

Simscape™ Release Notes

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Simscape™ Release Notes

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Summary by Version

This table provides quick access to what's new in each version. For clarification, see “Using Release Notes” on page 2.

Version (Release)	New Features and Changes	Version Compatibility Considerations	Fixed Bugs and Known Problems
Latest Version V3.7 (R2012a)	Yes Details	Yes Summary	Bug Reports Includes fixes
V3.6 (R2011b)	Yes Details	No	Bug Reports Includes fixes
V3.5 (R2011a)	Yes Details	Yes Summary	Bug Reports Includes fixes
V3.4 (R2010b)	Yes Details	Yes Summary	Bug Reports Includes fixes
V3.3 (R2010a)	Yes Details	Yes Summary	Bug Reports Includes fixes
V3.2 (R2009b)	Yes Details	Yes Summary	Bug Reports Includes fixes
V3.1 (R2009a)	Yes Details	Yes Summary	Bug Reports Includes fixes
V3.0 (R2008b)	Yes Details	Yes Summary	Bug Reports Includes fixes
V2.1 (R2008a)	Yes Details	No	Bug Reports Includes fixes

Version (Release)	New Features and Changes	Version Compatibility Considerations	Fixed Bugs and Known Problems
V2.0.1 (R2007b+)	No	No	Bug Reports Includes fixes
V2.0 (R2007b)	Yes Details	No	Bug Reports Includes fixes
V1.0 (R2007a)	Yes Details	Yes Summary	Bug Reports

Using Release Notes

Use release notes when upgrading to a newer version to learn about:

- New features
- Changes
- Potential impact on your existing files and practices

Review the release notes for other MathWorks® products required for this product (for example, MATLAB® or Simulink®). Determine if enhancements, bugs, or compatibility considerations in other products impact you.

If you are upgrading from a software version other than the most recent one, review the current release notes and all interim versions. For example, when you upgrade from V1.0 to V1.2, review the release notes for V1.1 and V1.2.

What Is in the Release Notes

New Features and Changes

- New functionality
- Changes to existing functionality

Version Compatibility Considerations

When a new feature or change introduces a reported incompatibility between versions, the **Compatibility Considerations** subsection explains the impact.

Compatibility issues reported after the product release appear under Bug Reports at the MathWorks Web site. Bug fixes can sometimes result in incompatibilities, so review the fixed bugs in Bug Reports for any compatibility impact.

Fixed Bugs and Known Problems

MathWorks offers a user-searchable Bug Reports database so you can view Bug Reports. The development team updates this database at release time and as more information becomes available. Bug Reports include provisions for any known workarounds or file replacements. Information is available for bugs existing in or fixed in Release 14SP2 or later. Information is not available for all bugs in earlier releases.

Access Bug Reports using your MathWorks Account.

Documentation on the MathWorks Web Site

Related documentation is available on mathworks.com for the latest release and for previous releases:

- Latest product documentation
- Archived documentation

Version 3.7 (R2012a) Simscape Software

This table summarizes what's new in Version 3.7 (R2012a):

New Features and Changes	Version Compatibility Considerations	Fixed Bugs and Known Problems
Yes Details below	Yes—Details labeled as Compatibility Considerations , below. See also Summary.	Bug Reports Includes fixes

New features and changes introduced in this version are

- “Modeling Delays in Simscape Language” on page 4
- “New Blocks for Modeling Delays” on page 4
- “1D and 2D Interpolation Available in Simscape Language” on page 5
- “Input Filtering Usability Enhancements” on page 5
- “Zero Damping Allowed for Resistive Elements” on page 6
- “Changes to Simscape Demos” on page 7

Modeling Delays in Simscape Language

The new `delay` construct in Simscape™ language lets you refer to past values of expressions in the `equations` section of the Simscape file. For more information, see the delay reference page, and the new demo, Variable Transport Delay.

New Blocks for Modeling Delays

The new Delays sublibrary of the Physical Signals library contains two blocks:

- PS Constant Delay block returns the input signal delayed by a specified time, which is constant throughout the simulation. You specify the delay time as a block parameter.
- PS Variable Delay block delays the input signal by a variable time. You specify the delay time and the input history as additional inputs.

Use these blocks to model idealized transport phenomena at system level.

1D and 2D Interpolation Available in Simscape Language

The new `tablelookup` function in Simscape language lets you interpolate expressions in the equations section of the Simscape file. It computes an output value by interpolating the input value against a set of data points in a one-dimensional or two-dimensional table, and supports three interpolation and two extrapolation options. This functionality is similar to that of the Simulink and Simscape Lookup Table blocks. It allows you to incorporate table-driven modeling directly in your custom block, without the need of connecting an external Lookup Table block to your model. For more information, see the `tablelookup` reference page.

The PS Lookup Table (1D) and PS Lookup Table (2D) blocks in the Foundation library now use the `tablelookup` function in the Simscape language. The block functionality and user interface remain the same.

Input Filtering Usability Enhancements

In previous releases, input filtering was automatically turned on whenever you used an explicit solver in a Simscape model. To turn off input filtering when using an explicit solver, you had to supply first derivative of the input signal as an additional input signal to the Simulink-PS Converter block. For models using other types of solvers, input filtering was not available.

Now input filtering is independent of the solver used in the model. You can control whether you filter input or provide time derivatives for each input signal individually, by configuring the Simulink-PS Converter block connected to that input signal. You can:

- Set the **Filtering and derivatives** parameter to `Filter input`, and select whether you want to use the first-order or second-order filter. Input filtering makes the input signal smoother and generally improves model performance. The additional benefit is that the Simscape engine computes the time derivatives of the filtered input. The first-order filter provides one derivative, while the second-order filter provides the first and second derivatives. If you use input filtering, it is very important to select the appropriate value for the filter time constant.

- Set the **Filtering and derivatives** parameter to `Provide input derivative(s)`, and provide either just the first time derivative, or the first and the second time derivatives, through additional input ports on the Simulink-PS Converter block.

By default, input signals are used as is, without performing input filtering or otherwise providing time derivatives of the input signal. If you use an explicit solver, MathWorks recommends that you provide input derivatives by selecting one of the options listed above. If you do not provide input derivatives, and the solver you use requires them, you get an error message indicating how many input derivatives you need to provide. For more information, see “Harmonizing Simulink and Simscape Solvers” and the Simulink-PS Converter block reference page.

Compatibility Considerations

Input filtering is no longer automatically turned on for models using explicit solvers. Therefore if you have an existing model that uses an explicit solver, its performance and simulation results may be different from the previous version.

Because Simscape solver no longer automatically provides the required input derivatives, you may get an error message indicating how many input derivatives you need to provide.

To preserve the old behavior, open each Simulink-PS Converter block and set the **Filtering and derivatives** parameter to `Filter input`, while keeping the value of the **Input filtering time constant** parameter unchanged. If any of the Simulink-PS Converter blocks in your model had input derivatives provided as additional signals, set the **Filtering and derivatives** parameter for such block to `Provide input derivative(s)`.

Zero Damping Allowed for Resistive Elements

In previous releases, resistive blocks in the Foundation library required positive damping coefficients. Negative damping values are nonphysical. However, zero damping values are useful for model checking and testing. For example, if you use a Rotational Damper block as part of a customized gear model, it is convenient to be able to set the **Damping coefficient** parameter to 0 temporarily, to compute undamped responses.

The following blocks now allow zero damping values, to support model testing:

- Resistor (Electrical Elements library)
- Linear Hydraulic Resistance (Hydraulic Elements library)
- Rotational Damper (Rotational Elements library)
- Translational Damper (Translational Elements library)

Changes to Simscape Demos

The following demo has been added in Version 3.7:

Demo Name

Variable Transport Delay
(ssc_transport_delay)

Description

Provides an example of modeling a variable transport delay using Simscape language. The Transport Delay subsystem models signal propagation through media moving between the Input and the Output terminals. The media velocity may vary, thus it is specified through the block port. The distance between the terminals is constant and it is specified as a block parameter. To see the implementation details, look under mask of the Transport Delay subsystem, then right-click the Variable Transport Delay block and select **View Simscape source**.

Version 3.6 (R2011b) Simscape Software

This table summarizes what's new in Version 3.6 (R2011b):

New Features and Changes	Version Compatibility Considerations	Fixed Bugs and Known Problems
Yes Details below	No	Bug Reports Includes fixes

New features and changes introduced in this version are

- “Simscape Language Enables User-Defined Diagnostics During Simulation” on page 8
- “New Block for Modeling Discrete Delays” on page 8
- “Specialized Simulator for Linear Systems” on page 9
- “Rebuilding of Custom Block Libraries Now Required” on page 9

Simscape Language Enables User-Defined Diagnostics During Simulation

The new `assert` construct in Simscape language lets you implement run-time error messages when the custom block is used in a model. In the component file, you specify the condition to be evaluated, as well as the error message to be output if this condition is violated. When the custom block based on this file is used in a model, it will output this error if the condition is violated during simulation. For more information, see “Programming Run-Time Errors and Warnings”.

New Block for Modeling Discrete Delays

The Asynchronous Sample & Hold block, in the new Discrete sublibrary of the Physical Signals library, sets output Y equal to input U when the rising edge of the trigger input becomes greater than zero. Use this block, in conjunction with other physical signal blocks, to model discrete and event-based behaviors.

Specialized Simulator for Linear Systems

The new specialized simulator, implemented for linear systems, reduces number of states and accelerates simulation. The specialized linear simulator is automatically employed based on the system structure, you do not have to select or enable it explicitly.

Rebuilding of Custom Block Libraries Now Required

Due to further scalability improvements, as well as other internal enhancement to facilitate add-on product functionality, you have to rebuild your custom block libraries once you upgrade to Version 3.6 (R2011b). It is required that you rebuild your custom block libraries for use with each new version of Simscape software. For more information, see “When to Rebuild the Custom Library”.

To rebuild the libraries, run `ssc_build` on the component Simscape files. If you try to use the custom blocks without rebuilding the libraries, you will get an error message.

Running `ssc_clean` before `ssc_build` is strongly recommended but not required. If you run into errors after running `ssc_build`, run `ssc_clean` and then try running `ssc_build` again.

Version 3.5 (R2011a) Simscape Software

This table summarizes what's new in Version 3.5 (R2011a):

New Features and Changes	Version Compatibility Considerations	Fixed Bugs and Known Problems
Yes Details below	Yes Summary	Bug Reports Includes fixes

New features and changes introduced in this version are

- “Additional Hydraulic Sources” on page 10
- “Improved Simulation Diagnostics ” on page 11
- “Improved Scalability ” on page 11
- “Improved Algorithms for Algebraic Loop Detection and Zero-Crossing Robustness” on page 11
- “Change in Evaluating Unit Expressions” on page 12

Additional Hydraulic Sources

Two new blocks have been added to the Hydraulic Sources library:

- Hydraulic Constant Flow Rate Source block represents an ideal source of hydraulic energy that is powerful enough to maintain specified flow rate at its outlet regardless of the pressure differential across the source. The **Source flow rate** parameter specifies the flow rate through the source.
- Hydraulic Constant Pressure Source block represents an ideal source of hydraulic energy that is powerful enough to maintain the specified pressure differential between its inlet and outlet regardless of the flow rate through the source. The **Pressure** parameter specifies the pressure differential across the source.

Use these blocks for models where flow rate or pressure remain constant throughout simulation.

Improved Simulation Diagnostics

The following improvements in simulation diagnostics have been implemented, to aid debugging:

- Equation dependency diagnostics now point to the specific equations (with line number and file location info) within the component Simscape files.
- Equation dependency diagnostics have been extended to include switched-linear and nonlinear equations in the analysis.
- Equation dependency diagnostics are now triggered on nonlinear solver failures that occur after the start of simulation.
- Zero-crossing related warnings and error messages now point to the specific equations (with line number and file location info) within the component Simscape files.

Improved Scalability

Various scalability improvements have been implemented in this release, accelerating simulation of larger systems.

Compatibility Considerations

Due to this change, you have to rebuild your custom block libraries once you upgrade to Version 3.5 (R2011a). To rebuild the libraries, run `ssc_build` on the component Simscape files. If you try to use the custom blocks without rebuilding the libraries, you will get an error message.

Running `ssc_clean` before `ssc_build` is strongly recommended but not required. If you run into errors after running `ssc_build`, run `ssc_clean` and then try running `ssc_build` again.

Improved Algorithms for Algebraic Loop Detection and Zero-Crossing Robustness

The following simulation algorithm improvements have been implemented in this release:

- False algebraic loop detection and prevention—The improved algorithm can now recognize false algebraic loops and prevent them from affecting simulation results.

- Performance and zero-crossing robustness improvements—Zero-crossing detection algorithm has been optimized to ignore zero-crossings that do not result in model behavior changes during simulation.

Change in Evaluating Unit Expressions

In the Unit Manager parser, multiplication (*) used to mistakenly have higher precedence than division (/). This issue is now fixed. When evaluating unit expressions, * and / now have the same precedence and are evaluated based on left associativity.

Compatibility Considerations

Due to this change, custom units specified in the unit registry may now evaluate differently. For example, if you have added a unit $m/s*s$, in previous releases it was evaluated as $m/(s*s) = m/s^2$. It will now evaluate to $(m/s)*s = m$. You can use parentheses to preserve the old behavior.

Version 3.4 (R2010b) Simscape Software

This table summarizes what's new in Version 3.4 (R2010b):

New Features and Changes	Version Compatibility Considerations	Fixed Bugs and Known Problems
Yes Details below	Yes Summary	Bug Reports Includes fixes

New features and changes introduced in this version are

- “Simulation Data Logging Enhancements” on page 13
- “Zero-Crossing Handling Enhancements” on page 14
- “C++ Code Generation Support” on page 15
- “Sparse Solver Enhancement” on page 15
- “Component Descriptor Is No Longer Inherited from the Base Class” on page 15
- “Documentation Enhancements” on page 16
- “Changes to Simscape Demos” on page 16

Simulation Data Logging Enhancements

The following data logging enhancements have been implemented in this version:

- `plot` and `plotxy` commands have been added. The `plot` command lets you plot logged data against time, while the `plotxy` command plots two sets of data against each other. Also, `plot` and `plotxy` methods are now available for `simscape.logging.Node` and `simscape.logging.Series` objects. For more information, see the respective reference pages.
- New configuration parameter, **Decimation**, lets you downsample logged data by skipping time steps. For more information, see “Data Logging Options” in the *Simscape User’s Guide*.

- Simulation data is now logged according to the value specified for the **Output options** parameter in the **Data Import/Export** pane of the Configuration Parameters dialog box.

Compatibility Considerations

For models that do not use the default value of the **Output options** parameter in the **Data Import/Export** pane of the Configuration Parameters dialog box, logged simulation data may change compared to the previous release.

Zero-Crossing Handling Enhancements

The creation and detection of zero-crossing conditions in Simscape models have been improved.

New Implementation of Relational Functions Without Creating Simulink Zero-Crossing Conditions

The Simscape language now implements relational functions in a different way from how relational operators are implemented. Unlike relational operators, these relational functions now do not create Simulink zero-crossing conditions.

For more information about zero crossings in Simscape models, see “Creating and Detecting Zero Crossings in Simscape Models” in the *Simscape User’s Guide*.

For more information about creating models in the Simscape language, see the *Simscape Language Guide* and the equations syntax.

Improved Zero-Crossing Detection Diagnostics

If your model generates a Simulink warning or error about zero crossings involving Simscape blocks, the warning or error message now specifies which blocks are generating this zero-crossing diagnostic message.

If you globally disable zero-crossing detection in a Simulink model containing Simscape blocks, and if you are using a variable-step solver without a local solver, you now receive a diagnostic warning or error. You can control which message that you receive in the **Simscape** pane of the model Configuration Parameters dialog box, through the **Zero-crossing control is globally**

disabled in Simulink drop-down list. This option supports context-sensitive or “What’s This?” help, by default accessed through right-clicking the item.

See “Harmonizing Simulink and Simscape Solvers” in the *Simscape User’s Guide*.

C++ Code Generation Support

You can now generate C++ code from Simscape models. Encapsulated C++ code generation is not supported.

For more information, see “Code Generation ” and “Limitations” in the *Simscape User’s Guide*.

Sparse Solver Enhancement

The implementation and control of matrix linear algebra in the Solver Configuration block have been improved and simplified. Whether you choose the sparse solver or the full solver, your linear algebra choice is now implemented in both model simulation and code generated from the model.

For more information, see the Solver Configuration block reference page.

Component Descriptor Is No Longer Inherited from the Base Class

In Simscape Language, the name of the block built from a component file generally corresponds to the component file name. You can provide a more descriptive name for the block by adding a comment line immediately following the component declaration. This comment line is called the descriptor. For more information, see “How to Customize the Block Name”.

If you use subclassing, the subclass inherits all of the members (parameters, variables, nodes, inputs and outputs) from the base class (for more information, see “Subclassing and Inheritance”). In previous releases, descriptor was one of the inherited properties. That is, if you had a subclass component without a descriptor, the resulting block name was derived from the descriptor of the base class, instead of the component file name. This could create issues with library building if both the subclass component and the base class component were in the same sublibrary.

Starting with this release, descriptor is no longer inherited from the base class. In other words, if a component file does not contain a comment line immediately following the component declaration, the component name is always used for the block name.

Compatibility Considerations

For existing subclass components, if the component does not have a descriptor line, upon rebuilding the library the block name will change compared to the previous release. To preserve the old name, add a descriptor line to the subclass component file.

Documentation Enhancements

The “Model Simulation” chapter has been expanded and improved with revised and new sections, including:

- “How Simscape Models Represent Physical Systems”
- “How Simscape Simulation Works”
- “Setting Up Solvers for Physical Models”
- “Customizing Solvers for Physical Models”
- “Real-Time Simulation”
- “Finding an Operating Point”
- “Linearizing at an Operating Point”
- “Finding and Using Operating Points in an Electronic Circuit”

More information about real-time simulation is available in *Simulating with Hardware in the Loop*, in the *Motion, Control, and Real-Time Simulation* chapter of the *SimMechanics™ User's Guide*.

Changes to Simscape Demos

The following demo has been added in Version 3.4:

Demo Name

Electrical Transformer
(ssc_transformer)

Description

Presents a view inside a transformer core using the electromagnetic blocks from the Magnetic block library.

Version 3.3 (R2010a) Simscape Software

This table summarizes what's new in Version 3.3 (R2010a):

New Features and Changes	Version Compatibility Considerations	Fixed Bugs and Known Problems
Yes Details below	Yes Summary	Bug Reports Includes fixes

New features and changes introduced in this version are

- “Magnetic Blocks Added to Foundation Library” on page 18
- “Simulation Data Logging Now Available” on page 19
- “Simscape Diagnostics Improvements” on page 19
- “Sparse Jacobian Support” on page 19
- “Ability to Generate Simscape Language Equations from Symbolic Expressions” on page 20
- “Placing Simscape Blocks in Nonvirtual Subsystems” on page 20
- “Trimming and Linearization Documentation Enhancements” on page 20
- “Changes to Simscape Demos” on page 20

Magnetic Blocks Added to Foundation Library

Foundation library now contains magnetic domain and Magnetic block library. This library contains electromagnetic elements, such as reluctances, actuators, and electromagnetic converters, as well as magnetic sensors and sources.

Use these blocks to model magnetic circuits that can be represented by a one-dimensional flux flow, for example, solenoids and transformers.

Magnetic block models are based on the following assumptions:

- The magnetic system is assumed lossless. You can model losses in interconnecting systems instead – in electric systems using resistors and in mechanical systems using friction.
- Modeling of superconductors (with zero relative permeability) is not supported.

For more information see the block reference pages. See also for information on the magnetic domain definition. The Across variable is magnetomotive force (mmf), and the Through variable is flux. Note that these result in a pseudo-bond graph, because the product of mmf and flux is energy, not power.

Simulation Data Logging Now Available

You can now log simulation data to workspace for debugging and verification purposes. Data logging lets you analyze how internal block variables change with time during simulation. For example, you may want to see that the pressure in a hydraulic cylinder is above some minimum value, or compare it against the pump pressure. If you log simulation data to workspace, you can later query, plot, and analyze it without rerunning the simulation. For more information, see “Data Logging” in the *Simscape User’s Guide*.

Simscape Diagnostics Improvements

Simscape error messages triggered by initial dynamic state inconsistencies and by nonlinear solver convergence failures are now more detailed. These messages report specific components of your models that may have caused the error.

Sparse Jacobian Support

You can now use a Jacobian method with an implicit Simulink solver in your Simscape models. You can choose a method yourself or allow Simulink to determine an appropriate Jacobian method for you. Depending on the sparsity pattern and number of states of your model, your simulation may be more efficient.

See “Choosing a Jacobian Method for an Implicit Solver” in the Simulink documentation.

Ability to Generate Simscape Language Equations from Symbolic Expressions

If you have Symbolic Math Toolbox™ software, you can use the `simscapeEquation` function to generate Simscape language equations from symbolic expressions. For more information, see *Generating Simscape Equations* in the Symbolic Math Toolbox documentation.

Placing Simscape Blocks in Nonvirtual Subsystems

Nonvirtual subsystems that support continuous states include Enabled subsystems and Atomic subsystems. These subsystems can contain Simscape blocks. However, physical connections and physical signals must not cross nonvirtual boundaries. For more information, see “Restricted Simulink Tools” in the *Simscape User’s Guide*.

Compatibility Considerations

Simscape solver no longer permits physical connections and physical signals to cross nonvirtual subsystem boundaries, because the semantics of these types of connections are unclear. If either a physical signal or a physical connection crosses a nonvirtual boundary, the solver issues an error upon simulation. To resolve the issue, place all blocks belonging to a given Physical Network in the same nonvirtual subsystem.

Trimming and Linearization Documentation Enhancements

The documentation on Simscape model trimming and linearization has been revised and expanded. See “Finding an Operating Point” and “Linearizing at an Operating Point”.

Changes to Simscape Demos

The following demos have been added in Version 3.3:

Demo Name

Circuit Breaker
(ssc_circuitbreaker)

Solenoid with Magnetic Blocks
(ssc_solenoid_magnetic)

Description

Implements a simple circuit breaker model.

Shows how to model a solenoid using the electromagnetic blocks from the new Magnetic block library.

Version 3.2 (R2009b) Simscape Software

This table summarizes what's new in Version 3.2 (R2009b):

New Features and Changes	Version Compatibility Considerations	Fixed Bugs and Known Problems
Yes Details below	Yes—Details labeled as Compatibility Considerations , below. See also Summary.	Bug Reports Includes fixes

New features and changes introduced in this version are

- “Pneumatic Blocks Added to Foundation Library ” on page 22
- “New and Enhanced Switches ” on page 24
- “Intermediate Terms in Simscape Language Equations” on page 24
- “Local Solver Support in Physical Networks” on page 24
- “Simulink Manifest Tool Support” on page 25
- “SimState Support” on page 25
- “Model Reference Accelerator Mode Support ” on page 25
- “Physical Port Rotation for Simscape Blocks” on page 26
- “Changes to Simscape Demos” on page 26

Pneumatic Blocks Added to Foundation Library

Foundation library now contains pneumatic domain and Pneumatic block library. This library contains pneumatic elements, such as orifices, chambers, and pneumatic-mechanical converters, as well as pneumatic sensors and sources.

Use these blocks to model pneumatic systems, for applications such as:

- Factory automation — basic pneumatic linear/rotational actuators, valves (variable orifices), and air supply
- Robotics — robotic arms and haptic interfaces

- Gaseous transportation systems and pipelines

You can also use these blocks to model dry air and low pressure flows, for example, for HVAC applications.

Pneumatic block models are based on the following assumptions:

- Working fluid is an ideal gas satisfying the ideal gas law.
- Specific heats at constant pressure and constant volume, c_p and c_v , are constant.
- Processes are adiabatic, that is, there is no heat transfer between components and the environment (except for components with a separate thermal port).
- Gravitational effects are neglected.

For more information see the block reference pages, as well as “Modeling Pneumatic Systems” in the *Simscape User’s Guide*.

Compatibility Considerations

To avoid duplicate block names in different Simscape domains and increase naming consistency across domains, the following hydraulic blocks have been renamed:

Old Block Name	New Block Name
Constant Area Orifice	Constant Area Hydraulic Orifice
Constant Volume Chamber	Constant Volume Hydraulic Chamber
Piston Chamber	Hydraulic Piston Chamber
Resistive Tube	Hydraulic Resistive Tube
Variable Area Orifice	Variable Area Hydraulic Orifice
Variable Chamber	Variable Hydraulic Chamber
Ideal Hydraulic Flow Rate Sensor	Hydraulic Flow Rate Sensor
Ideal Hydraulic Pressure Sensor	Hydraulic Pressure Sensor

Old Block Name	New Block Name
Ideal Hydraulic Flow Rate Source	Hydraulic Flow Rate Source
Ideal Hydraulic Pressure Source	Hydraulic Pressure Source

Old models containing any of these blocks will be updated automatically once you open and save them.

New and Enhanced Switches

The following switching capability enhancements have been implemented in Foundation libraries:

- New Physical Signal PS Switch block has been added to the Nonlinear Operators library. It contains three physical signal input ports, a physical signal output port, and one parameter, **Threshold**. If the second input is greater than or equal to the threshold, then the output is connected to the first input. Otherwise, the output is connected to the third input. The second input never connects to the output.
- Electrical Switch block has been enhanced to use a value specified in the **Threshold** parameter (rather than zero) for opening and closing the switch.

Intermediate Terms in Simscape Language Equations

You can now introduce intermediate terms in Simscape Language equations by using the `let` and `in` keywords. This functionality helps increase the equation readability, as well as avoid duplicating information by defining an intermediate term once and then using it in multiple equations. For more information, see the Simscape Language Guide.

Local Solver Support in Physical Networks

The Solver Configuration block now lets you use sample-based local solver with a specific sample time. In sample-based simulation, all the Physical Network states, otherwise represented as continuous, become discrete states. The solver updates the states once per time step. This option is especially useful for code generation, or hardware-in-the-loop (HIL) simulations. For more information, see the Solver Configuration reference page.

Simulink Manifest Tool Support

Dependency analysis tools for Simscape files have been added in this release. They consist of the following command-line options:

- `simscape.dependency.file` — Perform dependency analysis for a single Simscape file.
- `simscape.dependency.lib` — Perform dependency analysis for a Simscape custom library.
- `simscape.dependency.model` — Perform dependency analysis on a model containing Simscape and Simulink blocks.

Manifest reports generated using Simulink Manifest Tools now also include model dependencies for the Simscape blocks. For more information, see “Checking File and Model Dependencies” in the *Simscape Language Guide*.

SimState Support

Simscape software now supports Simulink SimState feature, introduced in R2009a. This feature allows you to save all runtime data necessary for restoring the simulation state of a model. For more information, see “Saving and Restoring the Simulation State as the SimState” in the *Simulink User’s Guide*.

Note When using SimState to save and restore simulations of models involving Simscape blocks, please ensure both 'DstWorkspace' and 'SrcWorkspace' to be 'base' by using:

```
simset('DstWorkspace', 'base', 'SrcWorkspace', 'base')
```

Model Reference Accelerator Mode Support

Simscape and its add-on products now fully support Model Reference Accelerator Mode, both for model simulation and for code generation.

Physical Port Rotation for Simscape Blocks

When you rotate a regular Simulink block, its ports are by default reordered after rotation, to maintain the left-right and top-down block diagram orientation convention used in control system modeling applications. This convention is not applicable to physical modeling and is potentially confusing, because it results in effectively rotating and flipping the block at the same time.

Therefore, starting with Version 3.2 (R2009b), when you rotate a Simscape block (including blocks from add-on products), its ports are not reordered. This behavior is similar to that of the masked blocks with **Port Rotation** set to **Physical**. For illustration of differences between the *default port rotation* type and the *physical port rotation* type, see “Changing a Block’s Orientation” in the *Simulink User’s Guide*.

Compatibility Considerations

This change in the behavior of the ports after block rotation may result in visually crossed connection lines in some of your existing block diagrams with rotated blocks. The effect is purely cosmetic and has no impact on actual model connections or simulation.

Changes to Simscape Demos

The following demos have been added in Version 3.2:

Demo Name	Description
Pneumatic Actuation Circuit (ssc_pneumatic_actuator)	This demo shows how the Foundation Library pneumatic components can be used to model a controlled pneumatic actuator. The Directional 5-way valve, Double-acting pneumatic actuator and Pipe blocks are masked subsystems created from Foundation Library blocks.

Pneumatic Motor
(ssc_pneumatic_motor)

This demo shows how the Rotational Pneumatic-Mechanical Converter block can be used to approximate the behavior of a pneumatic vane motor.

Pneumatic Motor and Directional Control Valve
(ssc_pneumatic_motor_and_valve)

This model shows the pneumatic vane motor, as defined in the Pneumatic Motor demo, deployed in a typical pneumatic circuit.

Version 3.1 (R2009a) Simscape Software

This table summarizes what's new in Version 3.1 (R2009a):

New Features and Changes	Version Compatibility Considerations	Fixed Bugs and Known Problems
Yes Details below	Yes—Details labeled as Compatibility Considerations , below. See also Summary.	Bug Reports Includes fixes

New features and changes introduced in this version are

- “Simscape Language Source Protection” on page 28
- “Expanded MATLAB Support of Simscape Files” on page 29
- “Viewable and Customizable Source Files for Foundation Library Blocks” on page 29
- “Simscape Language Syntax Changes” on page 30
- “Increased Efficiency of Simscape Language Equations Processing” on page 30
- “New Physical Signal Blocks to Facilitate Rounding ” on page 30
- “Model Reference Accelerator Mode Support ” on page 31
- “Changes to Simscape Demos” on page 31

Simscape Language Source Protection

Simscape language files can be protected to enable model sharing without disclosing the component or domain source. You can then share the protected (executable) files without disclosing the file content (similar to P-code vs M-code). While Simscape source files have the extension `.ssc`, Simscape protected files have the extension `.sscp`.

Use the `ssc_protect` command to protect individual files and directories.

Use the `ssc_mirror` command to create a protected copy of a whole package, along with a custom block library built from it.

For more information, see “Using Source Protection for Simscape Files”.

Expanded MATLAB Support of Simscape Files

MATLAB support of Simscape files has been expanded:

- If you issue the `open` command on a Simscape file, the file will open in the MATLAB Editor. The Simscape file must be on the MATLAB path, or in a package residing in a directory on the MATLAB path. For more information on packaging Simscape files, see “Organizing Your Simscape Files”.

If you issue the `open` command on a Simscape protected file (`*.sscp`), the corresponding Simscape source file (`*.ssc`) will open, provided it exists in the same directory as the Simscape protected file.

- Issuing the `help` command on a Simscape file displays the domain or component description, that is, all the comments immediately following the domain or component declaration, in the MATLAB Command Window.
- MATLAB Editor now supports syntax highlighting of Simscape files, similar to M-files. For more information, see “Adjust Editor Appearance”.

Viewable and Customizable Source Files for Foundation Library Blocks

You can now view the source files for many Foundation library blocks. When you open the block dialog box, it contains a link:

View source for *BlockName*

Click this link to open the Simscape source file for this block in the MATLAB Editor. To customize the block for your application, edit the source file and save it in a package directory. For more information, see “Simscape File Deployment”.

Compatibility Considerations

The block source has been optimized, with some previously defined but unused variables eliminated. Therefore, when you load an old model containing Foundation blocks, you might get warnings, for example:

```
Warning: In instantiating linked block 'model/R1' : Resistor block (mask) does not have a parameter named 'current_Log'.
```

You can safely ignore these warnings. Once you save the model, the warnings will disappear.

Simscape Language Syntax Changes

The following changes have been implemented in Simscape language:

- The `throughs` keyword has been obsoleted. Use `variables(Balancing=true)` to declare `Through` variables in a domain.
- The `equation` keyword has been changed to `equations`.
- The name of a Simscape file must match the name of the component or domain it defines. If this is not the case, you will get an error when trying to build a library or use the block in a model.

For more information, see the Simscape Language Guide.

Compatibility Considerations

The changes are relatively minor, but may require modifying your existing Simscape files. The following table summarizes the old and new syntax.

Old Syntax	New Syntax
<code>throughs</code>	<code>variables(Balancing=true)</code>
<code>equation</code>	<code>equations</code>

Increased Efficiency of Simscape Language Equations Processing

Simscape language equations are now processed more efficiently, reducing the time required to process equations with multiple `if` statements.

New Physical Signal Blocks to Facilitate Rounding

Three new Physical Signal blocks have been added to the Nonlinear Operators library:

- PS Ceil block performs rounding of the signal toward positive infinity

- PS Floor block performs rounding of the signal toward negative infinity
- PS Fix block performs rounding of the signal toward zero

Model Reference Accelerator Mode Support

Simscape and its add-on products now support Model Reference Accelerator Mode for model simulation, but not for code generation. Model Reference Accelerator Mode for code generation is supported only by SimMechanics and SimDriveline™ software.

Changes to Simscape Demos

The following demo has been added in Version 3.1:

Demo Name

Creating A New Circuit
(ssc_new_elec)

Description

Use this demo as a template for creating a new electrical model. Open the demo and use **File > Save As** to save it under the desired model name. Then delete the unwanted components and add new ones. This demo also opens an Electrical Starter Palette, which contains links to the most often used electrical components.

Version 3.0 (R2008b) Simscape Software

This table summarizes what's new in Version 3.0 (R2008b):

New Features and Changes	Version Compatibility Considerations	Fixed Bugs and Known Problems
Yes Details below	Yes—Details labeled as Compatibility Considerations , below. See also Summary.	Bug Reports Includes fixes

New features and changes introduced in this version are

- “Simscape Language” on page 32
- “Explicit Solvers” on page 33
- “New Ways to Model Variable Chambers” on page 33
- “Model Reference Support ” on page 34
- “More Solver Performance and Robustness Enhancements ” on page 34

Simscape Language

New Simscape language extends the Simscape modeling environment by enabling you to create new components that do not exist in the Foundation library or in any of the add-on products. It is a dedicated textual physical systems modeling language with the following characteristics:

- Derives from MATLAB and familiar to those who use MATLAB
- Contains additional constructs specific to physical modeling and excludes constructs that have nothing to do with physical modeling
- Incorporated into the Simscape modeling interface
- Not focused on algorithm development

The Simscape language is intended to make modeling physical systems easy and intuitive. It lets you create new physical domains and components as textual files and then use them in Simscape block diagrams to model the

desired physical effects. For more information, see the Simscape Language Guide.

Explicit Solvers

It is now possible to choose any variable-step or fixed-step solver for models containing Simscape blocks. Note, however, that implicit solvers, such as ode14x, ode23t, and ode15s, are still a better choice for a typical model. In particular, for stiff systems, implicit solvers typically take many fewer timesteps than explicit solvers, such as ode45, ode113, and ode1.

By default, you will get a warning when using an explicit solver for a model containing Simscape blocks. For models that are not stiff, however, explicit solvers can be effective, often taking fewer timesteps than implicit solvers. Depending on the type of your model, you can configure your preferences to either turn off this warning (if your model is not stiff) or even change it into an error (to avoid inadvertent use of explicit solvers), by using the **Simscape** pane of the Configuration Parameters dialog box.

If you use an explicit solver, it requires time derivatives of the input signals. By default, needed input derivatives are provided by filtering the input through a low-pass filter. The derivative of the filtered input can then be computed by the Physical Networks simulation engine. The new **Derivatives** tab in the Simulink-PS Converter dialog box lets you turn off input filtering and instead provide the first derivative of input as an additional input signal to the Simulink-PS Converter block. For more information, see the Simulink-PS Converter block reference page.

Because input filtering can appreciably change the input signal and drastically affect simulation results if the time constant is too large, a warning is issued when input filtering is used. The warning indicates which Simulink-PS Converter blocks have their input signals filtered. This warning can also be turned off (or changed to an error) by changing the preferences on the **Simscape** pane of the Configuration Parameters dialog box.

New Ways to Model Variable Chambers

There are now two blocks that let you model fluid compressibility in variable chambers:

- Piston Chamber block lets you model fluid compressibility in a chamber created by the piston in a cylinder. It replaces the Variable Volume Chamber block, available in previous releases.
- Variable Chamber block lets you model fluid compressibility in variable volume chambers of any shape. The instantaneous value of the chamber volume is provided by using a physical signal port.

Compatibility Considerations

The Variable Volume Chamber block, available in previous releases, has been deprecated. It has been replaced by the Piston Chamber block in other (structural) blocks and in demos shipped with the product. If you have used the Variable Volume Chamber block in your models, it will continue to work. Going forward, however, use the Piston Chamber block to model fluid compressibility in cylinder chambers.

Model Reference Support

Simscape software now supports the Simulink model referencing functionality in Normal mode. Other Simulink models can now reference Simscape models in normal (non-code-generation) execution. Simscape models continue to be able to reference Simulink models (that do not contain Simscape blocks) in normal execution. See “Limitations” for more details.

More Solver Performance and Robustness Enhancements

Version 3.0 contains multiple further enhancements to simulation algorithms, resulting in improved robustness and reliability.

Version 2.1 (R2008a) Simscape Software

This table summarizes what's new in Version 2.1 (R2008a):

New Features and Changes	Version Compatibility Considerations	Fixed Bugs and Known Problems
Yes Details below	No	Bug Reports Includes fixes

New features and changes introduced in this version are

- “Trimming Now Available for Simscape Models” on page 35
- “Thermal Unit Conversions Now Supported” on page 35
- “Enhancement to Specifying Units” on page 36
- “New Blocks” on page 37
- “Enhancements to Simulation Algorithms” on page 37
- ““What’s This?” Context-Sensitive Help Available for Simulink Configuration Parameters Dialog” on page 37
- “New Simscape Demo” on page 38

Trimming Now Available for Simscape Models

Finding and managing operating points by trimming has been implemented for models that include Simscape and SimHydraulics® blocks. Simulink Control Design™ product is required for using this functionality. For more information, see “Finding an Operating Point” in the Simscape documentation.

Thermal Unit Conversions Now Supported

You can now specify temperature for your thermal models in a variety of units, including degrees Celsius, Fahrenheit, and Rankine. The unit manager automatically handles conversions between thermal units.

Thermal units sometimes require an affine conversion, that is, a conversion that performs both multiplication and addition. In situations when you deal

with a relative, rather than absolute, temperature, you need to convert using just the linear term. Thermodynamic variables in block dialogs are automatically tagged as appropriate and handled by the unit manager. However, when an input or output signal is related to thermodynamic variables and contains units of temperature, you must decide whether affine conversion needs to be applied. The Simulink-PS Converter and PS-Simulink Converter block dialogs now contain the **Apply affine conversion** checkbox. If you select it, the unit manager uses the affine conversion, otherwise it applies the default linear conversion.

For more information, see “Thermal Unit Conversions” in the Simscape documentation, as well as the Simulink-PS Converter and PS-Simulink Converter block reference pages.

The `pm_addunit` command has also been modified to support affine conversions. Its second argument, `conversion`, may now be either a positive real scalar or a 1x2 array. If this argument has two elements, then it is specifying an affine conversion, with the first element (a positive real number) being the linear conversion coefficient, and the second being the offset.

Enhancement to Specifying Units

Simscape block dialogs have drop-down combo boxes for units next to a parameter value. You can either select a unit from the drop-down list, or type a commensurate unit name (or a mathematical expression with unit names) directly into the units combo box of the block dialog. For more information, see “How to Specify Units in Block Dialog Boxes” in the Simscape documentation.

Similarly, the Simulink-PS Converter and PS-Simulink Converter block dialogs now contain a drop-down list, which is prepopulated with some common input or output units. You can either select a unit from the list or type a unit name, or a mathematical expression with unit names. Note that you must still match the unit type:

- For a PS-Simulink Converter block, these units must be commensurate with the units of the input physical signal coming into the block.
- Signal units that you specify in a Simulink-PS Converter block must match the input type expected by the Simscape block connected to it.

New Blocks

Version 2.1 contains two new blocks:

- Gyration block in the Electrical Elements library simulates an ideal gyrator, which can be used to implement an inductor with a capacitor.
- PS Abs block in the Physical Signals library returns absolute value of input signal.

Enhancements to Simulation Algorithms

Version 2.1 contains multiple enhancements to simulation algorithms, resulting in improved robustness and reliability.

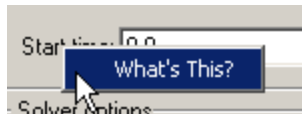
“What’s This?” Context-Sensitive Help Available for Simulink Configuration Parameters Dialog

R2008a introduces “What’s This?” context-sensitive help for parameters that appear in the Simulink Configuration Parameters dialog, including those on the **Simscape** pane. This feature provides quick access to a detailed description of the parameters, saving you the time it would take to find the information in the Help Browser.

To use the “What’s This?” help, do the following:

- 1 Place your cursor over the label of a parameter.
- 2 Right-click. A **What’s This?** context menu appears.

For example, the following figure shows the **What’s This?** context menu appearing after a right-click on the **Start time** parameter in the **Solver** pane.



- 3 Click **What’s This?**. A context-sensitive help window appears showing a description of the parameter.

New Simscape Demo

The following demo has been added in Version 2.1:

Demo Name

House Heating System
(ssc_house_heating_system)

Description

The demo represents a simple house heating system consisting of a heater, thermostat, and a house structure with four thermally distinguishable parts: inside air, house walls, windows, and roof. You can investigate system behavior with the heating system turned on or off, and plot the heat cost and indoor versus outdoor temperatures.

Version 2.0 (R2007b) Simscape Software

This table summarizes what's new in Version 2.0 (R2007b):

New Features and Changes	Version Compatibility Considerations	Fixed Bugs and Known Problems
Yes Details below	No	Bug Reports Includes fixes

New features and changes introduced in this version are

- “Code Generation Now Available for Simscape Models” on page 39
- “New Thermal Block Libraries ” on page 39
- “Additional Physical Signal Blocks” on page 40
- “Improved Simulation Performance ” on page 40
- “New Simscape Demos” on page 41

Code Generation Now Available for Simscape Models

Code generation has been implemented for models that include Simscape and SimHydraulics blocks. For more information, see “Code Generation ” in the Simscape documentation.

New Thermal Block Libraries

Version 2.0 contains new block libraries of fundamental thermal elements, sensors, and sources:

- Conductive Heat Transfer
- Convective Heat Transfer
- Radiative Heat Transfer
- Thermal Mass
- Thermal Reference
- Ideal Heat Flow Source

- Ideal Heat Flow Sensor
- Ideal Temperature Source
- Ideal Temperature Sensor

Additional Physical Signal Blocks

The new Physical Signal blocks introduced in Version 2.0 are listed below:

- PS Constant
- PS Math Function
- PS Max
- PS Min
- PS Sign

Improved Simulation Performance

In Version 2.0, various solver improvements have led to improved simulation performance:

- Enhanced handling of dependent dynamic states (higher-index DAEs)

Simscape can now handle dependencies among the dynamic states as long as they are linear in the states and independent of time and inputs. This allows you, for example, to connect capacitors in parallel (even with their parasitic series resistances set to 0), inductors in series, and so on.

- Significant reduction of the number of equations, which substantially increased simulation speed

The typical speedup of your models is between 5 and 10 times. There are some models that are below and above this range. Also, the number of states and equations changed between releases. This means that you will have to reset any calculations that relied on the states (such as initial state setting).

The changes to the simulation technology are significant. You may find that some of your models may require different or tighter tolerances to converge, while others will require no change. Refer to the troubleshooting section in the User's Guide for help in finding the cause of a problem if simulation failed.

New Simscape Demos

The following demos have been added in Version 2.0:

Demo Name

DC Motor Thermal Circuit
(ssc_dc_motor_thermal_circuit)

Round Rod Heat Conduction
(ssc_round_rod_heat_conduction)

Description

The demo illustrates how the thermal behavior of a motor can be simulated in lumped parameters.

The demo illustrates the usage of thermal blocks for developing a model of a long iron rod that is heated with a heat source through its left face. The right face and the outer cylindrical surface are open to atmosphere, with a force heat convection.

Version 1.0 (R2007a) Simscape Software

This table summarizes what's new in Version 1.0 (R2007a):

New Features and Changes	Version Compatibility Considerations	Fixed Bugs and Known Problems
Yes Details below	Yes—Details labeled as Compatibility Considerations , below. See also Summary.	Bug Reports

New features introduced in this version are described here.

Product Introduction

Simscape software extends the Simulink product line with tools for modeling and simulating multidomain physical systems. It enables you to describe multidomain physical systems containing mechanical, hydraulic, and electrical components as physical networks.

Simscape key features are:

- Single modeling environment for modeling and simulating physical systems, such as mechanical, electrical, and hydraulic systems
- Foundation library of physical modeling building blocks and fundamental mathematical elements
- Connection blocks to bridge modeling domains
- Full simulation and limited editing capabilities for models built with SimMechanics, SimDriveline, or SimHydraulics blocks (no license for these products required as long as the products are installed)
- Ability to specify units of parameters and variables, with all unit conversion handled automatically

Simscape software can be used for a variety of automotive, aerospace, defense, and industrial equipment applications. Together with SimMechanics, SimDriveline, SimHydraulics, and SimPowerSystems™

(all available separately), Simscape lets you model complex interactions in electromechanical and hydromechanical systems.

Block Libraries Moved from SimHydraulics to Simscape

The Foundation and Utilities block libraries that used to be included in SimHydraulics (V1.0 and V1.1) are now part of Simscape product.

Compatibility Considerations

Several blocks that used to be in SimHydraulics V1.1 and are now part of Simscape software have undergone changes that have compatibility impact. These blocks are:

- Fluid Inertia
- Inertia
- Mass
- PS Integrator
- Rotational Spring
- Translational Spring

Each of these blocks has a parameter that specifies the initial condition for use in computing the block's initial state at the beginning of a simulation run. In this version, there is a difference in the way these initial conditions are computed, and as a result, the blocks work differently than they used to in the previous version. For details, see the block reference pages.

Compatibility Summary for Simscape Software

This table summarizes new features and changes that might cause incompatibilities when you upgrade from an earlier version, or when you use files on multiple versions. Details are provided in the description of the new feature or change.

Version (Release)	New Features and Changes with Version Compatibility Impact
Latest Version V3.7 (R2012a)	See the Compatibility Considerations subheading for this new feature or change: <ul style="list-style-type: none"> • “Input Filtering Usability Enhancements” on page 5
V3.6 (R2011b)	None
V3.5 (R2011a)	See the Compatibility Considerations subheading for these new features or changes: <ul style="list-style-type: none"> • “Improved Scalability” on page 11 • “Change in Evaluating Unit Expressions” on page 12
V3.4 (R2010b)	See the Compatibility Considerations subheading for these new features or changes: <ul style="list-style-type: none"> • “Simulation Data Logging Enhancements” on page 13 • “Component Descriptor Is No Longer Inherited from the Base Class” on page 15

Version (Release)	New Features and Changes with Version Compatibility Impact
V3.3 (R2010a)	<p>See the Compatibility Considerations subheading for this new feature or change:</p> <ul style="list-style-type: none"> • “Placing Simscape Blocks in Nonvirtual Subsystems” on page 20
V3.2 (R2009b)	<p>See the Compatibility Considerations subheading for these new features or changes:</p> <ul style="list-style-type: none"> • “Pneumatic Blocks Added to Foundation Library” on page 22 • “Physical Port Rotation for Simscape Blocks” on page 26
V3.1 (R2009a)	<p>See the Compatibility Considerations subheading for these new features or changes:</p> <ul style="list-style-type: none"> • “Viewable and Customizable Source Files for Foundation Library Blocks” on page 29 • “Simscape Language Syntax Changes” on page 30
V3.0 (R2008b)	<p>See the Compatibility Considerations subheading for this new feature or change:</p> <ul style="list-style-type: none"> • “New Ways to Model Variable Chambers” on page 33
V2.1 (R2008a)	None
V2.0.1 (R2007b+)	None

Version (Release)	New Features and Changes with Version Compatibility Impact
V2.0 (R2007b)	None
V1.0 (R2007a)	See the Compatibility Considerations subheading for this new feature or change: <ul style="list-style-type: none"><li data-bbox="872 508 1298 600">• “Block Libraries Moved from SimHydraulics to Simscape” on page 43