SimPowerSystems 4

Model and simulate electrical power systems

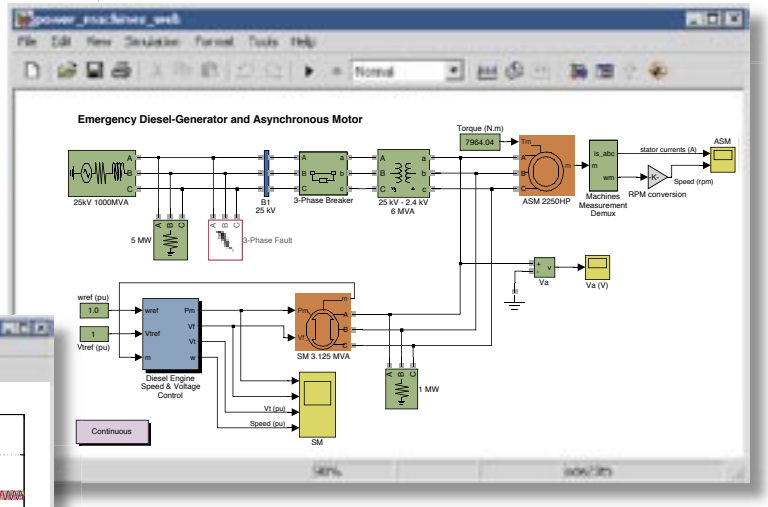
SimPowerSystems extends Simulink® with tools for modeling and simulating basic electrical circuits and detailed electrical power systems. These tools let you model the generation, transmission, distribution, and consumption of electrical power, as well as its conversion into mechanical power. SimPowerSystems is well suited to the development of complex, self-contained power systems, such as those in automobiles, aircraft, manufacturing plants, and power utility applications .

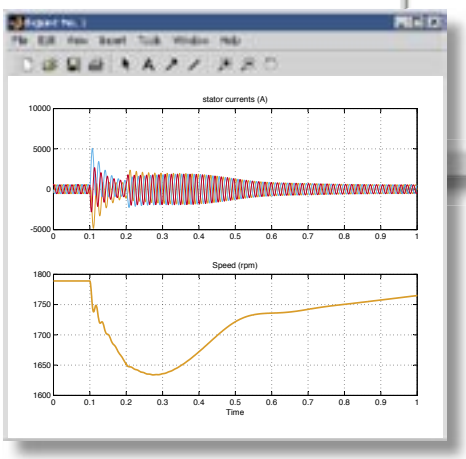
Together, SimPowerSystems and Simulink provide an efficient environment for multi-domain modeling and controller design. By connecting the electrical parts of the simulation to other Simulink blocks, you can rapidly draw the circuit topology and simultaneously analyze the circuit's interactions with mechanical, thermal, and control systems.

The block libraries and simulation methods in SimPowerSystems were developed by TransÉnergie Technologies Inc. of Montreal.

KEY FEATURES

- Enables electrical circuit modeling and simulation using standard symbols
- Provides comprehensive block libraries for building detailed power system models
- Provides detailed models of common AC and DC electric drives
- Draws on Simulink solver technology to deliver highly accurate simulations
- Uses discretization and phasor simulation modes to speed model execution and enable real-time execution
- Provides analysis methods to obtain state-space representations of circuits, compute load flow for machines, and work with currents and voltages





A SimPowerSystems model of an asynchronous motor and diesel-generator uninterruptible power supply (UPS). The Simulink Scope display shows stator currents and speed of the asynchronous machine.

Comprehensive Block Libraries

The SimPowerSystems libraries contain more than 150 blocks distributed in eight sublibraries. The blocks represent simple electrical components, such as resistors, inductors, and capacitors, and complex components, such as transistors and electric drives. The lines joining these components represent ideal conduction lines. You can pass numeric signals into the circuit model from Simulink and extract numeric signals from the circuit model for analysis in traditional Simulink blocks.

You can use the library with Simulink to create electrical block diagrams that connect SimPowerSystems elements and control algorithms, enabling you to study the way the control system relates to the power system.

The SimPowerSystems library includes the following sublibraries:

Electrical sources— AC and DC voltage and current sources

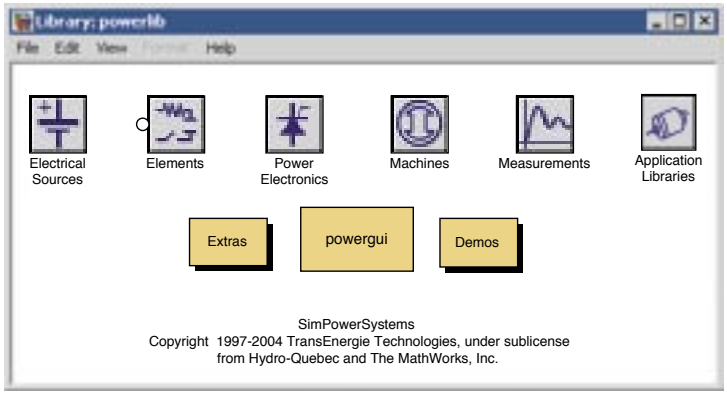
Electrical circuit elements— resistor, inductor, capacitor; linear and saturable transformers; arrestors and breakers; and transmission line models

Electric machinery— models of synchronous, permanent magnet synchronous, and DC machines; excitation systems; and models of both hydraulic and steam turbine-governor systems

Power electronics— diodes, simplified and complex thyristors, GTOs, switches, MOSFETs, IGBT models, and Universal Bridges

Control and measurement— voltage, current, and impedance measurements; RMS measurements; active and reactive power calculations; timers, multimeters and Fourier analysis; HVDC control; total harmonic distortion; and abc-to-dq0 and dq0-to-abc transformations

Three-phase components— RLC loads and branches; breakers and faults; pi-section lines; voltage sources; diodes, thyristors, and transformers; and generators, analyzers, and measurements



The SimPowerSystems block library contains common electrical power network components and devices. The Powergui block lets you control the simulation and analysis.

Electric Drives and Other Applications Libraries

SimPowerSystems provides the following specialized application libraries:

FACTS—phasor models of flexible AC transmission systems

Distributed Resources— phasor models of wind turbines

Electric Drives—editable models of electric drives for actuating mechanical rotational motion that include detailed descriptions of the motor, converter, and controller for each drive

The Electric Drives library includes permanent magnet, synchronous, and asynchronous (induction) types. The converters and controllers implement the most common strategies for controlling the speed and torque for these motors.

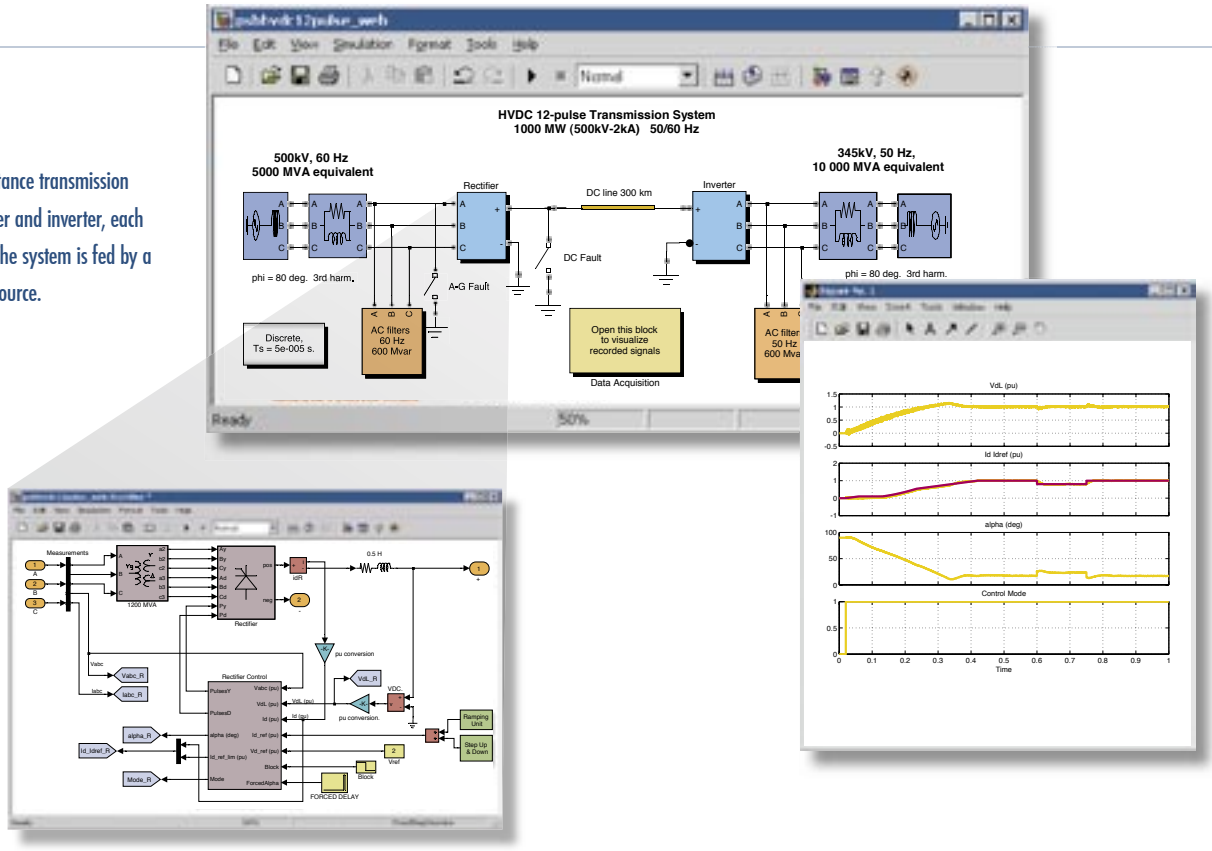
Solver Technology

Simulink solvers are well suited to continuous-time (analog), discrete-time, hybrid, and mixed-signal simulations of any size. They support algebraic constraints and state events, including discontinuities such as instantaneous changes in plant dynamics. They provide fast, reliable, and accurate simulation results.

With SimPowerSystems, you can use the variable-step integrators in Simulink to perform highly accurate simulations of power system models. Some of these integrators handle the numerically stiff systems that often arise in modeling real power systems. The zero-crossing detection capabilities of Simulink let you detect and solve discontinuities with full machine precision.

You can enhance simulation speed by up to 10 times over normal simulation by using the Simulink Accelerator (available separately).

Simulation of a long-distance transmission system through a rectifier and inverter, each with its own controller. The system is fed by a high-voltage DC power source.



Simulation Modes

SimPowerSystems provides two alternatives to continuous simulation of your power system: discretization and phasor simulation.

Discretization simulates your system with fixed time-step trapezoidal integration, and is especially effective for power system models that include power electronic devices. This mode also facilitates the execution of your model in real time.

Phasor simulation replaces the differential equations representing the network with a set of algebraic equations at a fixed frequency. Phasor simulation facilitates transient stability studies of multimachine systems.

Power System Analysis Methods

SimPowerSystems provides system analysis tools that:

- Display steady-state voltage and currents
- Display and modify initial state values
- Perform load flows and machine initialization
- Display impedance vs. frequency measurements
- Generate a report of the steady-state calculations

The SimPowerSystems graphical user interface displays steady-state values of measured current and voltages and all state variables, including inductor currents and capacitor voltages.

The load flow computational engine computes initial currents of synchronous and asynchronous machines. This feature automatically writes the resulting initial currents into the parameters for the machines. You simply specify the values for voltage and power that you want to simulate in your circuit and then click a button to compute the load flow.

SimPowerSystems lets you analyze the electrical network topology and compute the equivalent state-space model of your circuit without running a simulation. You can link the state-space model to the LTI Viewer interface in the Control Design Toolbox (available separately) to obtain time-domain and frequency-domain responses.

You can use the data analysis, visualization, and optimization capabilities of MATLAB® to analyze output data, automate parameter sweeps, and calibrate your model.

Multidomain Physical Modeling in Simulink

SimPowerSystems provides expanded capabilities for simulating physical systems in Simulink.

Standard Simulink blocks define a transfer function between input and output signal flows. For applications such as control systems design and signal processing, this approach is natural, practical, and functional.

Modeling interactions among components in electrical systems requires a broader paradigm. For example, unidirectional signal flow is inadequate for modeling the voltage-current relationship across a resistor or for modeling electrical components that interact with each other.

With SimPowerSystems, you can create a control system as a standard unidirectional signal flow block diagram and then connect this model to a power circuit, modeled using a mixture of traditional Simulink blocks and the specialized physical modeling blocks in SimPowerSystems.

Required Products

MATLAB
Simulink

Related Products

Real-Time Workshop® Generate optimized, portable, and customizable code from Simulink models

Simulink Control Design. Perform linear analysis for control system design

SimDriveline. Model and simulate mechanical driveline systems

SimMechanics. Model and simulate mechanical systems

Virtual Reality Toolbox. Animate and visualize Simulink systems in three dimensions

Platform and System Requirements

For platform and system requirements, visit *www.mathworks.com/products/simpower* ■

For demos, application examples, tutorials, user stories, and pricing:

- Visit **www.mathworks.com**
- Contact The MathWorks directly

US & Canada	508-647-7000
Benelux	+31 (0)182 53 76 44
France	+33 (0)1 41 14 67 14
Germany	+49 (0)241 470 750
Italy	+39 (011) 2274 700
Korea	+82 (0)2 6006 5114
Spain	+34 93 362 13 00
Sweden	+46 (8)505 317 00
Switzerland	+41 (0)31 950 60 20
UK	+44 (0)1223 423 200

Visit **www.mathworks.com** to obtain contact information for authorized MathWorks representatives in countries throughout Asia Pacific, Latin America, the Middle East, Africa, and the rest of Europe.

The MathWorks Tel: 508.647.7000 info@mathworks.com www.mathworks.com

09490v05 9/04