

# **SimHydraulics® Release Notes**

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*SimHydraulics*<sup>®</sup> *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.

<b>Version (Release)</b>	<b>New Features and Changes</b>	<b>Version Compatibility Considerations</b>	<b>Fixed Bugs and Known Problems</b>
<b>Latest Version V1.10.1 (R2012a)</b>	No	No	Bug Reports Includes fixes
V1.10 (R2011b)	Yes Details	No	Bug Reports
V1.9 (R2011a)	Yes Details	No	Bug Reports Includes fixes
V1.8 (R2010b)	Yes Details	No	Bug Reports Includes fixes
V1.7 (R2010a)	Yes Details	Yes Summary	Bug Reports
V1.6 (R2009b)	Yes Details	No	Bug Reports Includes fixes
V1.5 (R2009a)	Yes Details	No	Bug Reports Includes fixes
V1.4 (R2008b)	Yes Details	No	Bug Reports
V1.3 (R2008a)	Yes Details	No	Bug Reports Includes fixes

<b>Version (Release)</b>	<b>New Features and Changes</b>	<b>Version Compatibility Considerations</b>	<b>Fixed Bugs and Known Problems</b>
V1.2.1 (R2007b)	Yes Details	No	Bug Reports
V1.2 (R2007a)	Yes Details	Yes Summary	Bug Reports Includes fixes
V1.1 (R2006b)	Yes Details	No	Bug Reports Includes fixes
V1.0 (R2006a+)	Yes Details	Not applicable	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](http://mathworks.com) for the latest release and for previous releases:

- Latest product documentation
- Archived documentation

## Version 1.10.1 (R2012a) SimHydraulics Software

This table summarizes what's new in Version 1.10.1 (R2012a):

<b>New Features and Changes</b>	<b>Version Compatibility Considerations</b>	<b>Fixed Bugs and Known Problems</b>
No	No	Bug Reports Includes fixes



## Version 1.10 (R2011b) SimHydraulics Software

This table summarizes what's new in Version 1.10 (R2011b):

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

New features and changes introduced in this version are

- “New Gate Valve Block” on page 5
- “Swash Plate Block Enhancement” on page 5
- “Segmented Pipe Block Enhancement” on page 5

### New Gate Valve Block

The new Gate Valve block in the Flow Control Valves library models a valve consisting of a round orifice in the valve housing and a flat gate, which moves perpendicular to the orifice axis. The orifice in the gate has the same diameter as the orifice in the housing. As the gate moves, it opens or closes the valve passage. The flow rate through the valve is proportional to the orifice opening and to the pressure differential across the orifice.

### Swash Plate Block Enhancement

The Swash Plate block in the Pumps and Motors library now has the **Piston offset from the plate** parameter, which lets you specify the offset between the piston tip and the plate. The default value is 0, which corresponds to the block implementation in the previous version.

### Segmented Pipe Block Enhancement

Additional parameters in the Segmented Pipeline block let you specify the initial condition for pressure inside the pipe segments. You have two options:

- **The same initial pressure for all nodes** — The initial pressure in all pipe segments is the same, and is specified by the **Initial pressure** parameter value. This is the default.
- **Custom** — Lets you specify initial pressure individually for each pipe segment, by using the **Initial pressure vector** parameter. The vector size must be equal to the number of pipe segments, defined by the **Number of segments** parameter value.

## Version 1.9 (R2011a) SimHydraulics Software

This table summarizes what's new in Version 1.9 (R2011a):

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

- “New Swash Plate Block” on page 7
- “New Porting Plate Variable Orifice Block” on page 7
- “New Angle Sensor Block” on page 7
- “Changes to SimHydraulics Demos” on page 8

### New Swash Plate Block

The new Swash Plate block in the Pumps and Motors library models a swash plate mechanism used in axial-piston machines to convert translational motion of a piston into rotational motion of a drive shaft. For details, see the block reference page and the new Hydraulic Axial-Piston Pump with Load-Sensing and Pressure-Limiting Control (sh\_hydraulic\_axial\_piston\_pump) demo.

### New Porting Plate Variable Orifice Block

The new Porting Plate Variable Orifice block in the Pumps and Motors library models a variable orifice located between the piston chamber and a crescent-shaped slot on a porting plate in hydraulic axial-piston machines. For details, see the block reference page and the new Hydraulic Axial-Piston Pump with Load-Sensing and Pressure-Limiting Control (sh\_hydraulic\_axial\_piston\_pump) demo.

### New Angle Sensor Block

The new Angle Sensor block in the Pumps and Motors library models an ideal angle sensor with measuring range from zero to 360 degrees. With

the sensor probe connected to a mechanical rotational port, the output is a value between 0 and  $2\pi$ , regardless of the number of revolutions performed by the probe and direction of rotation. For an example of block usage, see the new Hydraulic Axial-Piston Pump with Load-Sensing and Pressure-Limiting Control (sh\_hydraulic\_axial\_piston\_pump) demo.

## Changes to SimHydraulics Demos

The following demo has been added in Version 1.9:

### Demo Name

Hydraulic Axial-Piston Pump with Load-Sensing and Pressure-Limiting Control  
(sh\_hydraulic\_axial\_piston\_pump)

### Description

The demo models a test rig designed to investigate interaction between an axial-piston pump and a typical control unit, simultaneously performing the load-sensing and pressure-limiting functions. To assure required accuracy, the model of the pump must account for such features as interaction between pistons, swash plate, and porting plate, which makes it necessary to build a detailed pump model.

## Version 1.8 (R2010b) SimHydraulics Software

This table summarizes what's new in Version 1.8 (R2010b):

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

- “New Jet Pump Block” on page 9
- “Hydraulic Pipeline Block Enhancement” on page 9
- “Changes to SimHydraulics Demos” on page 9

### New Jet Pump Block

The new Jet Pump block in the Pumps and Motors library models a jet liquid-liquid pump operating with identical primary and secondary fluids containing no gas. For details, see the block reference page and the new Well Jet Pump (sh\_well\_jet\_pump) demo.

### Hydraulic Pipeline Block Enhancement

The Hydraulic Pipeline block now contains an additional parameter that lets you set the initial pressure inside the pipe at the start of simulation. See the block reference page for details.

### Changes to SimHydraulics Demos

The following demos have been added in Version 1.8:

**Demo Name**

Rotating Hydraulic Actuator  
(sh\_rotating\_hydraulic\_actuator)

Well Jet Pump  
(sh\_well\_jet\_pump)

**Description**

Simulates a typical hydraulic cylinder actuator used to operate friction clutches, brakes and other devices installed on rotating shafts.

Simulates a well jet pump installation, consisting of a surface-mounted centrifugal pump and a jet pump installed in the well below water level.

## Version 1.7 (R2010a) SimHydraulics Software

This table summarizes what's new in Version 1.7 (R2010a):

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

New features and changes introduced in this version are

- “Simplified Blocks for Real-Time Simulation” on page 11
- “Low-Pressure Blocks with Variable Elevations” on page 12
- “Cartridge Valve Modeling Blocks ” on page 12
- “Lubrication System Modeling Blocks” on page 13
- “Centrifugal Pump Enhancement” on page 13
- “Initial Piston Position in the Single-Acting Hydraulic Cylinder Block” on page 13
- “Changes to SimHydraulics Demos” on page 14

### Simplified Blocks for Real-Time Simulation

The following new blocks implement simplified models that reproduce only basic functionality in exchange for better numerical efficiency:

- Single-Acting Hydraulic Cylinder (Simple) block represents a simplified version of a single-acting hydraulic cylinder. The model assumes fluid compressibility, friction, and leakages to be negligible. The hard stops are assumed to be fully inelastic, to eliminate any possible oscillations at the end of the stroke.
- Double-Acting Hydraulic Cylinder (Simple) block represents a simplified version of a double-acting hydraulic cylinder. The model assumes fluid compressibility, friction, and leakages to be negligible. The hard stops

are assumed to be fully inelastic, to eliminate any possible oscillations at the end of the stroke.

- 4-Way Ideal Valve block represents a 4-way critically-centered valve. Initial openings of all orifices are set to 0, which significantly simplifies the model.
- Valve Actuator block represents a simplified version of a valve actuator, built as a first-order lag.

Use these blocks for real-time and HIL (hardware-in-the-loop) simulation, if such simplifications are acceptable.

## **Low-Pressure Blocks with Variable Elevations**

Additional blocks in the Low-Pressure Blocks library incorporate elevation information and let you specify elevations as input signals, rather than as block parameters:

- Resistive Pipe LP with Variable Elevation block represents a hydraulic pipeline which accounts for friction losses and port elevations.
- Hydraulic Pipe LP with Variable Elevation block represents a hydraulic pipeline with resistive, fluid compressibility, and elevation properties.

Use these blocks for low-pressure system simulation in which the pipe ends change their positions with respect to the reference plane.

## **Cartridge Valve Modeling Blocks**

Two new blocks extend the cartridge valve modeling capabilities:

- Cartridge Valve Insert with Conical Seat block represents an insert of a hydraulic cartridge valve consisting of a poppet interacting with the conical seat.
- Hydraulic 4-Port Cartridge Valve Actuator block represents double-acting hydraulic valve actuator driven by four pressures. Use this block as a pilot actuator for cartridge valves, as well as pilot-operated pressure and control valves, in applications where all the forces, except spring and pressure forces, and flow consumption can be neglected.



There are also additional parameters in the Hydraulic Cartridge Valve Actuator block that account for initial conditions and dynamic properties of the model. See the block reference page for details.

## Lubrication System Modeling Blocks

The following blocks have been added to facilitate modeling lubrication systems:

- Centrifugal Force in Rotating Cylinder block simulates centrifugal forces exerted by fluid on a piston if the cylinder rotates about its symmetry axis. Such cylinders are used in control mechanisms of various friction clutches, brakes, square-jaw positive clutches, dog clutches, and so on. No inertial effects are considered in the model. In other words, the angular velocity is assumed to be constant or changing at very low speed.
- Rotating Pipe block models a hydraulic pipeline represented as a short bore drilled through a shaft at some angle to its axis, or as a short pipe that connects actuator or bearings, mounted on the shaft, with the channel inside the shaft. Such connections are typical for lubrication systems and for hydraulically-operated clutches and mechanisms. The shaft angular velocity is assumed to be constant or changing at very low speed.

## Centrifugal Pump Enhancement

The Centrifugal Pump block now contains additional parameters that let you simulate operation at zero angular velocity. See the block reference page for details.

## Initial Piston Position in the Single-Acting Hydraulic Cylinder Block

The **Piston initial position** parameter in the block dialog box has been renamed to **Initial distance between piston and cap**, and the way it is used in the block output has been changed.

In previous versions, the **Piston initial position** parameter let you specify the distance that the piston is extended at the beginning of simulation by setting the piston initial position to any point within its stroke, but this value was not included in calculating the rod displacement. In other words, the

rod displacement output at the block's physical signal port was with respect to the initial piston position.

In the current version, the **Initial distance between piston and cap** parameter value is included in calculating the rod displacement output by the block:

$$x_{pst} = x_0 + x_p$$

where

$x_{pst}$	Rod displacement output by the physical signal port
$x_0$	Initial distance between piston and cap
$x_p$	Rod displacement with respect to its initial position

For details, see the block reference page.

### **Compatibility Considerations**

The block output changes because of the new way it calculates rod displacement. It used to start out at zero but now starts out at the initial position. If you have used this block with nonzero initial position in your models, the block output will differ by this value:

$$x_{new} = x_0 + x_{old}$$

where

$x_{new}$	Rod displacement output by the physical signal port in the current version
$x_{old}$	Rod displacement output by the physical signal port in the previous version
$x_0$	Piston initial position value

### **Changes to SimHydraulics Demos**

The following demos have been added in Version 1.7:

**Demo Name**

Diesel Engine In-Line Injection System  
(sh\_diesel\_engine\_in\_line\_injection\_system)

Fuel Supply System with Variable Elevation  
(sh\_fuel\_supply\_system\_with\_variable\_elevations)

Hydraulic Actuation System with Cartridge Valves  
(sh\_actuation\_system\_cartridge\_valve)

Hydraulic Closed-Loop Actuator with Fixed-Step  
Integration  
(sh\_hydraulic\_closed\_loop\_actuator\_fixed\_step)

**Description**

Simulates an in-line multi-element injection system. The objective of the simulation is to investigate the entire system operation.

Simulates a three-tank fuel supply system where side tanks periodically change elevations during the simulation cycle.

Simulates a complex actuation system equipped with cartridge valves.

Represents two versions of the same closed-loop hydraulic actuator. In the second version, standard SimHydraulics® blocks are replaced with their simplified versions and the model is optimized for fixed-step integration.

## Version 1.6 (R2009b) SimHydraulics Software

This table summarizes what's new in Version 1.6 (R2009b):

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

- “Additional 4-Way and 6-Way Directional Valve Configurations” on page 16
- “Additional Low-Pressure Blocks” on page 16
- “New Ball Valve with Conical Seat Block” on page 17

### Additional 4-Way and 6-Way Directional Valve Configurations

Nine 4-way directional valve blocks and one 6-way directional valve block have been added to the Directional Valves library, and the original 4-Way Directional Valve block has been modified, to enable additional valve configurations. For more information, see “Modeling Directional Valves”, as well as individual block reference pages.

### Additional Low-Pressure Blocks

The following blocks have been added to the Low-Pressure Blocks library:

- Variable Head Two-Arm Tank block represents a tank with constant pressurization and volume-dependent fluid level. The tank has two hydraulic ports and a physical signal port, which exports the volume of fluid in the tank.
- Variable Head Three-Arm Tank block represents a tank with constant pressurization and volume-dependent fluid level. The tank has three hydraulic ports and a physical signal port, which exports the volume of fluid in the tank.

Both blocks account for the fluid level change caused by the volume variation, as well as for pressure loss in the connecting pipes that can be caused by a filter, fittings, or some other local resistance. You can specify pipeline diameter, pressure loss coefficient, and elevation information for each hydraulic port separately.

### **New Ball Valve with Conical Seat Block**

The new Ball Valve with Conical Seat block in the Flow Control Valves library models a ball valve created by a spherical ball and a conical seat. The valve is characterized by the ball diameter, cone angle, and orifice diameter.

## Version 1.5 (R2009a) SimHydraulics Software

This table summarizes what's new in Version 1.5 (R2009a):

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

- “New Low-Pressure Blocks Library” on page 18
- “Changes to SimHydraulics Demos” on page 19

### New Low-Pressure Blocks Library

The Low-Pressure Blocks library, added in this release, contains five new blocks that incorporate elevation information:

- Constant Head Tank block represents a tank where pressurization and fluid level remain constant regardless of volume change. The block accounts for the fluid level elevation with respect to the tank bottom, as well as for pressure loss in the connecting pipe that can be caused by a filter, fittings, or some other local resistance.
- Variable Head Tank block represents a tank with constant pressurization and volume-dependent fluid level. The block accounts for the fluid level change caused by the volume variation, as well as for pressure loss in the connecting pipe that can be caused by a filter, fittings, or some other local resistance.
- Resistive Pipe LP block represents a hydraulic pipeline which accounts for friction losses and port elevations.
- Hydraulic Pipe LP block represents a hydraulic pipeline with resistive, fluid compressibility, and elevation properties.
- Segmented Pipe LP block represents a hydraulic pipeline with resistive, fluid inertia, fluid compressibility, and elevation properties.

These blocks enable additional applications, such as low-pressure fluid transportation system simulation.

## Changes to SimHydraulics Demos

The following demos have been added in Version 1.5:

<b>Demo Name</b>	<b>Description</b>
Water Supply System (sh_water_supply_system)	The water supply system modeled in the demo consists of three pumping stations located at 45, 25, and 30 m with respect to the reference plane, respectively. All three stations are expected to pump water in a tank located at 61 m. The objective of simulation is to determine steady-state flow rates and pressures.
Fluid Transportation System with Three Tanks (sh_three_tanks)	The demo illustrates a classical problem of fluid transportation: to determine flow rates, pressures, and fluid volumes in a system built of three constant head tanks. The tanks are located at different elevations and connected with pipelines combined together in a common node. The pipelines are simulated with the Segmented Pipeline LP block, which accounts for hydraulic losses, fluid inertia, and the head due to different node elevations.

## Version 1.4 (R2008b) SimHydraulics Software

This table summarizes what's new in Version 1.4 (R2008b):

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

- “Explicit Solvers Now Available for SimHydraulics Models” on page 20
- “New Variable-Displacement Hydraulic Machine Block” on page 20
- “Improved Usability of the 4-Way Directional Valve Block” on page 21
- “Changes to SimHydraulics Demos” on page 21

### Explicit Solvers Now Available for SimHydraulics Models

Using explicit solvers has been implemented for models that include Simscape™ and SimHydraulics blocks. For more information, see “Setting Up Solvers for Physical Models” in the Simscape documentation.

### New Variable-Displacement Hydraulic Machine Block

The Variable-Displacement Hydraulic Machine block, able to work as a pump or a motor, enables modeling variable-efficiency machines based on manufacturer's data sheets. The machine displacement is controlled by the signal provided through the physical signal port C. The machine efficiency is simulated by implementing regime-dependable leakage and friction torque based on the experimentally established correlations between the machine efficiencies and pressure, angular velocity, and displacement.



## Improved Usability of the 4-Way Directional Valve Block

The 4-Way Directional Valve block dialog box has been reorganized using tabs to improve usability. Use the **Initial openings** tab to set all the initial orifice openings. The **Basic parameters** tab contains the model parameterization options and the corresponding parameters. The parameters themselves have not changed.

## Changes to SimHydraulics Demos

The following demos have been added in Version 1.4:

### Demo Name

Hydraulic Drill-Ream Actuator  
(sh\_drill\_ream\_actuator)

Front-Loader Actuation System  
(sh\_front\_loader\_actuation\_system)

Pipeline System with Centrifugal Pump  
(sh\_pipeline\_system\_centrifugal\_pump)

### Description

The actuator is intended to drive a machine tool working unit performing a sequence of three technological operations: coarse drilling, fine drilling, and reaming. The actuator speed is controlled by one of three pressure-compensated flow control valves metering out return flow from the cylinder. The selection of an appropriate flow control is performed by directional valves that are activated by a control unit.

The model shows a simplified version of an actuation system consisting of the lift and tilt cylinders. Each of the cylinders is controlled by an open center, 5-way, 3-position directional valve. The valves are connected in series through their unloading branch in such a way that the system pump is unloaded when both command levers are in neutral position. If either tilt or lift command is applied, the unloading path is closed.

The demo represents a typical pipeline system with the centrifugal pump. The system is built of three manifolds connected with hoses. The combination of valves installed inside manifolds allows flow rate to be directed

through different branches. The manifold models account for local resistances, elbows, and cylindrical channels.

Also, the Variable Volume Chamber Test Rig (sh\_variable\_chamber\_test\_rig) demo has been renamed to Variable Volume Piston Chamber Test Rig, and all the Variable Volume Chamber blocks in it have been replaced with Piston Chamber blocks.

## Version 1.3 (R2008a) SimHydraulics Software

This table summarizes what's new in Version 1.3 (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 SimHydraulics Models” on page 23
- “New Cartridge Valve Insert and Hydraulic Cartridge Valve Actuator Blocks” on page 23
- “Additional Configurations for the Centrifugal Pump Block” on page 24
- “Additional Fluids Available in the Hydraulic Fluid Block” on page 24

### Trimming Now Available for SimHydraulics 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 Trimming Simscape Models in the Simscape documentation.

### New Cartridge Valve Insert and Hydraulic Cartridge Valve Actuator Blocks

Two new blocks facilitate modeling cartridge valves:

- Cartridge Valve Insert block in the Directional Valves library represents an insert of a hydraulic cartridge valve consisting of a poppet interacting with the sleeve seat. The poppet position is determined by pressures at ports A, B, and X and force of the spring. This is a structural model based on a Variable Orifice block and a Hydraulic Cartridge Valve Actuator block, described below.

- Hydraulic Cartridge Valve Actuator block in the Valve Actuators library represents a double-acting hydraulic valve actuator driven by three pressures. Use this block as a pilot actuator for cartridge valves, as well as pilot-operated pressure and control valves in applications where all the forces, except spring and pressure forces, and flow consumption can be neglected.

## **Additional Configurations for the Centrifugal Pump Block**

The Centrifugal Pump block represents a centrifugal pump of any type as a data-sheet-based model. Depending on data listed in the manufacturer's catalogs or data sheets for your particular pump, you can now choose one of the following model parameterization options:

- **By approximating polynomial** — Provide values for the polynomial coefficients. These values can be determined analytically or experimentally, depending on the data available. This is the default method, equivalent to the implementation available in the previous release.
- **By two 1D characteristics: P-Q and N-Q** — Provide tabulated data of pressure differential and brake power versus pump delivery characteristics. The pressure differential and brake power are determined by one-dimensional table lookup. You have a choice of three interpolation methods and two extrapolation methods.
- **By two 2D characteristics: P-Q-W and N-Q-W** — Provide tabulated data of pressure differential and brake power versus pump delivery characteristics at different angular velocities. The pressure differential and brake power are determined by two-dimensional table lookup. You have a choice of three interpolation methods and two extrapolation methods.

## **Additional Fluids Available in the Hydraulic Fluid Block**

The following predefined fluids have been added to the Hydraulic Fluid block:

- ISO VG 22 (ESSO UNIVIS N 22)
- ISO VG 46 (ESSO UNIVIS N 46)
- Brake fluid DOT3

- Brake fluid DOT4
- Brake fluid DOT5
- Water

See the block reference page for more information. The “Examples” section shows how you can get information on the fluids and their properties.

## Version 1.2.1 (R2007b) SimHydraulics Software

This table summarizes what's new in Version 1.2.1 (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 described here:

### Code Generation Now Available for SimHydraulics Models

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

## Version 1.2 (R2007a) SimHydraulics Software

This table summarizes what's new in Version 1.2 (R2007a):

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

New features and changes introduced in this version are

- “SimHydraulics Now Requires Simscape” on page 27
- “Block Libraries Moved from SimHydraulics to Simscape” on page 27
- “Sharing Models Using the Simscape Editing Modes” on page 28
- “New SimHydraulics Blocks” on page 28
- “Initial Conditions Added for Certain Blocks” on page 28
- “Block Library Links Must Be Resolved” on page 29
- “Changes to SimHydraulics Demos” on page 30

### SimHydraulics Now Requires Simscape

SimHydraulics now depends on and requires Simscape, the platform for all Physical Modeling products, which includes common Physical Modeling utilities and block libraries.

### 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.

## Sharing Models Using the Simscape Editing Modes

When working with SimHydraulics models, you now have a selection of two Simscape editing modes that allow full or restricted editing of models.

- The Restricted mode requires SimHydraulics software to be installed, but does not require a license. It allows you change a limited set of model parameters, but not the blocks or connections, in a SimHydraulics model.
- The Full mode requires SimHydraulics software to be installed with a license. It allows you to change anything in a SimHydraulics model.

## New SimHydraulics Blocks

The new blocks introduced in Version 1.2 are listed below:

- Centrifugal Pump
- Single-Acting Rotary Actuator
- Double-Acting Rotary Actuator
- Hydraulic Single-Acting Valve Actuator
- Hydraulic Double-Acting Valve Actuator
- Valve Hydraulic Force
- Spool Orifice Hydraulic Force

## Initial Conditions Added for Certain Blocks

Several blocks now have a parameter that specifies the initial condition for use in computing the block's initial state at the beginning of a simulation run. Note that some of these blocks, which used to be included in SimHydraulics (V1.0 and V1.1), are now part of Simscape product. The following is a complete list of blocks where you can specify an initial condition through the block dialog box:

- Gas-Charged Accumulator
- Spring-Loaded Accumulator
- Constant Volume Chamber
- Variable Volume Chamber



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

For details, see the block reference pages.

### **Compatibility Considerations**

In this version, there is a difference in the way the initial conditions are computed, and as a result, the blocks that have an initial condition parameter work differently than they used to in the previous version.

### **Block Library Links Must Be Resolved**

All SimHydraulics blocks in your models must now have resolved block library links. You can neither disable nor break these library links. This is a global requirement of Simscape modeling environment. Consult the Simscape documentation for further details.

### **Compatibility Considerations**

If you have an existing SimHydraulics model with disabled or broken links from SimHydraulics blocks to the SimHydraulics block library, you must restore all the broken block library links for your model to be valid.

If you have disabled or broken the SimHydraulics library link for blocks that you have customized and want to keep these modified blocks in your model, you must move these modified blocks to your own custom library or libraries, then copy the block instances that you need to your model.

You must still restore the block link to its parent library, whether that parent library is SimHydraulics or your own.

## Changes to SimHydraulics Demos

The following demos have been added in Version 1.2:

Demo Name	Description
Hydraulic Actuator with Two-Chamber Snubbers (sh_actuator_with_2_chamber_snubbers)	The reciprocal actuator demonstrated in this model is equipped with snubbers (cushions) on both sides of the cylinder.
Digital Hydraulic Actuator (sh_digital_hydraulic_actuator)	The digital hydraulic actuator consists of three double-acting cylinders mounted in the same shell and interconnected through the hard stops.
Hydraulic Actuator with Load-Sensing Variable-Displacement Pump (sh_hydraulic_actuator_load_sensing_pump)	The circuit demonstrates usage of a load-sensing and pressure-limiting unit in a conventional reciprocal system with variable load on the forward stroke.
Hydraulic Actuator with Telescopic Cylinder (sh_hydraulic_actuator_tlescopic_cylinder)	The actuator is built around a telescopic hydraulic cylinder, which is equipped with three rods interacting with each other through hard stops.
Closed-Circuit Reciprocal Actuator (sh_hydraulic_closed_circuit_reciprocal_actuator)	The demo illustrates a closed-circuit hydraulic actuator driven by a variable-velocity electrical motor.
Power-Assisted Steering Mechanism (sh_hydraulic_power_assisted_steering)	The model represents a simplified version of a power-assisted steering mechanism showing all its major parts.
Hydraulic System with Servo-Valve (sh_hydraulic_system_with_servo_valve)	The demo represents the model of a two-stage servo-valve with a 4-way, 3-position spool valve in the power stage and a flapper-nozzle amplifier in the pilot stage.
Hydraulic Transmission with Secondary Control (sh_hydraulic_transmission_secondary_control)	The system demonstrates usage of the so-called <i>secondary control</i> in hydrostatic transmissions with a variable-displacement motor.
Hydrostatic Transmission with Shuttle Valve (sh_hydrostatic_transmission_shuttle_valve)	The circuit demonstrates a hydrostatic transmission with a shuttle valve in the control unit.

Hydraulic Circuit with Load-Sensing Velocity Control (sh_load_sensing_velocity_control)	The circuit is equipped with the load-sensing velocity regulator installed between the pump and directional valve.
Oscillating Hydraulic Mechanism (sh_oscillating_hydraulic_mechanism)	The oscillating hydraulic mechanism consists of a single-acting hydraulic rotary actuator, winch, flow control valve, two-position electrohydraulic valve, and power and control units.
Reciprocal Actuator with Counterbalance Valves (sh_reciprocal_actuator_cntrb_valves)	The actuator is built of a double-acting cylinder, directional valve, flow control, block of counterbalance valves, power unit, replenishment arrangement, and a control unit.
Sequencing Circuit with Rotary Actuators (sh_sequencing_circuit_rotary_actuators)	The sequence circuit is based on four check valves installed in both pressure and return lines of the second rotary actuator.

The following demos that used to be in SimHydraulics 1.1 are now part of Simscape product:

<b>Demo Name</b>	<b>Description</b>
Simple Mechanical System (ssc_simple_mechanical_system)	This model is built of both rotational and translational mechanical blocks to illustrate their use in a system.
Mechanical System with Translational Friction (ssc_mechanical_system_translational_friction)	The demo illustrates a mass loaded with a spring and viscous damper.
Mechanical System with Translational Hard Stop (ssc_mechanical_system_translational_hardstop)	The demo illustrates two masses interacting through a hard stop.

Mechanical Rotational System with Stick-Slip Motion  
(ssc\_rot\_system\_stick\_slip)

This model demonstrates a mechanical rotational system, where a load is driven by a velocity source with a friction element between them, and stick-slip motion is developed in the regions of constant velocities.

Linkage Mechanism  
(ssc\_linkage\_mechanism)

The model demonstrates the use of the Lever block in a linkage mechanism.

## Version 1.1 (R2006b) SimHydraulics Software

This table summarizes what's new in Version 1.1 (R2006b):

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

New features introduced in this version are described here.

### Linearization Support

The Simulink `linmod` and `dlinmod` commands create continuous- or discrete-time linear time-invariant (LTI) state-space models from Simulink models. You can now use these commands to generate an LTI state-space model from a model containing SimHydraulics components.

There are two basic ways `linmod` and `dlinmod` can be used, and the behavior of linearization differs depending on which method is chosen. If `linmod(md1)` is called (that is, the arguments for time, state, and input are not provided), then consistent initial conditions are solved for in the same way as on the first step of a simulation. If you call `linmod(md1, t, x, u)`, it is particularly important to provide it with a consistent state to linearize about. For more information, see “Linearizing at an Operating Point” in the Simscape User’s Guide.

### New Solver Option Allows Starting Transient Analysis from a Steady State

A new solver option allows you to specify that simulation starts from a steady state. Steady state means that the system variables are no longer changing with time.

If you select the **Start simulation from steady state** check box in the Solver block dialog, the solver attempts to find the steady state that would result if the inputs to the system were held constant for a sufficiently large

time, starting from the initial state obtained from the initial conditions computation. Although the solver tries to find the particular steady state resulting from the given initial conditions, it is not guaranteed to do so. All that is guaranteed is that if the steady-state solve succeeds, the state found is a steady state (within tolerance). Simulation then starts from this steady state.

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**Note** If the simulation fails at or near the start time when you use the **Start simulation from steady state** option, consider clearing the check box and simulating with the plain initial conditions computation only.

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## Extended Functionality for Working with Physical Units

Version 1.1 provides the following commands that help you specify the physical units for your system:

- `pm_adddimension`
- `pm_addunit`
- `pm_getunits`

Unit names are defined in the `pm_units.m` file, which is shipped with the product. You can open this file to see how the physical units are defined, and also as an example when adding your own units. This file is located in the directory `matlabroot\toolbox\physmod\pm_util\pm_util`.

Use the `pm_getunits` command to get an up-to-date list of units currently defined in your unit registry. Use the `pm_adddimension` and `pm_addunit` commands to define additional units.

## New SimHydraulics Blocks

The new blocks introduced in Version 1.1 are listed below:

- Annular Orifice
- Cylinder Friction

- Reservoir
- Elbow
- Pipe Bend
- T-junction
- Gradual Area Change
- Sudden Area Change
- Variable-Displacement Motor
- Variable-Displacement Pump
- Shuttle Valve
- PS Product
- PS Divide

## Version 1.0 (R2006a+) SimHydraulics Software

This table summarizes what's new in Version 1.0 (R2006a+):

New Features and Changes	Version Compatibility Considerations	Fixed Bugs and Known Problems
Yes Details below	Not applicable	Bug Reports

New features introduced in this version are described here.

### Product Introduction

SimHydraulics software is a modeling environment for the engineering design and simulation of hydraulic power and control systems within Simulink and MATLAB. It is based on the Physical Network approach and contains a comprehensive library of hydraulic blocks, as well as one-dimensional translational and rotational mechanical elements and utility blocks.

SimHydraulics software key features are:

- Enables modeling and simulation of hydraulic power and control systems in Simulink
- Provides intuitive and convenient description of multidomain models based on physical networks
- Includes a library of hydraulic components, such as pumps, valves, accumulators, and pipelines, that account for effects such as fluid compressibility, turbulence transition, and fluid inertia
- Provides foundation library of hydraulic building blocks, as well as fundamental mechanical and mathematical elements, to enable efficient extension and customization of models
- Provides customizable library of hydraulic fluids

SimHydraulics software employs a network approach to model building. Components in the network correspond to physical elements, such as pumps, motors, valves, etc. The lines that join the components correspond to physical



connections that transmit power between components. Unlike traditional Simulink block diagrams, these connections are non-directional and do not require the user to resolve the causality of the system while building the model. SimHydraulics libraries contain more than 75 models of hydraulic and mechanical components. All the models were developed to be easily characterized by data normally available in manufacturer's catalogs or data sheets. Building a model of a system is analogous to assembling the actual physical system with off-the-shelf components. The end result is a hydraulic circuit schematic in concurrence with ISO 1219 Fluid Power Standard.

SimHydraulics limitations are:

- Explicit solvers are not currently supported. Only the following solvers are supported: `ode15s`, `ode23t`, and `ode14x`.
- A SimHydraulics physical network should not exist within a Simulink algebraic loop. This means that you should not directly connect an output of a PS-Simulink Converter block to an input of a Simulink-PS Converter block of the same physical network.
- Code generation is not currently supported.

## Compatibility Summary for SimHydraulics 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.

<b>Version (Release)</b>	<b>New Features and Changes with Version Compatibility Impact</b>
<b>Latest Version V1.10.1 (R2012a)</b>	None
V1.10 (R2011b)	None
V1.9 (R2011a)	None
V1.8 (R2010b)	None
V1.7 (R2010a)	See the <b>Compatibility Considerations</b> subheading for this new feature or change: <ul style="list-style-type: none"> <li>• “Initial Piston Position in the Single-Acting Hydraulic Cylinder Block” on page 13</li> </ul>
V1.6 (R2009b)	None
V1.5 (R2009a)	None
V1.4 (R2008b)	None
V1.3 (R2008a)	None
V1.2.1 (R2007b)	None
V1.2 (R2007a)	See the <b>Compatibility Considerations</b> subheading for these new features or changes: <ul style="list-style-type: none"> <li>• “Initial Conditions Added for Certain Blocks” on page 28</li> <li>• “Block Library Links Must Be Resolved” on page 29</li> </ul>

<b>Version (Release)</b>	<b>New Features and Changes with Version Compatibility Impact</b>
V1.1 (R2006b)	None
V1.0 (R2006a+)	Not applicable