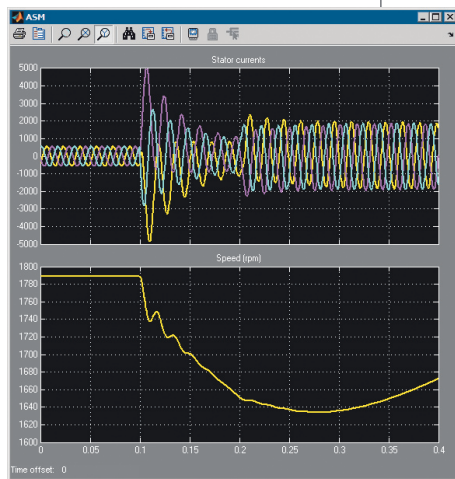


SimPowerSystems 5

Model and simulate electrical power systems

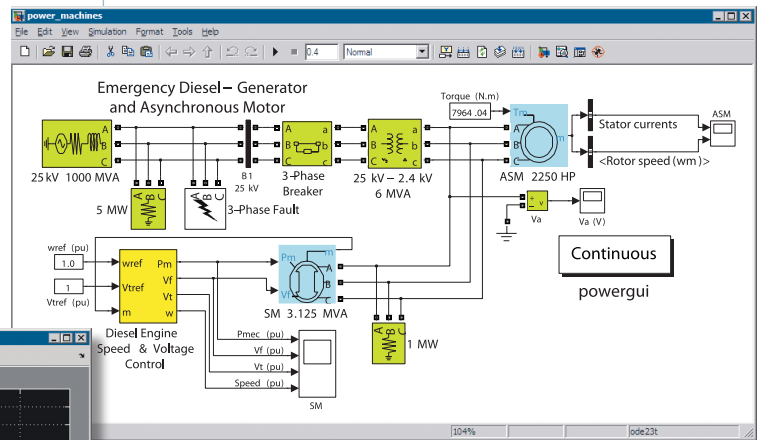
SimPowerSystems™ extends Simulink® with tools for modeling and simulating the generation, transmission, distribution, and consumption of electrical power. It provides models of many components used in these systems, including three-phase machines, electric drives, and libraries of application-specific models such as Flexible AC Transmission Systems (FACTS) and wind-power generation. Harmonic analysis, calculation of Total Harmonic Distortion (THD), load flow, and other key power system analyses are automated. SimPowerSystems models can be discretized to speed up simulations.

SimPowerSystems supports the development of complex, self-contained power systems, such as those in automobiles, aircraft, manufacturing plants, and power utility applications. You can combine SimPowerSystems with other MathWorks physical modeling products to model complex interactions in multidomain physical systems. The block libraries and simulation methods in SimPowerSystems were developed by Hydro-Québec of Montreal.



KEY FEATURES

- Modeling environment for building electrical power system models for AC, DC, and mixed AC/DC systems
- Libraries of application-specific models, including models of common AC and DC electric drives, Flexible AC Transmission Systems (FACTS), and wind-power generation
- Discretization and phasor simulation modes for faster model execution
- Ideal switching algorithm, enabling fast and accurate simulation of power electronic devices
- Analysis methods for obtaining state-space representations of circuits and computing load flow for machines
- Demonstration models of key electrical technologies



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

Modeling Electrical Power Systems

With SimPowerSystems, you build a model of a system just as you would assemble a physical system. The components in your model are connected by physical connections that represent ideal conduction paths. This approach lets you describe the physical structure of the system rather than deriving and implementing the equations for the system. From your model, which closely resembles a schematic, SimPowerSystems automatically constructs the differential algebraic equations (DAEs) that characterize the behavior of the system. These equations are integrated with the rest of the Simulink model.

You can use the sensor blocks in SimPowerSystems to measure current and voltage in your power network, and you can then pass these signals into standard Simulink blocks. Source blocks enable Simulink signals to assign values to the electrical variables current and voltage. Sensor and source blocks let you connect a control algorithm developed in Simulink to a SimPowerSystems network.

Modeling Custom Components

SimPowerSystems enables you to model custom components by using the fundamental elements included in its libraries and by combining these elements with Simulink blocks.

Components provided in SimPowerSystems include:

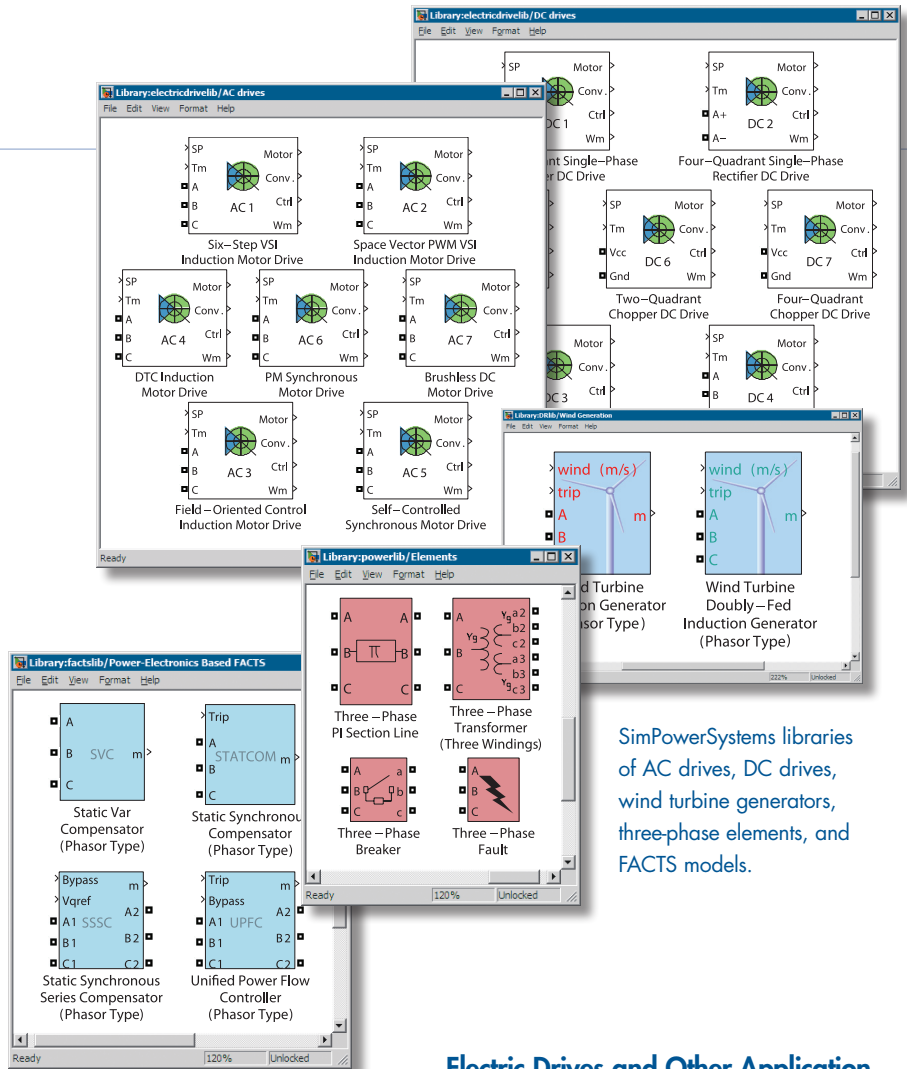
Electrical elements: Linear and saturable transformers; arrestors and breakers; and transmission line models

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

Power electronics: Diodes, simplified and complex thyristors, GTOs, switches, IGBT models, and universal bridges that allow selection of standard bridge topologies

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; π -section lines; voltage sources; transformers; synchronous and asynchronous generators; and motors, analyzers, and measurements



SimPowerSystems libraries of AC drives, DC drives, wind turbine generators, three-phase elements, and FACTS models.

Electric Drives and Other Application Libraries

SimPowerSystems provides the following specialized application libraries:

Flexible AC Transmission Systems

(FACTS): Phasor models of flexible AC transmission systems

Distributed Resources: Phasor models of wind turbines

Electric Drives: Editable models of electric drives that include detailed descriptions of the motor, converter, and controller for each drive

The Electric Drives library includes permanent magnet, synchronous, and asynchronous (induction) motors. The converters and controllers implement the most common strategies for controlling the speed and torque for these motors, such as direct-torque control and field-oriented control.

Simulation Capabilities

SimPowerSystems provides three solution methods for your power system network as well as an ideal switching algorithm that improves simulation performance for systems with high-frequency switching.

With SimPowerSystems, you can use the variable-step integration algorithms in Simulink to perform highly accurate simulations of power system models. Some of these integration algorithms 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.

Discretization simulates your system with fixed time-step trapezoidal integration. It 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 systems with multiple machines.

The ideal switching algorithm in SimPowerSystems enables fast and accurate simulation of systems containing power electronic devices. This algorithm uses an improved method of calculating the state-space representation of the system instead of relying on current sources with high-impedance snubbers to model power electronic devices. This method gives you greater flexibility in selecting a solver and results in shorter simulation times.

Power System Analysis Methods

SimPowerSystems provides system analysis tools that enable you to:

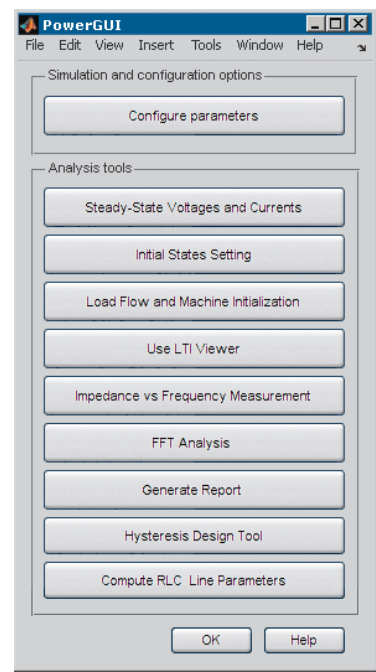
- Display steady-state voltage and currents
- Display and modify initial state values
- Perform load flows and machine initialization
- Display impedance vs. frequency measurements
- Generate a report of the steady-state calculations

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

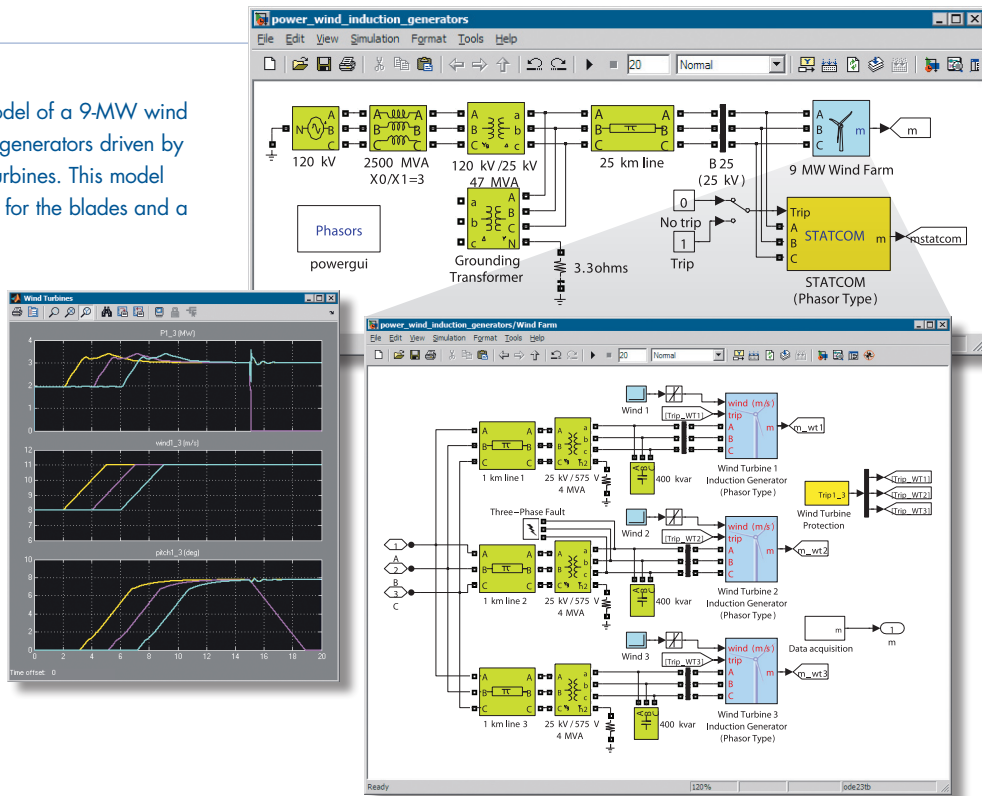
The load flow computational engine computes initial currents of synchronous and asynchronous machines. You specify the desired steady-state machine conditions in your circuit. SimPowerSystems then computes the load flow. The resulting rotor position, initial currents, and internal fluxes are automatically entered into the parameters for the machines.

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 Control System Toolbox™ to obtain time-domain and frequency-domain responses.

SimPowerSystems PowerGUI dialog box. The buttons are used to run key power system analyses.



SimPowerSystems model of a 9-MW wind farm using induction generators driven by variable-pitch wind turbines. This model includes pitch control for the blades and a protection system.



Multidomain Physical Modeling in MATLAB and Simulink

SimPowerSystems provides extended capabilities for modeling electrical power systems. You can create your physical plant model using physical connections and connect it directly to your control model built using signal flows in Simulink. SimPowerSystems models can also be connected directly to other MathWorks application- and domain-specific physical modeling tools, enabling you to model complex interactions in multidomain physical systems. You can use MATLAB® to parameterize your model, automate simulation tests, analyze output data, and optimize system performance. As a result, you can test your entire system (multi-domain physical plant and controller) within the MATLAB and Simulink environment.

Required Products

MATLAB®
Simulink®

Related Products

SimDriveline™

Model and simulate mechanical driveline systems

SimElectronics™

Model and simulate electronic and electro-mechanical systems

SimHydraulics®

Model and simulate hydraulic systems

SimMechanics™

Model and simulate mechanical systems

Simscape™

Model and simulate multidomain physical systems

Platform and System Requirements

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

Learn More

www.mathworks.com/products/simpower

Resources

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