

Simscape™ Electrical™ Release Notes



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Simscape™ Electrical™ Release Notes

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Dynamic Load (Three-Phase) Block: Model a four-quadrant dynamic load	1-2
Controlled Voltage Source (Three-Phase) Block: Apply an ideal controlled three-phase voltage to your network	1-2
Current and Voltage Sensor (Three-Phase) Block: Measure current and voltage at three-phase electrical nodes	1-2
PS Output Port for Fuse and Relay Blocks: Output block state as physical signal	1-2
Pressure Transducer Block Measurement Port: Select domain type for pressure measurement	1-3
Earthing Transformer Block: Create a neutral point for your three-phase power network	1-3
Frequency-Dependent Overhead Line (Three-Phase) Block: Model a three-phase line over a wide range of frequencies	1-3
Programmable Voltage Source Blocks: Provide a single- or three-phase voltage with programmable magnitude, frequency, and phase shift to your network	1-4
Restructured Libraries: Easily discover blocks for building networks that have the right mix of performance and fidelity for your model-based design goals	1-4
Block Name Changes and Mergers: Updated block names and merged blocks allow you to easily identify and configure model components	1-6
Function Name Changes: Functions renamed to ee_functionName	1-14
Example Model Name Changes: Example models renamed to ee_modelName	1-15
Three-Phase Electrical Domain Changes: The three-phase electrical domain is renamed and moved to the Simscape foundation package	1-15
Featured Examples	1-15

Specialized Power Systems	1-17
Robust Discrete Solver: New powergui option simplifies advanced simulation settings	1-17
CCCV Battery Charger Block: Model a constant-current constant-voltage battery charger device	1-17
Autotuning Option for Electric Drive Blocks: AC3, AC4, AC6, and AC7 electric drive blocks can calculate PID control parameters	1-17
Sensorless Speed Estimation for AC Drive Blocks: AC3 and AC4 electric drive blocks can estimate rotational velocity	1-18
Independent Simulation Type Selection: powergui solver settings are not inherited from Simulink automatic solver settings	1-18

R2018b

Simscape Electronics and Simscape Power Systems combined into Simscape Electrical	2-2
Electronics and Mechatronics	2-3
SPICE Conversion Assistant: Convert SPICE models to Simscape components	2-3
FEM-Parameterized PMSM Flux Parameterization: Specify flux linkage in polar or Cartesian coordinates	2-3
Servomotor Block Loss Parameterization: Tabulate losses and efficiency as a function of speed, torque, and DC supply voltage	2-3
Battery Characteristics Visualization: Plot voltage-charge characteristics for battery model parameter values	2-3
Peltier Device Block: Model conversion between electrical and thermal energy	2-4
elec_getNodeDvDtSummary and elec_getNodeDvDtTimeSeries Functions: Calculate derivatives of terminal voltages with respect to time	2-4
Featured Examples	2-4
Power Systems	2-5

Single-Phase Permanent Magnet Synchronous Motor Block: Model a single-phase PMSM with a squirrel-cage rotor	2-5
Multiphase Switched Reluctance Machines: Model low-current four- and five-phase SRMs	2-5
One-Quadrant Chopper Block: Convert from fixed to variable DC voltage bidirectionally	2-5
Average-Value Converters: Model DC-DC semiconductor converters that are suitable for real-time simulation	2-5
Run-Time Parameter Support for All Machine Blocks: Speed up simulation tasks and modify component parameter values without regenerating C code	2-6
Single-Phase Asynchronous Machine Blocks: Model a single- phase ASM using fundamental or fundamental SI parameterization	2-6
Asynchronous Machine Saturation: Include magnetic saturation in three-phase ASMs using open circuit lookup tables	2-7
Double-Squirrel Cage Asynchronous Machines: Specify a single or double cage for ASM squirrel cage blocks	2-7
Synchronous Machine Rotor Angle: Define the rotor axis alignment for synchronous machine blocks	2-8
Synchronous Machine Block Accuracy Improvement: SM blocks that use standard parameters and the SM field circuit block return more accurate results	2-8
Machine Plotting and Display Options: Perform plotting and display actions using the Electrical menu	2-9
Controlled Current Source (Three-Phase) Block: Control the current loop of a cascading control system	2-9
Expanded Control Library: Speed up modeling by using prebuilt and documented algorithm components	2-9
Battery Characteristics Visualization: Plot voltage-charge characteristics for battery model parameter values	2-10
Block Name Changes: Blocks names disambiguated from identically named blocks in the Simscape Electrical Electronics and Mechatronics library	2-11
HDL Code Generation from Simscape Electrical Power Systems Models: Convert models to HDL code for simulation on FPGA devices	2-11
Featured Examples	2-12
Specialized Power Systems	2-13
SVPWM Generator (3-Level) Block: Generate pulses for three- phase three-level neutral-point-clamped converters	2-13
Featured Example	2-13

R2019a

Version: 7.1

New Features

Bug Fixes

Compatibility Considerations

Dynamic Load (Three-Phase) Block: Model a four-quadrant dynamic load

The Dynamic Load (Three-Phase) block models a four-quadrant load that you can vary over the course of simulation. You specify the real and reactive power demand of the block using a physical signal input port.

Controlled Voltage Source (Three-Phase) Block: Apply an ideal controlled three-phase voltage to your network

The Controlled Voltage Source (Three-Phase) block maintains the specified voltage regardless of the load. You specify the reference voltage using a physical signal input port.

Current and Voltage Sensor (Three-Phase) Block: Measure current and voltage at three-phase electrical nodes

The Current and Voltage Sensor (Three-Phase) block represents an ideal three-phase voltage and current sensor. It measures voltage and current of a three-phase electrical node and outputs two three-element physical signal vectors.

PS Output Port for Fuse and Relay Blocks: Output block state as physical signal

Optional PS output ports on Fuse and Relay blocks let you output the block state as a physical signal. The port visibility is controlled by a new parameter in the block dialog box:

- Fuse block — The parameter name is **PS output for fuse state**. The default value is **Hidden**. When you set it to **Visible**, a PS output port **x** appears on the block icon. The port outputs 0 if the fuse is intact, and 1 if the fuse is blown.
- Relay block — The parameter name is **PS output for relay state**. The default value is **Hidden**. When you set it to **Visible**, a PS output port **x** appears on the block icon. The port outputs a vector of length two, the first element corresponding to the C-S1 connection and the second to the C-S2 connection. The elements are 1 if the corresponding connection is closed, and 0 otherwise.

Pressure Transducer Block Measurement Port: Select domain type for pressure measurement

The Pressure Transducer block turns a pressure measurement into voltage. The block now lets you measure pressure in a variety of domains. The new **Fluid port type** parameter has these options:

- Hydraulic
- Thermal Liquid
- Gas (default)
- Moist Air
- Two-Phase Fluid

Compatibility Considerations

In previous releases, the Pressure Transducer block had a pneumatic measurement port. Pneumatic blocks are no longer part of the Foundation library, but they are included in the Simscape product installation as an example custom library. The legacy Pressure Transducer block, with a pneumatic port, is now part of this custom library. From 2019a, use the Gas library for modeling pneumatic systems, and use the latest version of the Pressure Transducer block with a gas port. For more information, see “Gas Domain and Block Library: Model gas systems with various levels of idealization” (Simscape).

Earthing Transformer Block: Create a neutral point for your three-phase power network

The Earthing Transformer block is a three-phase coupler that provides your power system with a **neutral** connection for earthing.

Frequency-Dependent Overhead Line (Three-Phase) Block: Model a three-phase line over a wide range of frequencies

The Frequency-Dependent Overhead Line (Three-Phase) block generates frequency-dependent parameters that consider skin effect and earth return based on the simplified parameters that you specify. The block is suitable for power-system transient and harmonic analyses.

Programmable Voltage Source Blocks: Provide a single- or three-phase voltage with programmable magnitude, frequency, and phase shift to your network

The Programmable Voltage Source block models a single-phase AC voltage source with programmable magnitude, frequency, phase shift, and DC voltage offset. You can also include harmonics and noise in the voltage source.

The Programmable Voltage Source (Three-Phase) block models a three-phase voltage source with programmable AC magnitude, frequency, and phase shift. You can also include impedance and harmonics in the voltage source.

For both blocks, you can parameterize each programmable property individually using:

- A constant value
- A ramp
- A step
- Modulation

Alternatively, you can input a property using an external signal connected to a physical signal input port on the single- or three-phase programmable voltage source block.

Restructured Libraries: Easily discover blocks for building networks that have the right mix of performance and fidelity for your model-based design goals

Electronics and Mechatronics and **Power Systems**, two of the three top-level Simscape Electrical block libraries have been integrated. Some library names are changed to reflect the commonality of blocks that they now contain.

To open the top-level block library, at the MATLAB® command prompt, enter `simscapeelectrical` or `ee_lib`.

Library Restructure

R2018b	R2019a
Electronics and Mechatronics <ul style="list-style-type: none"> • Actuators and Drivers • Integrated Circuits • Logic • Passive Devices • Switches • Semiconductor Devices • Sensors • Sources 	"Connectors and References" "Control" "Electromechanical" "Integrated Circuits" "Passive" "Semiconductors and Converters" "Sensors and Transducers"
Power Systems <ul style="list-style-type: none"> • Connections • Control • Machines • Passive Devices • Semiconductors • Sensors • Sources • Switches and Breakers 	"Sources" "Switches and Breakers" "Utilities" "Additional Components"
Specialized Power Systems	"Specialized Power Systems"

Compatibility Considerations

MATLAB code generates an error if a function argument includes:

- The previous name of a library
- The incorrect 'libraryName/block Name' combination

Block Name Changes and Mergers: Updated block names and merged blocks allow you to easily identify and configure model components

Block names have been updated to better indicate the functionality and the electrical domain, in terms of the number of phases, of the component.

Merged machine blocks allow you to easily switch between SI and per-unit parameterizations. Merged diode, transformer, switch, and reluctance machine blocks combine several model variants in a single block.

Block Name Changes and Mergers

Block Name Prior to R2019a	Block Name from R2019a	Merger
AC Cable	AC Cable (Three-Phase)	N/A
ASM Current Controller	Induction Machine Current Controller	N/A
ASM Direct Torque Control	Induction Machine Direct Torque Control	N/A
ASM Direct Torque Control with Space Vector Modulator	Induction Machine Direct Torque Control with Space Vector Modulator	N/A
ASM Field-Oriented Control	Induction Machine Field-Oriented Control	N/A
ASM Flux Observer	Induction Machine Flux Observer	N/A
ASM Scalar Control	Induction Machine Scalar Control	N/A
Asynchronous Machine Measurement	Induction Machine Measurement	N/A
Asynchronous Machine Squirrel Cage (fundamental)	Induction Machine Squirrel Cage	Asynchronous Machine Squirrel Cage (fundamental, SI)
Asynchronous Machine Squirrel Cage (fundamental, SI)	Induction Machine Squirrel Cage	Asynchronous Machine Squirrel Cage (fundamental)
Asynchronous Machine Wound Rotor (fundamental)	Induction Machine Wound Rotor	Asynchronous Machine Wound Rotor (fundamental, SI)
Asynchronous Machine Wound Rotor (fundamental, SI)	Induction Machine Wound Rotor	Asynchronous Machine Wound Rotor (fundamental)
Average-Value Inverter	Average-Value Inverter (Three-Phase)	N/A

Block Name Prior to R2019a	Block Name from R2019a	Merger
Average-Value Rectifier	Average-Value Rectifier (Three-Phase)	N/A
Average-Value Voltage Source Converter	Average-Value Voltage Source Converter (Three-Phase)	N/A
Brushless DC Motor	BLDC	N/A
Commutation Diode	Diode	Diode Diode (Piecewise Linear)
Converter	Converter (Three-Phase)	N/A
Coupled Lines	Coupled Lines (Three-Phase)	N/A
Current Sensor	Current Sensor (Three-Phase)	N/A
Delta Reference	Delta Reference (Three-Phase)	N/A
Delta11-Delta11-Wye Transformer	Three-Winding Transformer (Three-Phase)	Delta1-Delta1-Wye Transformer Wye-Delta11-Wye Transformer Wye-Delta1-Wye Transformer
Delta1-Delta1-Wye Transformer	Three-Winding Transformer (Three-Phase)	Delta11-Delta11-Wye Transformer Wye-Delta11-Wye Transformer Wye-Delta1-Wye Transformer

Block Name Prior to R2019a	Block Name from R2019a	Merger
Delta-Delta Transformer	Two-Winding Transformer (Three-Phase)	Wye-Delta1 Transformer Wye-Delta11 Transformer Wye-Wye Transformer
Diode	Diode	Commutation Diode Diode (Piecewise Linear)
Five-Phase Switched Reluctance Machine	Switched Reluctance Machine (Multi-Phase)	Four-Phase Switched Reluctance Machine
Four-Phase Switched Reluctance Machine	Switched Reluctance Machine (Multi-Phase)	Five-Phase Switched Reluctance Machine
Diode (Piecewise Linear)	Diode	Commutation Diode Diode
Floating Neutral	Floating Neutral (Three-Phase)	N/A
Grounded Neutral	Grounded Neutral (Three-Phase)	N/A
Hybrid Excitation Synchronous Machine	Hybrid Excitation PMSM	N/A
IGBT	IGBT (Ideal, Switching)	N/A
Induction Motor	Simplified Induction Motor	N/A
Line Voltage Sensor	Line Voltage Sensor (Three-Phase)	N/A
Machine Mechanical Power (pu)	Machine Mechanical Power	Machine Mechanical Power (SI)
Machine Mechanical Power (SI)	Machine Mechanical Power	Machine Mechanical Power (pu)
MOSFET	MOSFET (Ideal, Switching)	N/A
Neutral Port	Neutral Port (Three-Phase)	N/A
Open Circuit	Open Circuit (Three-Phase)	N/A

Block Name Prior to R2019a	Block Name from R2019a	Merger
Permanent Magnet Synchronous Motor	PMSM	N/A
Phase Voltage Sensor	Phase Voltage Sensor (Three-Phase)	N/A
Piezo Linear Motor	Piezo Linear Actuator	N/A
Piezo Rotary Motor	Piezo Rotary Actuator	N/A
PWL Current Source	Piecewise Linear Current Source	N/A
PWL Voltage Source	Piecewise Linear Voltage Source	N/A
Rectifier	Rectifier (Three-Phase)	N/A
RLC	RLC (Three-Phase)	N/A
Servomotor	Simplified PMSM Drive	N/A
Single-Phase ASM Direct Torque Control	Induction Machine Direct Torque Control (Single-Phase)	N/A
Single-Phase ASM Field-Oriented Control	Induction Machine Field-Oriented Control (Single-Phase)	N/A
Single-Phase Asynchronous Machine (fundamental)	Induction Machine (Single-Phase)	Single-Phase Asynchronous Machine (fundamental, SI)
Single-Phase Asynchronous Machine (fundamental, SI)	Induction Machine (Single-Phase)	Single-Phase Asynchronous Machine (fundamental)
Single-Phase Circuit Breaker	Circuit Breaker	N/A
Single-Phase Circuit Breaker (with arc)	Circuit Breaker (with arc)	N/A
Single-Phase Permanent Magnet Synchronous Motor	PMSM (Single-Phase)	N/A
Single-Phase Switch	SPST Switch	SPST Switch

Block Name Prior to R2019a	Block Name from R2019a	Merger
Single-Phase Two-Way Switch	SPDT Switch	SPDT Switch
SPDT Switch	SPDT Switch	Single-Phase Two-Way Switch
SPICE Environment Parameters	Environment Parameters	N/A
SPST Switch	SPST Switch	Single-Phase Switch
Switch	SPST Switch (Three-Phase)	N/A
Switched Reluctance Machine	Switched Reluctance Machine	Switched Reluctance Motor
Switched Reluctance Motor	Switched Reluctance Machine	Switched Reluctance Machine
Synchronous Machine Field Circuit (pu)	Synchronous Machine Field Circuit	Synchronous Machine Field Circuit (SI)
Synchronous Machine Field Circuit (SI)	Synchronous Machine Field Circuit	Synchronous Machine Field Circuit (pu)
Synchronous Machine Model 1.0 (SI parameters)	Synchronous Machine Model 1.0	N/A
Synchronous Machine Model 2.1 (fundamental)	Synchronous Machine Model 2.1	Synchronous Machine Model 2.1 (standard)
Synchronous Machine Model 2.1 (standard)	Synchronous Machine Model 2.1	Synchronous Machine Model 2.1 (fundamental)
Synchronous Machine Round Rotor (fundamental)	Synchronous Machine Round Rotor	Synchronous Machine Round Rotor (standard)
Synchronous Machine Round Rotor (standard)	Synchronous Machine Round Rotor	Synchronous Machine Round Rotor (fundamental)
Synchronous Machine Salient Pole (fundamental)	Synchronous Machine Salient Pole	Synchronous Machine Salient Pole (standard)
Synchronous Machine Salient Pole (standard)	Synchronous Machine Salient Pole	Synchronous Machine Salient Pole (fundamental)

Block Name Prior to R2019a	Block Name from R2019a	Merger
Three-Level Converter	Three-Level Converter (Three-Phase)	N/A
Three-Phase Bridge Cycloconverter Voltage Controller	Bridge Cycloconverter Voltage Controller (Three-Phase)	N/A
Three-Phase Hysteresis Current Controller	Hysteresis Current Controller (Three-Phase)	N/A
Three-Phase Power Measurement	Power Measurement (Three-Phase)	N/A
Three-Phase Sinusoidal Measurement (PLL)	Sinusoidal Measurement (PLL, Three-Phase)	N/A
Thyristor Rectifier Voltage Controller	Thyristor Rectifier Voltage Controller (Three-Phase)	N/A
Two-Way Switch	SPDT Switch (Three-Phase)	N/A
Wye-Delta1 Transformer	Two-Winding Transformer (Three-Phase)	Delta-Delta Transformer Wye-Delta11 Transformer Wye-Wye Transformer
Wye-Delta11 Transformer	Two-Winding Transformer (Three-Phase)	Delta-Delta Transformer Wye-Delta1 Transformer Wye-Wye Transformer
Wye-Delta11-Wye Transformer	Three-Winding Transformer (Three-Phase)	Delta11-Delta11-Wye Transformer Delta1-Delta1-Wye Transformer Wye-Delta1-Wye Transformer

Block Name Prior to R2019a	Block Name from R2019a	Merger
Wye-Delta1-Wye Transformer	Three-Winding Transformer (Three-Phase)	Delta11-Delta11-Wye Transformer Delta1-Delta1-Wye Transformer Wye-Delta11-Wye Transformer
Wye-Wye Transformer	Two-Winding Transformer (Three-Phase)	Delta-Delta Transformer Wye-Delta1 Transformer Wye-Delta11 Transformer

Compatibility Considerations

MATLAB code generates an error if it refers to a block within a library by an obsolete block name.

For example, the Single-Phase Switch block has been renamed as the SPST Switch block. The Single-Phase Switch block remains in the Switches & Breakers library.

Suppose an existing model named **modelName** contains a Single-Phase Switch block. When you open the model using the R2019a version of Simscape Electrical, the block will still be named **Single-Phase Switch**. A function that calls the block in the model as an argument does not generate an error if it uses this syntax:

```
functionName('modelName/Single-Phase Switch','argument2',...,'argumentX')
```

However, code generates an error if it uses a function to add a Single-Phase Switch from the Switches & Breakers library, or in any other way changes the Single-Phase Switch block that is in the library by using this syntax:

```
functionName('Switches & Breakers/Single-Phase Switch','argument2',...,'argumentX')
```

If your code generates an error, it could contain an obsolete name as an argument in a function for adding or changing a block that is in a library. Some functions that are commonly used to manipulate blocks and block properties are:

- add_block
- set_param
- get_param

Function Name Changes: Functions renamed to ee_functionName

Simscape Electrical function names are updated from pe_functionName and elec_functionName to ee_functionName. The pe and elec functions are still available, but will be removed in a future release.

Function Name Changes

Prior to R2019a	From R2019a
elec_calculateFluxPartialDerivatives	ee_calculateFluxPartialDerivatives
elec_generateIdealPMSMfluxData	ee_generateIdealPMSMfluxData
elec_getEfficiency	ee_getEfficiency
elec_getNodeDvDtSummary	ee_getNodeDvDtSummary
elec_getNodeDvDtTimeSeries	ee_getNodeDvDtTimeSeries
elec_getPowerLossSummary	ee_getPowerLossSummary
elec_getPowerLossTimeSeries	ee_getPowerLossTimeSeries
pe_calculateThdPercent	ee_calculateThdPercent
pe_getEfficiency	ee_getEfficiency
pe_getHarmonics	ee_getHarmonics
pe_getPowerLossSummary	ee_getPowerLossSummary
pe_getPowerLossTimeSeries	ee_getPowerLossTimeSeries
pe_plotHarmonics	ee_plotHarmonics

Example Model Name Changes: Example models renamed to ee_modelName

Simscape Electrical example model names are updated from `pe_modelName` and `elec_modelName` to `ee_modelName`. For each model, the simulation data log (simlog) is renamed to agree with the new model name.

Compatibility Considerations

MATLAB code generates an error if it:

- Uses an obsolete model name as an argument for any of function that loads, opens, simulates, or in any way changes the model
- References the obsolete simlog name to extract or explore simulation data.

Three-Phase Electrical Domain Changes: The three-phase electrical domain is renamed and moved to the Simscape foundation package

The three-phase electrical domain is renamed from `pe.electrical.three_phase.electrical` to `foundation.electrical.three_phase`. The domain is moved from Simscape Electrical package to the Simscape package.

Compatibility Considerations

A custom Simscape language file that uses `pe.electrical.three_phase.electrical` will not connect to any built-in three-phase blocks until the node domain is changed to `foundation.electrical.three_phase` and the component is rebuilt or updated.

Featured Examples

New examples in this release are:

- Frequency-Dependent Transmission Line — See how a frequency-dependent transmission line model compares to a classic pi-section transmission line model.

- Import IPMSM Flux Linkage Data from Motor-CAD — Import a motor design from Motor-CAD into a Simscape™ simulation.
- Load-Side Converter Control — Control RMS voltage in a load-side converter.
- PMSM Position Control — Control rotor position in a PMSM-based electrical drive.
- Power Factor Correction for CCM Boost Converter — Correct power factor by using a power factor correction (PFC) preconverter.
- Solar Panel Parameterization Validation — Validate a datasheet-parameterized solar array using current and power output data.
- Three-Phase PMSM Traction Drive — Tune a PID controller for an FEM-Parameterized PMSM.
- “Vienna Rectifier Control” — Control a Vienna rectifier using space-vector modulation.

Specialized Power Systems

Robust Discrete Solver: New powergui option simplifies advanced simulation settings

The robust discrete solver lets you simulate models that contain certain machine and transformer blocks without adding a parasitic load. The solver calculates and specifies the values for the advanced simulation settings.

To use the robust discrete solver option, select these settings for the powergui block:

- 1 In the **Solver** settings, for the **Simulation** parameter, select **Discrete**.
- 2 In the **Preferences** settings, select the **Automatically handle the Discrete solver and Advanced tab solver settings of blocks** option.

CCCV Battery Charger Block: Model a constant-current constant-voltage battery charger device

The CCCV Battery Charger block implements a generic smart battery charger. The model allows you to specify temperatures that effect the charge rate of the battery.

Autotuning Option for Electric Drive Blocks: AC3, AC4, AC6, and AC7 electric drive blocks can calculate PID control parameters

These electric drive blocks can determine the proportional and integral gain of the speed and flux controller from response time, damping, and bandwidth ratio of the desired loop specifications.

- Field-Oriented Control Induction Motor Drive
- DTC Induction Motor Drive
- PM Synchronous Motor Drive
- Brushless DC Motor Drive

To use the autotuning option, in the electric drive **Controller** settings:

- 1 Click **Show Autotuning Control**.
- 2 Enter the speed loop specifications.
- 3 Click **Calculate PI regulators gains**.

Sensorless Speed Estimation for AC Drive Blocks: AC3 and AC4 electric drive blocks can estimate rotational velocity

Specify a sensorless speed estimation measurement for the Field-Oriented Control Induction Motor Drive block or the DTC Induction Motor Drive block. The drive blocks estimate the motor speed from terminal voltages and currents by applying the model referencing adaptive system technique.

To use speed-estimation option, in the drive block **Controller** settings, select **Set sensorless**.

Independent Simulation Type Selection: powergui solver settings are not inherited from Simulink automatic solver settings

In R2019a, control of the settings for powergui blocks is independent from the Simulink® solver settings for the model. When you select **auto (Automatic solver selection)**, Simulink no longer manages or disables the solver settings for the powergui blocks in that model.

Compatibility Considerations

If you open an existing model that has the Simulink **auto (Automatic solver selection)** solver mode selected, the powergui settings do not automatically revert to the values that you had selected before you opted to use the Simulink **auto (Automatic solver selection)** solver mode. However, you can manually change the powergui settings to the values that you selected before you opted to use the Simulink **auto (Automatic solver selection)** solver mode.

R2018b

Version: 7.0

New Features

Bug Fixes

Compatibility Considerations

Simscape Electronics and Simscape Power Systems combined into Simscape Electrical

Simscape Electrical is a new product that includes the modeling, simulation, and analysis technologies previously contained in Simscape Electronics™ (formerly SimElectronics®) and Simscape Power Systems™ (formerly SimPowerSystems™).

Find the top-level Simscape Electrical block library, now named **Electrical**, under **Simscape** in the Simulink Library Browser. It contains three sublibraries: **Electronics and Mechatronics**, **Power Systems**, and **Specialized Power Systems**. To open the top level-block library, at the MATLAB command prompt, enter `simscapeelectrical`.

To access release notes for prior releases of Simscape Electronics and Simscape Power Systems, see:

- [Simscape Electronics Release Notes](#)
- [Simscape Power Systems Release Notes](#)

Electronics and Mechatronics

SPICE Conversion Assistant: Convert SPICE models to Simscape components

The new SPICE conversion assistant allows you to convert SPICE netlist files into equivalent Simscape component files. For more information, see [Converting a SPICE Netlist to Simscape Blocks](#).

FEM-Parameterized PMSM Flux Parameterization: Specify flux linkage in polar or Cartesian coordinates

The FEM-Parameterized PMSM block now has additional parameterization options:

- You can use polar coordinates, rather than i_d and i_q , to tabulate fluxes
- The block accepts flux tabulation options used by Motor-CAD, as well as tabulated iron losses

Servomotor Block Loss Parameterization: Tabulate losses and efficiency as a function of speed, torque, and DC supply voltage

The Servomotor block now has additional parameterization options that let you tabulate losses and efficiency as a function of speed, torque, and DC supply voltage. Previously, you could tabulate losses and efficiency only as a function of speed and torque. See the [block reference page](#) for details.

Battery Characteristics Visualization: Plot voltage-charge characteristics for battery model parameter values

A new quick plot feature lets you visualize the voltage-charge characteristics for the battery model parameter values. To plot the characteristics, right-click a Battery or Battery (Table-Based) block in your model and, from the context menu, select **Electrical > Basic characteristics**. The software automatically computes a set of bias conditions, based on the block parameter values, and opens a figure window containing a plot of no-load voltage versus the state-of-charge (SOC) for the block. For more information, see [Plot Basic Characteristics for Battery Blocks](#).

Peltier Device Block: Model conversion between electrical and thermal energy

The Peltier Device is a new block in the Sources library that lets you convert electrical energy into thermal energy and vice-versa.

elec_getNodeDvDtSummary and elec_getNodeDvDtTimeSeries Functions: Calculate derivatives of terminal voltages with respect to time

Checking terminal voltage derivatives with respect to time (dv/dt) helps ensure that all devices operate within their safe operating areas. Two new functions let you calculate voltage derivatives, based on logged simulation data, for block ports (terminals) that belong to the electrical domain:

- The `elec_getNodeDvDtSummary` function returns a three-column MATLAB table. The first column lists the applicable logging nodes, the second column lists the corresponding electrical terminals, and the third column lists the maximum absolute value of dv/dt for each terminal, in V/s.
- The `elec_getNodeDvDtTimeSeries` function returns a four-column MATLAB table. The first column lists the applicable logging nodes and the second column lists the corresponding electrical terminals. The third and fourth columns list the time-series data of terminal voltages, in V, and corresponding dv/dt values, in V/s, for these electrical terminals.

To use these functions, you have to enable simulation data logging and run the simulation. For more information, see [Data Logging](#).

Featured Examples

New examples in this release are:

- Use of Peltier Device as Thermoelectric Cooler
- Conducted Emission of a Buck Converter

Power Systems

Single-Phase Permanent Magnet Synchronous Motor Block: Model a single-phase PMSM with a squirrel-cage rotor

You can parameterize the Single-Phase Permanent Magnet Synchronous Motor (PMSM) block by specifying the flux linkage or the back electromotive force (BEMF) constant.

Multiphase Switched Reluctance Machines: Model low-current four- and five-phase SRMs

The Four-Phase Switched Reluctance Machine and Five-Phase Switched Reluctance Machine blocks represent electric motors that are driven by magnetic-reluctance torque. As is typical for reluctance machines, power is delivered to the stator rather than to the rotor.

You can parameterize either switched reluctance machine (SRM) block by specifying the saturated flux linkage, aligned inductance, and unaligned inductance or by specifying the current and angle vectors and the flux linkage matrix.

For examples that include these multiphase switched reluctance machines, see:

- Four-Phase Switched Reluctance Machine Control
- Five-Phase Switched Reluctance Machine Control

One-Quadrant Chopper Block: Convert from fixed to variable DC voltage bidirectionally

The One-Quadrant Chopper block is capable of bidirectional power flow between two connected electrical networks.

For an example that includes the One-Quadrant Chopper block, see One-Quadrant Chopper Control.

Average-Value Converters: Model DC-DC semiconductor converters that are suitable for real-time simulation

The Average-Value Chopper and Average-Value DC-DC Converter blocks allow you to convert DC voltages without switching. The relatively low computational cost of average-

value converters makes them more suitable for real-time simulation than high-frequency semiconductor converter models.

For examples that include these average-value converter blocks, see:

- Average-Value Chopper Control
- Average-Value DC-DC Converter Control

Run-Time Parameter Support for All Machine Blocks: Speed up simulation tasks and modify component parameter values without regenerating C code

You can now modify certain block parameters for all electric machine blocks between simulation runs without regenerating C code or triggering the diagram update.

For more information, see Run-Time Parameters.

Single-Phase Asynchronous Machine Blocks: Model a single-phase ASM using fundamental or fundamental SI parameterization

Both the Single-Phase Asynchronous Machine (fundamental) and Single-Phase Asynchronous Machine (fundamental, SI) blocks represent a single-phase asynchronous machine with a squirrel cage rotor that you parameterize using fundamental per-unit or SI parameters, respectively. Choose between these four variants for either block:

- Split-phase
- Capacitor-start
- Capacitor-start-capacitor-run
- Main and auxiliary windings

For examples that include these single-phase ASM blocks, see:

- Single-Phase Asynchronous Machine Direct Torque Control
- Single-Phase Asynchronous Machine Field-Oriented Control

Asynchronous Machine Saturation: Include magnetic saturation in three-phase ASMs using open circuit lookup tables

Model magnetic saturation using lookup tables of per-unit no-load stator current saturation and the per-unit terminal voltage saturation data for these asynchronous machine (ASM) blocks:

- Asynchronous Machine Squirrel Cage (fundamental)
- Asynchronous Machine Squirrel Cage (fundamental, SI)
- Asynchronous Machine Wound Rotor (fundamental)
- Asynchronous Machine Wound Rotor (fundamental, SI)

To plot saturation data for an ASM block in a MATLAB figure window, right-click the block in your model, select the **Electrical** menu on the block context menu, and then choose one of these actions:

- **Plot Open-Circuit Saturation** — Plots terminal voltage versus no-load stator current. The plot contains three traces:
 - Unsaturated
 - Saturated
 - Derived
- **Plot Saturation Factor** — Plots saturation factor applied to magnetic inductance versus magnetic flux linkage.
- **Plot Saturated Inductance** — Plots magnetizing inductance versus per-unit magnetic flux linkage.

If you use the saturation mode, the **Magnetizing inductance, L_m (pu)** parameter (for fundamental blocks) or the **Magnetizing reactance, X_m** parameter (for fundamental, SI blocks) is hidden because the block computes the value based on the saturation curve.

Double-Squirrel Cage Asynchronous Machines: Specify a single or double cage for ASM squirrel cage blocks

You can now specify a single or double cage for these Asynchronous Machine (ASM) Squirrel Cage blocks.

- Asynchronous Machine Squirrel Cage (fundamental)
- Asynchronous Machine Squirrel Cage (fundamental, SI)

When you model a double cage, you can specify separate referred rotor resistance and leakage inductance for each cage.

Synchronous Machine Rotor Angle: Define the rotor axis alignment for synchronous machine blocks

You can now define the reference point for the rotor angle measurement in these synchronous machine blocks:

- Synchronous Machine Model 2.1 (fundamental)
- Synchronous Machine Model 2.1 (standard)
- Synchronous Machine Round Rotor (fundamental)
- Synchronous Machine Round Rotor (standard)
- Synchronous Machine Salient Pole (fundamental)
- Synchronous Machine Salient Pole (standard)

The default value for the **Rotor angle definition** is Angle between the a-phase magnetic axis and the d-axis. When you select this value, the rotor *d*-axis and stator *a*-phase magnetic axis are aligned when the rotor angle is zero. The other value you can choose for this parameter is Angle between the a-phase magnetic axis and the *q*-axis. When you select this value, the rotor *q*-axis and stator *a*-phase magnetic axis are aligned when the rotor angle is zero.

Synchronous Machine Block Accuracy Improvement: SM blocks that use standard parameters and the SM field circuit block return more accurate results

Due to improved mapping of mask parameters to model coefficients, in certain configurations, the simulation results from models that contain these synchronous machine blocks are more accurate in R2018b:

- Synchronous Machine Model 2.1 (standard)
- Synchronous Machine Round Rotor (standard)

- Synchronous Machine Salient Pole (standard)
- Synchronous Machine Field Circuit (pu)

Machine Plotting and Display Options: Perform plotting and display actions using the Electrical menu

In previous releases, you could perform plotting and display actions for machine blocks using the **Power Systems** menu on the block context menu. Now, use the **Electrical** menu on the block context menu to perform those same actions. For more information, see Plotting and Display Options for Asynchronous and Synchronous Machines.

Controlled Current Source (Three-Phase) Block: Control the current loop of a cascading control system

Use the Controlled Current Source (Three-Phase) block to control the output current of a current loop in a cascading control system or to represent a low-fidelity converter without modeling switches.

Expanded Control Library: Speed up modeling by using prebuilt and documented algorithm components

Save time deriving, implementing, testing, debugging, and documenting algorithm models by using blocks from the expanded Control library. The blocks are Simulink blocks that are modular and decoupled, customizable, and compatible with Embedded Coder®. Each block provides open access to the implementation source code.

To access the new blocks in the Simulink Library Browser, select, **Electrical > Power Systems > Control**, and then:

- **ASM Control** — For these single-phase ASM control blocks:
 - Single-Phase ASM Direct Torque Control — For an example that includes this block, see Single-Phase Asynchronous Machine Direct Torque Control.
 - Single-Phase ASM Field-Oriented Control — For an example that includes this block, see Single-Phase Asynchronous Machine Field-Oriented Control.
- **SM Control** — For the SM PSS1A block, which models a power system stabilizer with parameters that can account for the low-frequency effect of high-frequency torsional filters or shape the gain and phase characteristics of the stabilizer.

- **General Control** — For these control blocks:
 - Change Detector — Detect a change in the Boolean input.
 - Counter — Implement a fixed-time-period counter.
 - Fourier Analysis — Obtain the magnitude and angle of the input signal for a specified harmonic.
 - Monostable Flip-Flop — Generate a single pulse of a specified duration in response to an external trigger.
 - Moving Average — Calculate the average value of the input over a moving window.
 - On-Off Delay — Add a time delay in response to a detected transition in the input signal.
 - Second-Order Filter — Implement a low-pass, high-pass, band-pass, or band-stop second-order filter.
 - Second-Order Low-Pass Filter (Discrete or Continuous) — Implement an IEEE Std 421.5 second-order low-pass filter.
 - Serial-In Parallel-Out Shift Register — Obtain a vector of last N samples of the input signals.
 - Set-Reset Flip-Flop — Implement a bistable.
 - Signal Sample and Hold — Sample and hold the input signal.
 - Variable-Frequency Second-Order Filter — Implement a low-pass, high-pass, band-pass or band-stop second-order filter with variable frequency.

Battery Characteristics Visualization: Plot voltage-charge characteristics for battery model parameter values

A new quick-plot feature lets you visualize the voltage-charge characteristics for the battery model parameter values. To plot the characteristics, right-click a Battery or Battery (Table-Based) block in your model and, from the context menu, select **Electrical > Basic characteristics**. The software automatically computes a set of bias conditions based on the block parameter values, and opens a figure window containing a plot of no-load voltage versus the state-of-charge (SOC) for the block.

Block Name Changes: Blocks names disambiguated from identically named blocks in the Simscape Electrical Electronics and Mechatronics library

Blocks names that are identical to the names of blocks in the Simscape Electrical Electronics and Mechatronics libraries are changed in R2018b.

Block Name Changes

Library Path	Name Prior to R2018b	New Name
Simscape > Electrical > Power Systems > Passive Devices > Fundamental Components	Transmission Line	Transmission Line (Three-Phase)
Simscape > Electrical > Power Systems > Semiconductors > Fundamental Components	Diode	Diode (Piecewise Linear)
	Thyristor	Thyristor (Piecewise Linear)
Simscape > Electrical > Power Systems > Sources	Current Source	Current Source (Three-Phase)
	Voltage Source	Voltage Source (Three-Phase)

Compatibility Considerations

To prevent a script that contains the previous name of a block from producing an error, update the block names in your code.

HDL Code Generation from Simscape Electrical Power Systems Models: Convert models to HDL code for simulation on FPGA devices

If you have an HDL Coder™ license, you can use the Simscape HDL Advisor advisor to deploy a linear or switched linear plant model developed using Simscape Electrical blocks to a target FPGA. To generate code using the Simscape HDL Advisor:

- 1 Configure the Power Systems model for conversion.
- 2 Convert the Power Systems model to an HDL code-compatible implementation model.
- 3 Generate HDL code from the implementation model.

For more information, see Real-Time Simulation.

Featured Examples

New examples in this release are:

- Average-Value Chopper Control
- Average-Value DC-DC Converter Control
- DC Motor Control (Lead-Lag)
- DC Motor Control (RST)
- DC Motor Control (Smith Predictor)
- DC Motor Control (State-Feedback and Observer)
- Five-Phase Switched Reluctance Machine Control
- Four-Phase Switched Reluctance Machine Control
- IPMSM Outer Loop Controller Evaluation
- One-Quadrant Chopper Control
- PMSM Parameterization from Datasheet
- PMSM Parameterization from Measurements
- Single-Phase Asynchronous Machine Direct Torque Control
- Single-Phase Asynchronous Machine Field-Oriented Control
- Vienna Rectifier

Specialized Power Systems

SVPWM Generator (3-Level) Block: Generate pulses for three-phase three-level neutral-point-clamped converters

The SVPWM Generator (3-Level) block outputs 12 pulses that it generates using the space vector pulse width modulation (SVPWM) technique. A proportional regulator controls the neutral point voltage deviation of the NPC converter based on the DC voltage references and the DC current flowing in or out of the DC link.

Featured Example

The Three-Level NPC Inverter Using Space-Vector PWM with Neutral-Point Voltage Control example shows how to operate a 2-MVA, 3-Level NPC inverter using the Space Vector Pulse-Width-Modulation (SVPWM) technique with neutral point voltage control.

