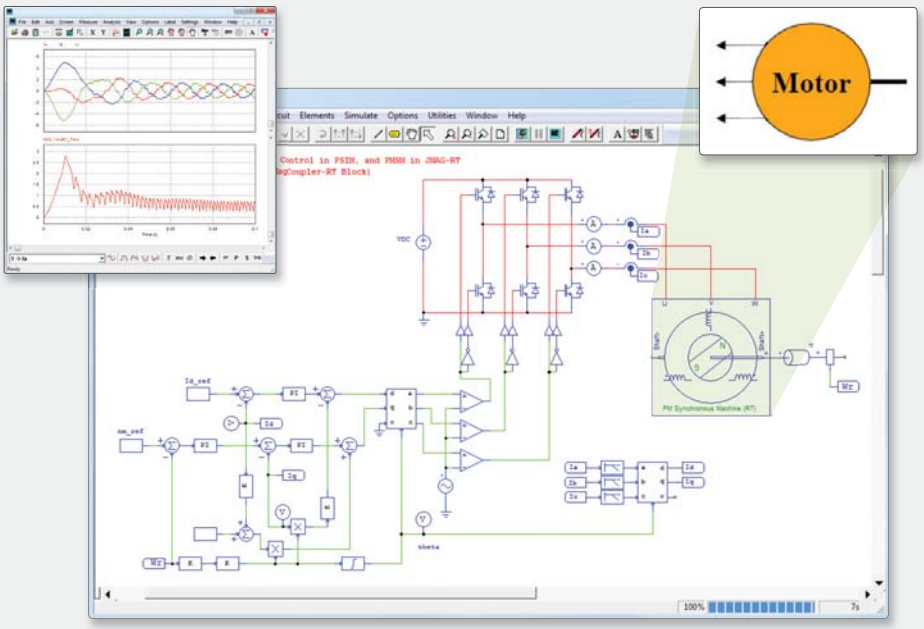
All the benefit but none of the cost of finite element analysis

The MagCoupler-RT Module provides the interface between PSIM and JMAG-RT data files. JMAG-RT is an add-on function of JMAG software. It generates a JMAG-RT data file which is a behavior model of an electromagnetic device such as an electric machine. The behavior model is another way of modeling electromagnetic devices as compared to a finite element model in JMAG.

JMAG-RT data files are obtained by running JMAG simulation in advance, and are stored in a lookup table form. During the PSIM simulation, JMAG is no longer needed, and PSIM interfaces directly with the JMAG-RT data.

The main advantage of JMAG-RT is that, since JMAG-RT data are obtained from JMAG simulation, the accuracy of a JMAG-RT model is comparable to that of a dynamic JMAG model. However, since JMAG is not involved in the simulation, the simulation speed is much faster.

With the MagCoupler-RT Module, one has all the benefit but none of the computational cost of finite element analysis.

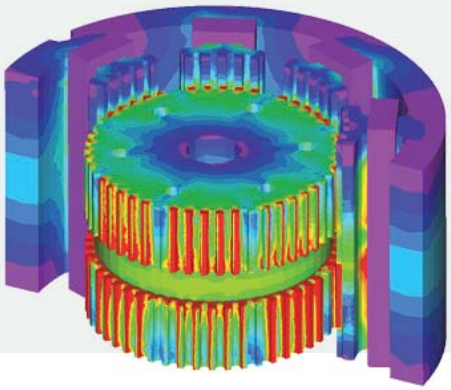


Above right: JMAG-RT Model

Above: PMSM drive with power converter and control in PSIM

FEATURES AND BENEFITS

- Easy to set up
- Accurate motor modeling in finite element analysis (FEA)
- Much faster than dynamic link with FEA software



PSIM®

SIMCOUPLER MODULE

For co-simulation with Matlab/Simulink®

Making best use of PSIM and Matlab/Simulink in a complementary way

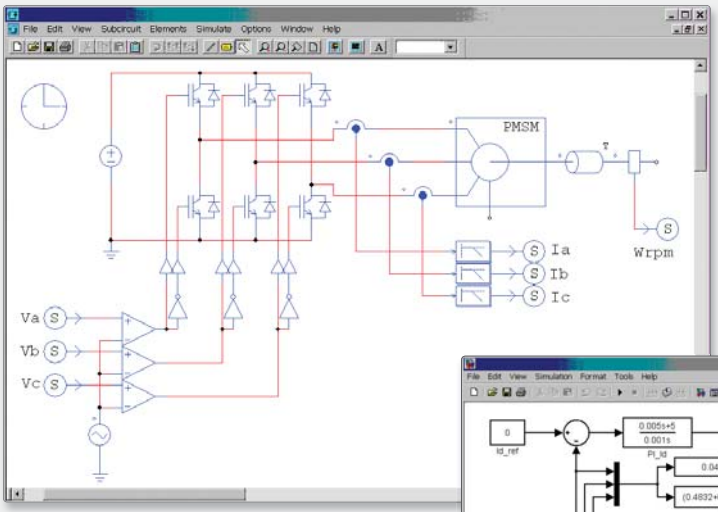
The SimCoupler Module provides the link for co-simulation between PSIM and Matlab/Simulink. With the link, part of a system can be implemented in PSIM, and the rest of the system in Matlab/Simulink.

The SimCoupler Module allows Matlab/Simulink users to make full use of PSIM's capability in power electronics and motor drive simulation, and to reuse legacy models that one already built in Simulink. At the same time, the SimCoupler Module gives power electronics researchers and engineers the option to simulate control in the Matlab/Simulink environment, and it further enhances PSIM's control simulation capability by providing access to various Simulink toolboxes.

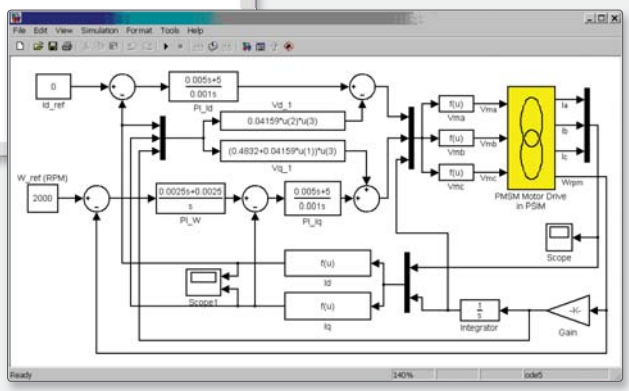
Setup of the co-simulation with SimCoupler is easy and straightforward, with minimum user input.

As an example, the example below shows a PMSM drive system with the power converter and motor in PSIM and control in Simulink. In PSIM, three motor currents and the speed are measured and passed to Simulink. In return, three modulation signals in Simulink are sent back to PSIM.

With SimCoupler, one can take full advantage of PSIM's power simulation capability and Matlab/Simulink's control simulation capability in a complementary way.



Left: Power stage of a PMSM drive system implemented in PSIM



Left: Control of a PMSM drive system implemented in Simulink

FEATURES AND BENEFITS

- Easy to set up co-simulation with minimum user input
- Waveform display in both PSIM and Simulink
- Best use of both software in a complementary way

MODCOUPLER MODULES

For co-simulation with ModelSim for VHDL and Verilog support

Quick VHDL and Verilog code validation for FPGA implementation

The ModCoupler-VHDL Module and ModCoupler-Verilog Module provide the link for co-simulation between PSIM and ModelSim for VHDL and Verilog code support.

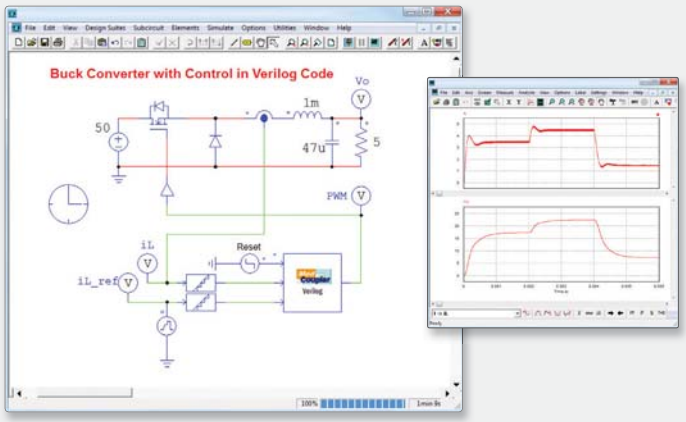
Due to its speed and flexibility, FPGA has been increasingly used in digital control implementation in power electronics. For the design of such a system, a simulation environment is essential in order to validate the controller implemented in VHDL or Verilog code and make sure that the digital and analog parts of the circuit work together properly. The simulation of both analog and digital circuits is a difficult task, involving the simultaneous usage of an analog and a digital simulator, or a mixed signal simulator.

With the ModCoupler Modules, the power circuit can be implemented in PSIM, and the control circuit in VHDL or Verilog code which can then be simulated by ModelSim for hardware implementation in FPGA.

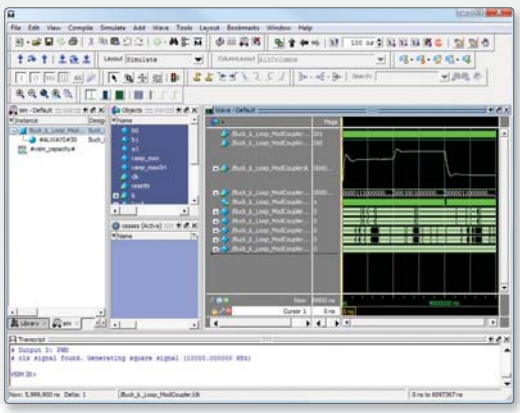
The co-simulation has proven to be very effective in the design of digital controllers implemented in FPGA for power converters, as it allows users to fully test and debug the control algorithm and VHDL/Verilog code in the easy-to-use simulation environment instead of on the actual hardware.

FEATURES AND BENEFITS

- Simple interface
- Capability to support VHDL and Verilog code for FPGA implementation
- Easy design validation and debugging in simulation environment



Above: Buck converter with control implemented in Verilog code



Right: ModelSim interface

PSIMBOOK EXERCISE

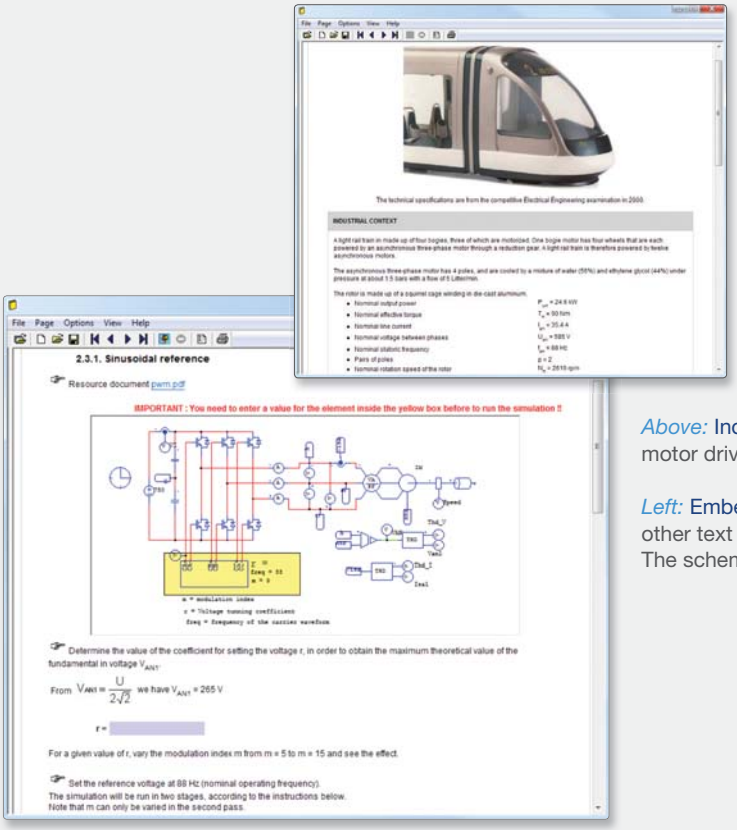
Unified documentation and simulation environment

Documentation and simulation all in one

PsimBook Exercise is a set of exercises that cover various subjects of power electronics and motor drives, including distribution transformers, phase-controlled rectifiers and ac/ac converter, unified power flow controller, dc motor control, and induction motor scalar and vector control. Each exercise includes specific objectives, industrial background, required knowledge and resources, problems and questions, schematic circuits required to solve the problems and answer questions, and the answer kit.

Unlike an e-book, the PsimBook Exercise has the unique feature that schematic circuits in the exercise document are live and fully interactive, and can be simulated by the PSIM simulation engine. Users will be able to study the operation of a circuit, understand the industrial context, change circuit parameters, and run the simulation, all in one integral environment.

PsimBook Exercise is ideally suited for teaching, training, and education.



Above: Industrial context of induction motor drive

Left: Embedded PSIM schematic and other text and background information. The schematic can be simulated.

FEATURES AND BENEFITS

- Integrated environment of documentation and simulation
- Easy to use
- Ideal for beginners of power electronics and motor drives

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POWERSYS has been marketing and distributing PSIM since 2002. POWERSYS is a consulting and software company providing global solutions of engineering software and services for industry, research and education in the field of electrical & electromechanical power systems.

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