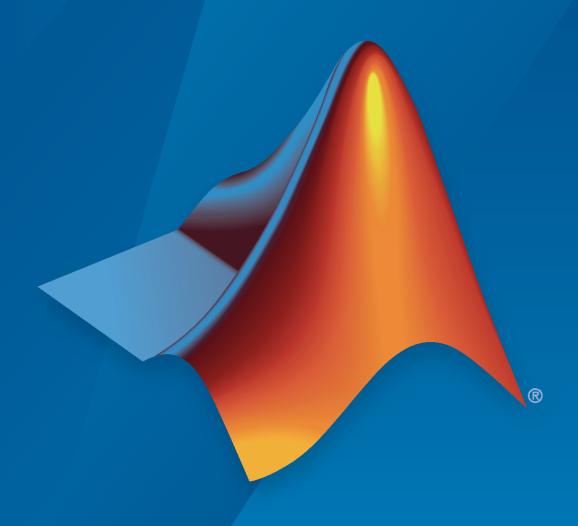# Simscape™ Driveline™ Release Notes

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Contents

R2016a

R2015b

R2012b

R2012a

R2011b

R2011a

R2022b

Version: 3.6

New Features

Bug Fixes

New and Improved Propeller Blocks: Simulate marine or aerodynamic propellers

The Marine Propeller block now allows you to parameterize the propeller performance according to the advance angle. This enables you to specify propeller behavior in all four operational quadrants. To parameterize according to advance angle, set **Parameterization** to `Tabulated data for advance angle`.

You can set the new **Rotational connections** parameter to:

- `Conserving` — The block operates as in the previous release, where you attach the rotational connections using the conserving ports **R1** and **C1**.
- `Physical signals` — The block hides ports **R1** and **C1** and enables physical signal ports **w** and **Q**, which represent the velocity input and resistive torque output, respectively.

The new Aerodynamic Propeller block enables you to add a constant or variable-pitch aerospace propeller to your model. The block functions similarly to the Marine Propeller block, but it takes power coefficient as an input parameter. You can use the block to:

Note that the Marine Propeller was previously the Propeller block.

New Wind Turbine block: Simulate a wind turbine with adjustable-pitch blades

The new Wind Turbine block takes the wind speed as a physical signal input at port **V** and the collective blade pitch as a physical signal input at port **β**. You can optionally output thrust using port **T**. The default parameters represent a reference turbine scaled to 6 MW.

Generic Engine Block Updates: Model a generic engine with improved configuration and visualization options

The Generic Engine block features these new usability improvements:

- You can now control the engine by using a torque command physical signal at port **Trq**. You can access this port by setting **Input type** to `Torque command`. This option is useful for hybrid electric vehicle applications. The throttle port from previous releases, **T**, is now port **Thr**.
- You can generate a visualization of the engine properties by clicking the **engine properties** hyperlink in the block description.
- When you set **Model parameterization** to `Normalized 3rd-order polynomial`, you can set **Engine type** to `Generic`. You can then parameterize the generic engine by using the **Maximum torque**, **Speed at maximum torque**, and **Maximum speed** parameters.

  The title of this option in previous releases was `Normalized 3rd-order polynomial matched to peak power`.

Longitudinal Vehicle Block Updates: Visualize road-load force

The Longitudinal Vehicle block now generates a visualization to display the road-load forces. When you click the **vehicle properties** hyperlink in the block description, a Live Script opens. To update

the plots for a new set of parameters, select the block and run the Live Script by using the **Run** button on the MATLAB® toolstrip.

tirread Tire Parameterization Import Function: Quickly parameterize vehicle tires using a TIR file

The `sdlUtility.tirread` function allows you to parameterize tires using a file with a `.tir` extension. The function accommodates two syntaxes:

- `STire = sdlUtility.tirread("sample.tir")` reads the file `sample.tir`, generates a structure array that contains the tire parameters, and saves the file as the workspace variable, `STire`.
- `sdlUtility.tirread(block, STire)` reads the tire parameters from the workspace variable, `STire`, and uses them to parameterize the specified Tire (Magic Formula) block.

Tire Consistency Updates: Transition between tire blocks while maintaining slip properties

The Tire (Friction Parameterized) block now supports relative slip to be consistent with the Tire (Magic Formula) block. The **Slip output type** parameter provides these options:

- `Absolute` — The block outputs an absolute slip physical signal. This setting is the same as in previous releases.
- `Relative` — The block outputs a relative slip physical signal.

New and Updated Examples

Explore these new examples:

- "Abstract Combustion Engine Car"
- "Tire Parameterization and Performance"
- "Tractor Transmission Energy Flow Chart"
- "Vehicle with Manual Transmission"

Explore these updated examples:

- "Helicopter Transmission"
- "Vehicle with Dual Clutch Transmission"

R2022a

Version: 3.5

New Features

Bug Fixes

Battery (System-Level) Block: Power models with a simple, self-discharging battery

Use the new Battery (System-Level) block to perform system-level analysis on your battery-electric or hybrid-electric propulsion models. This block is a medium-fidelity version of the Battery (Simscape Electrical) block.

Engine Library Updates: Streamline engine modeling using the new Spark Ignition Engine block and Engine Subcomponents sublibrary

The Engines & Motors library now contains the Spark Ignition Engine block and the Engine Subcomponents sublibrary. This block is an advanced version of the Generic Engine block, which computes the cycle-averaged torque. The Spark Ignition Engine block uses a subcomponent implementation of the blocks in the sublibrary to represent a versatile combustion engine that outputs instantaneous torque. The block represents an abstract, naturally aspirated, fuel injected combustion engine suited for timing control applications.

The Engine Subcomponents sublibrary contains these blocks:

- Air Intake
- Crankshaft
- Exhaust Manifold Thermal
- Ignition Trigger
- SI Combustion Cylinder

You can use the sublibrary to design custom engines using the Spark Ignition Engine block as a reference.

Ring Gear Motion: Control the motion of cycloidal and harmonic drive ring gears

You can now control the motion of the ring gear in the Harmonic Drive block and Cycloidal Drive block. Ring gear rotation allows adjustments such as cam phasing. To control the ring gear motion for either block, set **Ring gear rotation** to On.

Transmission Block: Simplify your vehicle model using an abstract transmission

The Transmission block represents a ratio-based, abstract transmission that responds to a physical signal. You specify the forward gear ratios as positive scalars in a vector of arbitrary length, and the reverse gear ratio as a negative scalar. The block includes clutch effects that you can parameterize. You can optionally include friction and thermal effects.

Belt Pulley Updates: Improved numerical robustness for translating pulleys

Beginning in R2021b, you could set **Friction model** to Modal to improve the numerical robustness of your pulley network. However, this option was only available when you set **Pulley translation** to

`Off`. Now this option is available for both settings of the **Pulley translation** parameter. To use this feature in the Belt Pulley block, set

- **Belt type** to `Flat belt` or `V-belt`.
- **Friction model** to `Modal`.

Featured Examples

These examples are newly available:

- Single Cylinder Spark Ignition Engine
- Transmission Testbed
- Wind Turbine

R2021b

Version: 3.4

New Features

Bug Fixes

Propeller Block: Add a marine propeller to your model

Add a constant or variable-pitch marine propeller to your model with the new Propeller block. The block takes torque as an input and outputs thrust. You can use the block to:

- Parameterize a propeller by using constants, polynomials, or tabulated data of thrust and torque coefficients.
- Include the effect of the hull of the vessel.
- Control the density with the optional input port **Rho**.
- Control the blade pitch with the optional input port **PR**.
- Simulate translational connections.
- Monitor the efficiency with the optional output port **E**.

You can locate the block in the **Simscape** > **Driveline** > **Engines & Motors** sublibrary.

Backlash Modeling for Gears: Include backlash with the Simple Gear block

You can simulate hard-stop or instantaneous blacklash in the Simple Gear block using the **Backlash model** parameter.

Longitudinal Vehicle Block: Efficiently perform a system-level analysis using an abstracted vehicle

You can use the Longitudinal Vehicle to analyze vehicle-level performance aspects such as energy efficiency requirements. The block offers a simpler alternative to the Vehicle Body block, which requires more parameters to produce a higher-fidelity representation.

You can parameterize the vehicle by using known values or constants, or you can select from predefined common parameterizations.

The block includes abstracted brakes and abstracted non-slipping tires.

Thermal Dampers: Include thermal effects in linear faultable damper blocks

You can now include the effects of heat flow and temperature change in the Translational Damper and Rotational Damper blocks by setting **Thermal port** to `Model`.

For more information, see Model Thermal Losses in Driveline Components.

Modal Pulley Blocks: Simulate pulley networks with improved ease and numerical robustness

You can now model pulley networks with the Belt Pulley or Belt Drive blocks using the **Modal friction model** parameter. To enable this parameter, set **Belt type** to `Flat belt` or `V-belt`.

This feature is available for stationary pulleys.

Logic-Controlled Clutch Block Updates: Conduct system-level analysis using an abstracted clutch with optional smoothing

You can use the Logic-Controlled Clutch block to smooth the physical signal input at port **E**. You can set the new **Transition model** parameter to:

- `Instantaneous` — The clutch engages when the input is `1`, and the clutch does not engage when the input is `0`. This setting is the same as the default block behavior before R2021b.
- `First-order lag` — The block introduces a first-order delay to the clutch engagement according to the value that you specify for the **Transition time constant** parameter.
- `Scaled by input` — You can smooth your input externally, and the block scales it for clutch engagement.

R2021a

Version: 3.3

New Features

Bug Fixes

Motor & Drive Block: Add a simplified DC motor-generator

Electrify your drive systems with the new Motor & Drive block. This block simplifies the process of adding an electric motor to your model and can aid in finding the right motor for your system. Use this block to model a generic motor and drive that can operate as a motor-generator and exhibits proportional efficiency losses. You must connect this block to a DC supply network.

The Motor & Drive block is a simplified version of the Motor & Drive (System Level) (Simscape Electrical) block. You only need basic information about your desired motor performance to get started. Once you tune the motor parameters to best fit your model, you can use these parameters to narrow your selection of potential motors.

Air Spring Block: Use air spring isolators to filter high-frequency oscillations

The new Air Spring block can simulate translational air springs in your model. The block uses common manufacturer supplied data parameterized by either stiffness or load with respect to height. Use the block to isolate connected equipment from undesired frequencies in the system.

Rope Block: Model tension networks with stability and optional slack

You can use the new Rope block to analyze tension in networks that involve travelling or stationary pulleys. The block models a physical connection between two contact points in a physical network. Specify the stiffness and damping of a rope, cable, belt, or any arbitrary tension transfer device to simulate tension force in your model. The Rope block can also simulate slack by removing resistance upon loss of tension. You can initialize the block to improve stability of the simulation.

You can view the new Compound Pulley example and the updated Best Practices for Modeling Pulley Networks topic page to learn how to model pulley systems with the Rope block.

Belt Pulley Block Update: Specify direction for all belt types

The Belt Pulley block now supports the **Belt direction** parameter for all belt types.

Custom Library Updates: Model a spark ignition engine with advanced configurability

Custom engine blocks and components demonstrate the accessibility of powerful custom block libraries.

- The existing Crank-Angle-Resolved Engine Model example uses a new custom block, Spark Ignition Engine, as part of the Spark Ignition Four-Cylinder Engine masked subsystem. The block can take throttle angle, valve timings, air-to-fuel ratio or fuel injection pulse, and spark timing as inputs. It can return instantaneous torque and cycle-average torque. You can now choose an engine configuration of up to four cylinders. Open the model `sdl_carem_si_na_i4_2000` to learn more.
- The engine subcomponent blocks in the custom library `crank_angle_resolved_engine_lib` now enable you to select an engine configuration of up to four cylinders.

Featured Examples

Explore the following new Simscape Driveline examples:

- Electro-Hydraulic Limited Slip Differential
- Compound Pulley

R2020b

Version: 3.2

New Features

Bug Fixes

Torque Converter Block Improvements

You can use the Two-mode setting of the **Coast mode modeling** parameter to specify parameters for the drive and the coast modes of torque converters, such as the speed ratio, torque ratio, and capacity factor vectors. The Two-mode setting simulates the behaviors of the torque converter and increases the robustness of the simulation when the speeds of the turbine and the impeller are close to each other.

Break and Clutch Blocks Update: Model fault types and triggers

You can now model faulting, identify the fault type and trigger, and set reporting preferences in the following blocks:

- Band Brake
- Double Shoe Brake
- Disc Brake
- Loaded-Contact Rotational Friction
- Loaded-Contact Translational Friction
- Disk Friction Clutch
- Cone Clutch

The fault trigger can be configured for a signal magnitude or specified time.

The Band Brake, Double Shoe Brake, and Disc Brake blocks can be set to a specified force or pressure when faulting is enabled.

The Loaded-Contact Rotational Friction, Loaded-Contact Translational Friction, Disk Friction Clutch, and Cone Clutch blocks can become locked or fail to transmit power when faulting is enabled.

Gear Block Usability Improvements: Expose thermal ports and parameters by using block parameter settings

Thermal ports and parameters allow you to model heat flow between a block and the connected network. Before R2020b, you had to use the block context menu or the Property Inspector to expose a thermal port and the related parameters. You can now expose thermal ports and parameters more easily for the following gear blocks by using block parameter settings.

To add a thermal port to your block, set **Friction model** to Temperature-dependent efficiencies. For the Harmonic Drive and Simple Gear blocks, you can also enable the thermal port by setting **Friction model** to Temperature and load-dependent efficiency.

Thermal modeling is now available as a block parameter for the following blocks:

- Cycloidal DriveCycloidal Drive
- Harmonic Drive
- Leadscrew
- Rack & Pinion
- Simple Gear

- Simple Gear with Variable Efficiency
- Worm Gear

Belt Pulley Block Updates: Model a translating pulley for all belt types

The Belt Pulley block now includes optional translating capabilities for all belt types. On the **Pulley** tab, you can now specify the pulley mass and initial translational velocity.

Featured Example

The Torque Converter in Two-Mode Modeling provides examples of using the Torque Converter block, such as lock-up during drive and coast modes and performance plotting.

R2020a

Version: 3.1

New Features

Bug Fixes

Ideal Compliance and Backlash Models: Neglect stiffness and damping in the Chain Drive and Universal Joint blocks

You can improve simulation performance by neglecting stiffness, damping, and backlash for the Chain Drive block or by neglecting compliance in the Universal Joint block. To neglect compliance and backlash for the **Chain Drive**, in the **Geometry** settings, set the **Chain model** parameter to `Ideal - no chain compliance or backlash`. To neglect compliance in the **Universal Joint** settings, set the **Compliance** parameter to `Off`.

Run-Time Parameter Expansion: Modify compound gear inertia parameters without recompiling

You can now designate the inertia parameters for certain compound gear blocks as run-time tunable. If you designate a parameter as run-time tunable and use a variable to define the parameter value, you can apply a value change between simulation runs without recompiling. For more information about run-time parameters for Simscape blocks, see Run-Time Parameters.

You can also improve simulation performance by neglecting inertia for compound gear blocks. In prior releases, to neglect inertia, you had to set the planet and carrier gear inertia parameters to `0`. Now, you can override any nonzero inertia values that you specify for these compound gear blocks by setting the **Inertia** parameter to `Off`.

The run-time and override capabilities are applicable for inertia parameters in these blocks:

- Compound Planetary Gear
- Differential
- Double-Pinion Planetary Gear
- Limited-Slip Differential
- Planetary Gear
- Ravigneaux Gear

Gear Temperature Modeling Improvement: Set initial temperature target value and priority for gear subcomponent blocks

You can improve model fidelity by using **Variables** settings to specify initial value targets and priorities for model variables. For more information, see Set Priority and Initial Target for Block Variables (Simscape). When you select a temperature-dependent friction model for these gear subcomponent blocks, you can now specify a target value and priority for the initial temperature:

- Planet-Planet
- Ring-Planet
- Sun-Planet
- Sun-Planet Bevel
- Sun-Planet Worm Gear

Gear Block Usability Improvements: Expose thermal ports and parameters by using block parameter settings

Thermal ports and parameters allow you to model heat flow between a block and the connected network. Before R2020a, you had to use the block context menu or the property inspector to expose a thermal port and the related parameters. You can now expose thermal ports and parameters more easily for certain gear blocks by using block parameter settings.

To add a thermal port to the Limited-Slip Differential, a compound gear block, click the block, and, in the **Differential** settings, set the **Friction model** parameter to `Temperature-dependent efficiencies`.

To add a thermal port to these compound and subcomponent gear blocks, click the block, and, in the **Meshing Losses** settings, set the **Friction model** parameter to `Temperature-dependent efficiencies`:

Compound Gear Blocks

- Compound Planetary Gear
- Differential
- Double-Pinion Planetary Gear
- Planetary Gear
- Ravigneaux Gear

Gear Subcomponent Blocks

- Planet-Planet
- Ring-Planet
- Sun-Planet
- Sun-Planet Bevel
- Sun-Planet Worm Gear

Featured Example

The Crank-Angle-Resolved Engine Model example shows how to model a four-cylinder, naturally-aspirated spark-ignition engine that computes crank-angle-resolved torque and executes a start-stop cycle.

R2019b

Version: 3.0

New Features

Bug Fixes

Source Code Access: View source code for Simscape Driveline blocks

You can now view the source code for many Simscape Driveline blocks. To open the Simscape source file for a block in the MATLAB Editor:

1   In a block library or model, double-click the block.

2   In the dialog box that opens, click the **Source code** link.

Brake and Clutch Block Usability Improvements: Expose thermal ports and parameters by using block parameter settings

Thermal ports and parameters allow you to model heat flow between a block and the connected network. Before R2019b, you had to use the block context menu or the property inspector to expose a thermal port and the related parameters. You can now expose thermal ports and parameters more easily for brake and clutch blocks by using block parameter settings.

To add a thermal port to these brake and clutch blocks by using the block parameter settings, click the block, and then:

- Band Brake, Disc Brake, Double-Shoe Brake — In the **Friction** settings, set the **Thermal port** parameter to `Model`.
- Cone Clutch, Loaded-Contact Rotational Friction, and Loaded-Contact Translational Friction — In the **Friction** settings, set the **Friction model** parameter to `Temperature-dependent friction coefficients` or `Temperature and velocity-dependent friction coefficients`.
- Dog Clutch — In the **Clutch** settings, set the **Thermal port** parameter to `Model`.
- Double-Sided Synchronizer and Synchronizer — In the **Clutch** settings, set the **Friction model** parameter to `Temperature-dependent friction coefficients` or `Temperature and velocity-dependent friction coefficients`.

Additional setting changes make block parameterization easier. For example, for the Double-Sided Synchronizer and Synchronizer blocks, the **Maximum engagement speed** parameter is now in the **Shift Linkage** settings.

Ideal Belt Model: Neglect slip in the Belt Pulley and Belt Drive blocks

You can improve simulation performance by neglecting belt slip for the Belt Drive and Belt Pulley blocks. To neglect belt slip, in the **Belt** settings, set the **Belt type** parameter to `Ideal - No slip`.

Clutch Modeling Improvements: Specify clutch-control data directly or with dynamic effects

The Cone Clutch and Dog Clutch now have a **Shift linkage control** parameter that allows you to choose either direct or dynamic input for clutch-control data.

For the Cone Clutch block, the **Shift linkage control** parameter provides these options:

- `Physical signal` — Input normal force directly through the optional physical signal port, **N**.

- `Conserving port` — Input normal force dynamically through the optional translational conserving port, **S**. When you select this option, related **Shift Linkage** parameters and the optional physical signal port, **X**, which outputs the shift linkage position, are also exposed.

For the Dog Clutch block, the **Shift linkage control** parameter provides these options:

- `Physical signal` — Input shift linkage position directly through the optional physical signal port, **S**.
- `Conserving port` — Input the shift linkage position dynamically through the optional translational conserving port, **S**. When you select this option, related **Shift Linkage** parameters are exposed.

Additional Models for the Flexible Shaft Block: Model a flexible shaft with variable diameter, stiffness, and damping

The Flexible Shaft block now allows you to model:

- Varying diameter and stiffness along the shaft length
- Support locations along the shaft length
- Speed-dependent translational bearing stiffness and damping
- Bearings that account for off-diagonal translational stiffness and damping

Run-Time Parameter Expansion: Modify driveline parameters without recompiling

You can now designate more Simscape Driveline block parameters as run-time tunable. If you designate a parameter as run-time tunable and use a variable to define the parameter value, you can apply a value change between simulation runs without recompiling. For more information about run-time parameters for Simscape blocks, see Run-Time Parameters.

Featured Example

The Fixed Caliper Disk Brake example shows how to model, parameterize, and test a caliper disk brake.

R2019a

Version: 2.16

New Features

Bug Fixes

Real-Time Performance Improvement: Speed up driveline simulation using the robust partitioning solver

To significantly increase simulation speed, especially in systems that contain clutches, select the `Robust simulation` setting for the Simscape Partitioning Local Solver **Partition method** parameter.

Varying Vehicle Body Mass Option: Vary the mass and center of gravity during simulation using an externally defined mass

The Vehicle Body block has an option to include externally defined mass and externally defined inertia. The mass, inertia, and center of gravity of the vehicle body can vary over the course of simulation in response to system changes.

Road Profile Block: Model profiles with varying elevation and friction properties

Vary road conditions by using the Road Profile block with the Vehicle Body and tire blocks. As the vehicle travels, the axle parameters and the position of the center of gravity (CG) determine the position of the front and rear axles. The block uses the axle positions to compute vehicle angle and tire friction coefficients.

Piston Fuel Consumption Option: Determine fuel consumption for the Piston Engine or Piston block

The **FC** port on the Piston and Piston Engine blocks outputs the fuel consumption rate of the engine. The block determines the fuel consumption rate using one of these models:

- `Constant per revolution`
- `Fuel consumption by speed and torque`
- `Brake specific fuel consumption by speed and torque`
- `Brake specific fuel consumption by speed and brake mean effective pressure`

For faster simulation, opt out of calculating the fuel consumption rate by selecting `No fuel consumption` for the **Fuel consumption model** parameter.

R2018b

Version: 2.15

New Features

Bug Fixes

Flexible Shaft Block: Model off-axis bending in rotating shafts

The Flexible Shaft block now lets you model a rotating shaft with torsional and transverse flexibility. Model a shaft with ends that are either free or mounted with a clamp, a pin, or bearing-supports. Attach rigid masses to the shaft and compare the lumped parameter and eigenmode steady-state responses.

For an example that shows how to model off-axis bending, see Shaft with Torsional and Transverse Flexibility.

Gear Faults: Model degraded performance in gears

The Simple Gear block now allows you to specify the efficiency as a function of a temporal trigger or a physical signal input trigger. Configure the fault to occur throughout 360 degrees of rotation or limit it to a rotational angle.

Rod Block: Model an axially flexible bar or cable

The Rod block allows you to model distributed longitudinal dynamics using a lumped parameter model. Parameterize the block by material properties or by stiffness and inertia to see the response of an axially flexible bar or cable in either compression or tension.

Varying Tire Property Option: Enable varying tire behavior from a drop-down menu

In prior releases, you used the Simscape menu to access block variants with different friction characteristics for tire blocks. In this release, advanced features for tire blocks are more easily accessible through drop-down menus on the block dialog box and in the Simulink Property Inspector.

For the Tire (Magic Formula) and Tire-Road Interaction (Magic Formula) blocks, you can now access different friction models or add a physical signal port for Magic Formula coefficients using the **Parameterize by** parameter.

For the Tire (Friction Parameterized) block, you can now access different friction models or add a physical signal port for static and kinetic friction coefficients using the **Friction model** parameter.

Japanese Language Localization Support: Block masks, parameters, variables, and error messages are available in Japanese

Simscape Driveline is available in Japanese for Japanese localized systems. For more information, see https://www.mathworks.com/help/releases/R2018b/matlab/internationalization.html.

Featured Examples

The Shaft with Torsional and Transverse Flexibility example compares the lumped parameter and eigenmode steady-state responses for a Flexible Shaft block.

R2018a

Version: 2.14

New Features

Bug Fixes

Compatibility Considerations

10-Speed Block: Model a 10R80 10-speed automatic transmission

The 10-Speed transmission block contains the clutch schedule for a 10R80 10-speed automatic transmission. The transmission block consists of four planetary gear sets and six clutches. The follower shaft connects to the planet gear carrier of the fourth planetary gear. Four of the clutches determine the power flow path for the base shaft.The other two clutches serve as brakes, grounding various gears of the planetary sets to the transmission housing.

The Transmission Testbed example allows you to:

- Compare the performance of the 10-speed transmission to other transmissions.
- See how the efficiency and drive ratio of the 10-speed transmission changes when you vary the transmission configuration.

Vehicle Body Block with Pitch Dynamics: Model effect of suspension on vehicle pitch

The Vehicle Body block now measures the pitch that occurs during vehicle acceleration. The pitch measurement allows you to examine tire-slip distribution and helps you to estimate ride comfort.

The block also now:

- Allows you to set the center of gravity of the vehicle to at or below the plane of travel.
- Has an option to generate a warning when normal force on either axle goes to zero.

Generic Engine Block Fuel Consumption Option: Speed up simulation when you specify zero-fuel consumption

The **FC** port on the Generic Engine block outputs the fuel consumption rate of the engine. In previous releases, even when the **FC** port was not connected to another block, the engine block determined the fuel consumption rate.

The block has a new default option for the **Fuel consumption model** parameter: `No fuel consumption`. When you use the new option, even if the **FC** port is connected to another block, the block does not determine the fuel consumption rate. Simulation speed increases because the block does not solve a nonlinear equation that is required for calculating the fuel consumption rate.

Pulley Block Improvements: Generate robust results over a wider range of models that contain pulley blocks

In previous releases, under certain conditions, the application of friction torque by the pulley block resulted in an unrealistic acceleration. The Belt Pulley and Belt Drive blocks now generate more robust results in such cases.

For an example that shows how to resist slip when a pulley supports an increasing, variable load, see the Capstan with Slip example.

Compatibility Considerations

If you are using the results from a model that contains a Belt Pulley block or Belt Drive block as a validation or verification baseline, simulate the model using the improved blocks to determine if the baseline has changed.

Featured Examples

The Capstan with Slip example shows how to hold in place an increasing load at one belt end of a Belt Pulley block by applying tension at the other belt end.

R2017b

Version: 2.13

New Features

Bug Fixes

Compatibility Considerations

Disc Brake Block: Model a disc brake with heat transfer and temperature-dependent behavior

To convert cylinder pressure to a braking force, use the Disc Brake block. The block applies the pressure-based force at the brake pad mean radius. An optional thermal port allows you to determine how heat generation affects the efficiency and temperature of the components of the brake. You can also set the priority and initial target values for the block variables before simulating.

Generic Engine Block Redline Limit: Restrict throttle input when approaching maximum speed

The Generic Engine block now allows you to prevent stalling due to excessive speed by controlling throttle input with a redline controller. To maintain upper and lower engine speed boundaries, use the redline controller and the idle controller.

To include redline control, for the **Redline control** parameter, select **Enable redline controller** and specify values for the **Redline speed**, **Redline time constant**, and **Redline threshold speed** parameters.

To preserve simulation results, legacy models have the **Redline control** parameter set to No redline controller.

Fundamental Friction Clutch Block Mode Chart: Speed up simulation with efficient state logic

The mode chart for the Fundamental Friction Clutch has more direct transitions between states. This change in logic results in faster transition times and fewer dynamic constraints.

The physical signal ports for friction torque and slip velocity now have units. The friction torque ports use N*m and the slip velocity port uses rad/sec.

Compatibility Considerations

Mode chart improvements may result in transition schedule changes in legacy models. If the clutch block is not locking as expected and the slip velocity oscillates near zero, decrease the value for the **Clutch velocity tolerance** parameter.

Simulating a model that contains connected blocks that have noncommensurate units generates an error message. To avoid generating an error message, reconfigure your legacy model to make block units commensurate with Fundamental Friction Clutch blocks that are:

- Part of a composite component
- Connected directly to a Simulink-PS Converter or PS-Simulink Converter block

For information on configuring units for Simscape blocks, see How to Work with Physical Units (Simscape).

Shock Absorber and Torsional Spring Damper Blocks with Configurable Hard Stop: Select numerically smooth options for fast simulation

The Shock Absorber and Torsional Spring-Damper blocks now have an additional parameter, **Hard stop model**, that lets you choose between three hard stop models:

- `Stiffness and damping applied smoothly through transition region, damped rebound` — The default choice for new models. It has an additional parameter, **Transition region**. The slider moves through the transition region, in which the force is scaled from zero. At the end of the transition region, the full stiffness and damping are applied. All equations are smooth and produce no zero crossings, resulting in faster and more robust simulation.
- `Full stiffness and damping applied at bounds, undamped rebound` — Equations produce no zero crossings when velocity changes sign, but there is a position-based zero crossing at the bounds. Having no damping on rebound helps to push the slider past this position quickly. This model has nonlinear equations.
- `Full stiffness and damping applied at bounds, damped rebound` — Equations are switched linear, but produce position-based zero crossings. Use this hard stop model if `simscape.findNonlinearBlocks` indicates that this block is preventing the network from being switched linear.This hard stop model is the same as in previous releases

To preserve simulation results, legacy models have the **Hard stop model** parameter set to `Full stiffness and damping applied at bounds, damped rebound`, which is equivalent to the hard stop model used in previous releases.

Belt Pulley Centrifugal Force Modeling: Speed up simulation by excluding centrifugal force

The Belt Pulley and Belt Drive blocks now have an option that allows you to include or to exclude centrifugal force contributions in your model.

To configure the centrifugal force contribution, access the **Belt** settings and for the **Centrifugal force** parameter, select one of these options:

- `Do not model centrifugal force - suitable for HIL simulation` — Default option, which does not include centrifugal force contributions.
- `Model centrifugal force` — Exposes the **Belt mass per unit length** parameter for configuring the centrifugal force contribution.

Legacy models have the **Centrifugal force** parameter set to `Model centrifugal force`.

R2017a

Version: 2.12

New Features

Bug Fixes

Compatibility Considerations

Limited-Slip Differential Block: Model differentials that limit the speed difference of output shafts

The Limited-Slip Differential block combines a differential with a disk friction clutch. The differential allows two connected shafts to rotate at different velocities when the wheel on only one of the shafts slips, for example, due to a traction imbalance. The clutch component in the Limited-Slip Differential block is a friction clutch that has two sets of flat friction plates. The clutch engages when the applied pressure exceeds engagement threshold pressure. The engagement allows the driveshaft to transmit more power to the higher-traction wheel on the slower-spinning shaft. The additional power reduces the difference in velocity of the two shafts.

Variable Target Specification: Guide initialization using desired variable values with relative priority

Several blocks in the Simscape Driveline library now contain a **Variables** tab that allows you to specify target value and priority for initializing variables. The **Variables** tab lists the public variables specified in the underlying component file, along with priority, initial value, and unit. Usually, the default value for each of these variables is `Unused`. Once you select the check box next to a variable name, you can specify its priority (`High` or `Low`), target initial value, and unit.

The values you specify during block-level variable initialization are not the actual values of the respective variables, but rather their target values at the beginning of simulation ($t = 0$). Depending on the results of the initial conditions solve, some of the targets may not be satisfied. The solver tries to satisfy the high-priority targets first. For more information, see About Variable Initialization (Simscape).

In previous releases, some blocks with the new **Variables** tab contained parameters for specifying the initial value for certain internal block variables at the start of simulation. These parameters have been removed. The table lists the parameters that have been removed and the names of the corresponding initializable variables.

Block Name	Parameter Name	Variable Name
Band Brake	**Initial Temperature**	**Temperature**
Chain Drive	**Chain initial displacement**	**Chain stretch**
Double-Shoe Brake	**Initial Temperature**	**Temperature**
Nonlinear Rotational Spring	**Initial Deformation**	**Deformation**
Nonlinear Translational Spring	**Initial Deformation**	**Deformation**
Variable Inertia	**Initial angular momentum**	**Angular momentum**
Variable Mass	**Initial Momentum**	**Momentum**
Variable Rotational Spring	**Initial Deformation**	**Deformation**
Variable Translational Spring	**Initial Deformation**	**Deformation**
Vehicle Body	**Initial Velocity**	**Velocity**

Although this change affects legacy models that use these blocks, the simulation results stay the same. For a block that uses the initialization parameter, when you open the model in the current release, the parameter is no longer visible. The specified value for the parameter is automatically mapped to the corresponding variable value and the priority is set to `High`.

Run-Time Parameters: Speed up simulation tasks and modify component parameter values without regenerating C code

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

Unlike Simulink® blocks, where parameters are tunable at run time unless otherwise specified, the default for Simscape Driveline block parameters is that they are modifiable at compile time. To make a parameter modifiable at run time, you have to designate it as such.

In Simscape Driveline, parameters are not tunable during simulation. If a parameter for a Simscape Driveline block is designated as run-time, it means that you can modify its value between simulation runs without recompiling the model. For more information, see Run-Time Parameters (Simscape).

Vehicle Body Block with Gravity and Air Density Parameters: Model vehicle behavior in different environments

In previous releases, the Vehicle Body block assumed standard values for acceleration due to gravity and the mass density of air. The block now allows you to specify nonstandard values using two new parameters: **Gravitational acceleration** and **Air density**.

Transmission Block Robustness and Usability Improvements: Set initial gear and easily configure the clutch schedule and transmission model

The blocks in the Transmissions library include an **Initial gear** parameter that allows you to set the initial gear engagement to neutral, reverse, or any of the available gears for the transmission. Each transmission block also includes a clutch schedule table and a Multi-Port Switch block that let you easily determine and select the desired clutch state. The Transmission Testbed example shows how to use these transmission blocks:

- 4-Speed CR-CR
- 4-Speed Ravigneaux
- 6-Speed Lepelletier
- 7-Speed Lepelletier
- 8-Speed
- 9-Speed

Simscape Driveline First-Generation End of Support: Simscape Driveline no longer supports the use or conversion of first-generation blocks

Simscape Driveline no longer supports first-generation blocks. The `sdl_update` function, which converts first-generation models and libraries to second-generation formats, is also discontinued.

Compatibility Considerations

To convert an existing model or custom library that contains Simscape Driveline First-Generation blocks, open your model or library in either:

- Simscape Driveline — R2016a or R2016b
- SimDriveline™ — R2011a–R2015b

Convert your model or library automatically using the `sdl_update` function, or manually through block replacement. For more, information, see Migrate to Second Generation.

Featured Example: Dynamometer

The Dynamometer example shows how to measure the power output of an engine.

R2016b

Version: 2.11

New Features

Bug Fixes

Thermal Effects in Clutches and Brakes: Model heat transfer and temperature-dependent behavior in clutches and brakes

These blocks in the Clutches and Brakes & Detents libraries now include thermal variants:

Library	Clutches	Brakes & Detents
Blocks	• Cone Clutch • Disk Friction Clutch • Dog Clutch • Double-Sided Synchronizer • Fundamental Friction Clutch • Synchronizer	• Band Brake • Double-Shoe Brake • Loaded-Contact Rotational Friction • Loaded-Contact Translational Friction

Thermal variants are alternative block implementations that account for heat generation due to friction, changes in component efficiency due to temperature fluctuations, and the impact of thermal mass on those temperature fluctuations.

Thermal ports are optional and hidden by default. To expose a thermal port, right-click the block in your model and, from the context menu, select **Simscape > Block choices**. Choose a variant that includes a thermal port. This action displays the thermal port on the block and allows you to specify thermal parameters.

Noise Source Blocks: Inject noise into mechanical systems

The Sources library contains four blocks that allow you to model zero-mean normally (Gaussian) distributed excitation. The blocks, which calculate the excitation based on noise power spectral density, are:

- Force Noise Source
- Rotational Velocity Noise Source
- Torque Noise Source
- Translational Velocity Noise Source

Sinusoidal Source Blocks: Excite mechanical systems with sinusoidal inputs

The Sources library contains four blocks that allow you to model sinusoidal excitation. The blocks, which generate sinusoidal excitation using values that you specify for the peak amplitude, phase shift, frequency, and offset of the output, are:

- Sinusoidal Force Source
- Sinusoidal Rotational Velocity Source
- Sinusoidal Torque Source
- Sinusoidal Translational Velocity Source

Damper Fault Blocks: Model mechanical failure in damper components

The Springs & Dampers sublibrary of the Couplings & Drives library contains two damper blocks that allow you to specify the damping coefficient as a function of temporal or behavioral triggers. Enable the damping coefficient to change at a particular time in the simulation or when the number of shocks for a given acceleration exceeds a limit to model fault behavior using these blocks:

- Translational Damper
- Rotational Damper

Logic-Controlled Clutch Block: Engage and disengage clutches with logic signals

Use a binary input to control clutch engagement using the Logic-Controlled Clutch block from the Clutches library. For an input of 1, the clutch engages, provides friction, and can lock. For an input of 0, the clutch does not engage or provide friction and it cannot lock.

R2016a

Version: 2.10

New Features

Bug Fixes

SimDriveline renamed to Simscape Driveline

SimDriveline software is now named Simscape Driveline. The product library is located in the **Simscape** node of the Simulink library browser under the name **Driveline**. You can open the product library at the MATLAB command prompt using the existing `sdl_lib` command.

Piston Block: Model instantaneous torque produced by piston based on geometry, current angle, and fuel input

Simscape Driveline introduces a Piston block. Use the new block to model the instantaneous torque of an internal combustion engine piston. The piston model is based on piston geometry, crankshaft angle, and throttle input. The new block appears in the Engines library.

Engine Block: Model engine with multiple pistons and shaft dynamics

Simscape Driveline introduces a Piston Engine block. Use the new block to model a multi-piston internal combustion engine. The block is based on the piston model provided by the Piston block. The new block appears in the Engines library.

Torque Converter Block Improvements: Model wider range of speed ratios and better transitions between motoring, coasting, and lockup

The Torque Converter block provides smoother transitions between transmission modes. The updated block is more efficient and stable in extreme dynamic conditions.

Gear Meshing Losses Improvement: Calculate meshing losses more efficiently under a wide range of conditions

Meshing calculations in Gear blocks are now more efficient. They incur fewer zero crossings, enabling faster and more robust gear simulation under a broader range of dynamic conditions.

R2015b

Version: 2.9

New Features

Bug Fixes

Variable Mass block

Model the effects of a time change in mass, such as that due to the fueling and loading of a vehicle. The Variable Mass block accounts for the time-varying inertia force that resists translational acceleration in driveline systems or components.

A physical signal port enables you to specify the mass value as a function of time. A minimum mass parameter ensures the variable mass is always positive and cannot fall below zero. The new block appears under a new library named Inertias & Loads.

Variable Inertia block

Model the effects of a time change in inertia, such as that due to the buildup of mud in a tire. The Variable Inertia block accounts for the time-varying inertia torque that resists rotational acceleration in driveline systems or components.

A physical signal port enables you to specify the inertia value as a function of time. A minimum inertia parameter ensures the variable inertia is always positive and cannot fall below zero. The new block appears under a new library named Inertias & Loads.

Unbalanced Load block

Model the effects of a load whose rotational inertia varies instantaneously with the rotation angle. Examples include the wobbling of a spinning axle and shaking of an off-center rotating machine. You can specify the load inertia in terms of its rotation path or as an angle-inertia lookup table. The Unbalanced Load block appears under a new library named Inertias & Loads.

Variable-friction tire model

Model the effects of a changing road-tire friction coefficient, for example, due to an encounter with an ice patch or water puddle. The following Tire blocks now provide variable-friction variants:

- Tire (Friction Parameterized)
- Tire (Magic Formula)
- Tire-Road Interaction (Magic Formula)

To switch between tire variants, right-click the Tire block and, under **Simscape > Block choices**, select the desired tire model. When using variable-friction tire variants, avoid sudden changes to the friction coefficients, as such changes can cause numerical issues in the model.

Optional inertia in compound gear blocks

Specify the inertias of internal gears in compound gear blocks, for example, to account for inertia torques during rapid changes in rotation direction or speed. You can specify the inertia of internal gears explicitly in a new dialog box tab named Inertia. The following blocks provide the new tab:

- Compound Planetary Gear
- Differential
- Planetary Gear

- Ravigneaux Gear

Each block provides an inertia parameter for at least one internal gear node. Planetary Gear and Compound Planetary Gear blocks contain one such node while Differential and Ravigneaux Gear blocks contain two. You can ignore internal gear inertias by setting their values to zero.

Number of wheels per axle parameter for Vehicle Body block

Model vehicles with different numbers of wheels in their front and rear axles. Examples include three-wheeled forklifts with two wheels in the front axle and one wheel in the rear axle. The Vehicle Body block now enables you to enter the numbers of wheels in the two axles separately as a two-element vector. The first element corresponds to the front axle and the second element to the rear axle. Entering a scalar instead of a two-element vector causes the two-wheel numbers to be the same.

R2015a

Version: 2.8

New Features

Bug Fixes

Thermal variants for all blocks in the Gears component library

Gear blocks now include thermal variants, alternative block implementations that account for heat generation due to meshing, changes in gear efficiency due to temperature fluctuations, and the impact of a gear's thermal mass on those temperature fluctuations.

You can switch between gear variants in the block's context-sensitive menu. You switch by right-clicking the gear block and selecting **Simscape > Block choices > Show thermal port** to model thermal effects, or **Simscape > Block Choices > No thermal port** to ignore those thermal effects.

Transmissions component library with prebuilt transmission templates

A new Transmissions library provides prebuilt transmission templates—subsystem models built on Simscape Driveline and Simscape blocks that represent various transmission types.

Use the templates to model 4- to 9- speed transmissions quickly, including CR-CR, Ravigneaux, and Lepelletier systems. Each template contains a clutch schedule that determines which clutches must engage and disengage in order to reach a certain gear.

Shift linkage position variant for Dog Clutch block

The Dog Clutch block now includes a variant that accepts the linkage position directly as a physical signal input instead of through a translational conserving port. The new variant provides a convenient means of specifying the shift linkage position when the position signal arises from a control system.

You can switch between variants in the block's context-sensitive menu. You do this by right-clicking the block and selecting **Simscape > Block choices > Physical signal position input** to use a physical signal port or **Simscape > Block choices > Mechanical port shift linkage** to use a translational conserving port.

Featured example showing four-wheel drive test bed

A new featured example shows how to model the dynamics of a "Four-Wheel Drive Testbed".

R2014b

Version: 2.7

New Features

Bug Fixes

Unidirectional locking option in Disk Friction Clutch block

The Disk Friction Clutch block includes a new parameter, **Directionality**. This parameter enables you to model bidirectional and unidirectional clutches. Bidirectional clutches can slip in the positive and negative directions while unidirectional clutches can slip only in the positive direction. The slip direction is positive if the follower shaft spins faster than the base shaft and negative if it spins slower.

R2014a

Version: 2.6

New Features

Bug Fixes

Cycloidal Drive block

Model a high-ratio speed-reduction mechanism based on the eccentric motion of a cycloidal disk in mesh with a ring gear. The Cycloidal Drive block includes efficiency losses in normal and reverse operation modes. This block is in the Gears library.

Harmonic Drive block

Model a high-ratio speed-reduction mechanism based on the elastic deformation of a flexible pinion in mesh with a ring gear. The Harmonic Drive block includes efficiency losses due to meshing between teeth and viscous friction at the ball bearings. This block is in the Gears library.

Lookup-table friction parameterization in synchronizer blocks

Compute contact friction in synchronizer blocks using a lookup-table parameterization. You can select the new parameterization from the Cone Clutch tab of the Synchronizer and Double-Sided Synchronizer block dialog boxes.

R2013b

Version: 2.5

New Features

Bug Fixes

Universal Joint block

The SimDriveline Couplings & Drives library provides one new block, Universal Joint. This block represents a rotational coupling that connects two driveline shafts at an arbitrary angle.

Double-Pinion Planetary Gear block

The SimDriveline Gears library provides one new block, Double-Pinion Planetary Gear. This block represents a planetary gear train containing two meshed planet gear sets between its sun and ring gears.

Helicopter transmission featured example

A new featured example models the dynamics of a "Helicopter Transmission" system.

R2013a

Version: 2.4

New Features

Bug Fixes

Translational Power Sensor and Rotational Power Sensor blocks

SimDriveline contains a new library, Sensors. The library contains two blocks.

Block	Description
Translational Power Sensor	Mechanical sensor used to measure average or instantaneous translational power
Rotational Power Sensor	Mechanical sensor used to measure average or instantaneous rotational power

Variable and nonlinear spring and damper component library

The Couplings & Drives library contains a new sublibrary, Springs & Dampers. The sublibrary contains eight blocks.

Block	Description
Nonlinear Translational Spring	Translational spring with nonlinear force-displacement curve
Nonlinear Translational Damper	Translational damper with nonlinear force-velocity curve
Nonlinear Rotational Spring	Rotational spring with nonlinear torque-displacement curve
Nonlinear Rotational Damper	Rotational damper with nonlinear torque-velocity curve
Variable Translational Spring	Translational spring with variable spring stiffness
Variable Translational Damper	Translational damper with variable damping coefficient
Variable Rotational Spring	Rotational spring with variable spring stiffness
Variable Rotational Damper	Viscous rotational damper with variable damping coefficient

Shock Absorber block

The Couplings & Drives library contains one new block.

Block	Description
Shock Absorber	Linear spring-damper with friction and hard stops

Simple Gear with Variable Efficiency block

The Gears library contains one new block.

Block	Description
Simple Gear with Variable Efficiency	Simple gear with externally specified meshing efficiency

Fuel consumption and idle speed controller added to Generic Engine block

The Generic Engine block contains new options:

- Specify and sense engine fuel consumption
- Specify an idle speed controller to prevent engine stall at low engine speeds

Featured examples

Three new featured examples are available:

- Engine Braking
- Simpson Three-Speed Transmission
- Suspension System Comparison

R2012b

Version: 2.3

New Features

Bug Fixes

Double-Shoe Brake and Band Brake blocks

SimDriveline adds two blocks to the Brakes and Detents library:

Block	Description
Double-Shoe Brake	Friction brake with two diametrically opposed rigid shoes positioned about a rotating drum
Band Brake	Friction brake with a flexible band wrapped around a rotating drum

Double-Sided Synchronizer and Synchronizer blocks

SimDriveline adds two blocks to the Clutches library:

Block	Description
Synchronizer	Clutch synchronizer with one dog clutch, one cone clutch, and one detent
Double-Sided Synchronizer	Double-sided clutch synchronizer with two dog clutches, two cone clutches, and one detent

Rolling Resistance block for custom tire models

SimDriveline adds one block to the Tires & Vehicles Library:

Block	Description
Rolling Resistance	Resistance force due to road-wheel contact

Optional rolling resistance in Tire (Friction Parameterized) and Tire (Magic Formula) blocks

The Tire (Friction Parameterized) and Tire (Magic Formula) blocks introduce an optional set of rolling resistance parameters. Represent tire rolling resistance with a constant resistance coefficient or with a pressure and velocity-dependent model that meets the SAE J2452 standard.

Five-speed transmission demonstration model with individually controlled double-sided synchronizers

A new example demonstrates a five-speed transmission model. The model contains five forward gears and one reverse gear driven by an engine. Proportional control systems govern a set of double-sided synchronizers that engage each gear with an output shaft.

Four new examples

SimDriveline introduces four examples:

- Five-Speed Transmission (highlighted above)

- Reversing Transmission
- Hydromechanical Hoist
- Braking Mechanism

R2012a

Version: 2.2

New Features

Bug Fixes

Compatibility Considerations

New Blocks

New Couplings and Drives Block

Block	Description
Belt Drive	Model a belt drive
Belt Pulley	Model a belt pulley
Chain Drive	Model a chain drive
Rope Drum	Model a rope drum

New Tire Blocks

Block	Description
Tire (Friction Parameterized)	Model a tire using kinetic and static friction coefficients
Tire (Simple)	Model a no-slip tire with minimal parameters

New and Updated Examples

New Examples

Example	Description
Stepping Mechanism with Detents sdl_stepping_mechanism_with_detents	Models a stepping mechanism, including using Translational Detent blocks.
Power Window System sdl_power_window	Models a power window system, including using the new Rope Drum and Belt Pulley blocks.
Sheet Metal Feeder sdl_sheet_metal_feeder	Models the feeding mechanism of a sheet metal cutter, including the use of the Loaded Contact Translational Friction block.

Updated Example

The "Vehicle with Four-Wheel Drive" example (sdl_4wd_dynamics) now uses Simulink subsystem variants to allow testing with several different tire models.

Input Filtering Usability Enhancements in SimDriveline Version 2 Transitional Library Blocks

SimDriveline Version 2 Transitional library blocks that accept Simulink inputs now have an **Input Handling** tab. You can choose between no filtering, first-order filtering, and second-order filtering with a time constant that you specify. For more information, see Input Handling Options in Version 2 Transitional Library Blocks.

Some Transitional library blocks have multiple Simulink input ports. Changing the settings under the **Input Handling** tab affects all Simulink input ports equally.

Simulink-PS Converter blocks provide input handling options in Transitional library blocks. The SimDriveline software uses these Simscape blocks in the architecture of the Transitional library blocks. These blocks exist behind a mask. For more information, see Input Filtering Usability Enhancements and Simulink-PS Converter.

Note In the Version 2 Transitional library, the Motion Actuator block does not require an acceleration input. The input port is still present to provide a consistent block interface, but it no longer uses an acceleration signal. For more information, see version 2 transitional library.

Compatibility Considerations

When using an explicit Simulink solver in a SimDriveline Version 2 model, you must specify a sufficient number of input derivatives in the **Input Handling** tab. Failure to do so results in an error.

R2011b

Version: 2.1

New Features

Compatibility Considerations

New and Updated Blocks

New Blocks

These blocks have been added in Version 2.1.

- Flexible Shaft
- Rotational Detent
- Translational Detent

Updated Blocks

These blocks have been improved in Version 2.1.

Block	Enhancement
Generic Engine	Simulation diagnostics added
Torque Converter	Additional parameterization options
Variable Ratio Transmission	Simulation diagnostics added

Changes to Data Logging Object Naming

If you log data in a SimDriveline model using the Simscape data logging feature, some internal node and subcomponent names will change when you log data from an unchanged model using SimDriveline 2.1, as compared with Version 2.0.

These changes enhance your understanding of the internal structure of SimDriveline models, as reflected in the data logging object.

Compatibility Considerations

If you have written a script that depends on the specific names of nodes and subcomponents in SimDriveline data logging objects, you need to update your script so that it conforms with the new naming scheme.

New Examples

The new version contains four new examples illustrating how to model hybrid (gasoline-electric) transmissions with SimDriveline software.

- sdl_power_split_hybrid
- sdl_parallel_hybrid
- sdl_series_hybrid
- sdl_dual_mode_hybrid

Improved Documentation

Manual Reconstruction of Version 1 Models

The reference chapter on working with legacy Version 1 models and libraries has been expanded with a new section on how to rebuild Version 1 models in Version 2 without automatic conversion. See Manual Reconstruction of Version 1 Models in Version 2 in Relationship of Version 1 and Version 2.

R2011a

Version: 2.0

New Features

Compatibility Considerations

SimDriveline 2.0 Software

SimDriveline 2.0 is a new version of an existing product in the Physical Modeling family that models and simulates drivetrain systems. The new version is fully integrated with Simscape software and supports physical connections, physical signals, data logging, local solvers, and other Simscape features. At the same time, this new version extends the Simscape library with additional rotational and translational mechanical components.

With SimDriveline software, you can model bodies rotating around and translating along multiple axes, connect them with gears, and create powertrains with clutches, transmissions, and other dynamic elements and subsystems. SimDriveline software also lets you actuate and measure torques, forces, and motion. You can model, simulate, analyze, and control the motion of complex drivetrains.

SimDriveline 2.0 also includes:

- Components that couple rotational and translational motion.
- Gears with optional friction loss.
- Clutches using Coulomb friction that lock and unlock.
- Improved algorithms for simulation of redundant dynamic constraints.
- A translator function to convert Version 1 models and user-defined libraries to be compatible with the new Version 2 product library.

Required Products

SimDriveline software is an extension of the Simscape product and requires these products:

- MATLAB
- Simulink
- Simscape

Selected Version 2 Capabilities Based on Simscape Software

For an introduction to Simscape blocks, modeling, and simulation, consult the *Simscape Getting Started Guide*.

For learn more about the Simscape features that improve how you model and simulate driveline systems, see these sections of the *Simscape User's Guide*:

- Basic Principles of Modeling Physical Networks.
- Data Logging.
- Setting Up Solvers for Physical Models and Customizing Solvers for Physical Models.

To learn how to define Simscape based blocks programmatically, see the *Simscape Language Guide*.

For details on Simscape mechanical and utility blocks that replace certain Version 1 blocks, see the block categories in the *Simscape Reference*.

Selected Version 2.0 Features Compared with Version 1 Features

Features Improved in Version 2.0

- Efficiency and other frictional losses in Version 2 gears.

  These loss features are now built into the gear blocks. MathWorks® recommends that you select adaptive zero-crossing in the Configuration Parameters menu of models that include gears with efficiency loss.

- Data logging without sensors.

  Version 2 supports the Simscape data logging capability.

- Simscape fixed-step local solver now supported.

  You can use a separate local, fixed-step solver on physical networks in Version 2 models.

- Redundant dynamic constraints now solved without errors.

  In Version 2 models, when ideal clutches lock and carry the same load, the load is now distributed between the clutches without generating simulation errors.

Features Changed in Version 2.0

- Certain mechanical rotational components in the Version 1 library now provided by the Simscape Foundation library, in its mechanical and utilities sublibraries.

  These equivalent components include Solver Configuration, Inertia, various sensors and sources, and simple rotational mechanisms.

- Direct connection to other Simscape components.

  You can directly connect Version 2 blocks to other components based on Simscape software, without an interface component, as long as you respect the Simscape rules concerning physical ports and connections. SimDriveline driveline ports and connection lines are now mechanical conserving rotational or translational ports and physical connection lines.

- Motion initial conditions set in Version 2 Inertia and Mass blocks.

  In Version 1, you set initial conditions in a separate block.

- Simulink variable-step solvers for variable-step simulation.

  Version 2 is compatible with all Simulink solvers. For variable-step simulation, MathWorks recommends that you select `ode23t` or `ode15s` in your model Configuration Parameters menu.

Other Changes in Version 2.0

- Version 2 generated code simulation is slower than with Version 1.

- Tunable parameters are not supported with the SimDriveline 2 libraries.

  Changing block parameter values for simulating with generated code requires changing those parameter values in the block dialog boxes and regenerating the code from the model. A workaround is:

  1. Create your own versions of the blocks using the Simscape language.
  2. Make the parameters that you want to tune into signal inputs by defining the input values as Simulink Constant blocks.

3 Convert these Simulink constant signals into physical signals with Simulink-PS Converter blocks.

4 Tune the Constant block values during the simulation.

Working with Version 1 Models and Libraries

Compatibility Considerations

Block diagrams built from Version 1 and block diagrams built from Version 2 can coexist in the same model or library. You can indirectly connect Version 1 block diagrams and Version 2 block diagrams using Version 1 Rotational Coupling interface blocks. You cannot connect them directly.

You can continue to create and use Version 1 models and libraries, separately from Version 2 models and libraries.

Converting Models and Libraries from Version 1 to Version 2

Optionally, you can convert models and user-defined libraries from Version 1 to Version 2 with a model conversion utility, accessed through the `sdl_update` function. This utility creates new models and user-defined libraries with Version 1 components replaced by new versions using a transitional library that is based on the SimDriveline 2 and Simscape libraries.

For more information on conversion, see the `sdl_update` function reference page and Relationship of Version 1 and Version 2.

Accessing Version 1

The Version 1 library and documentation are included with Version 2.

Accessing the Version 1 Library

To open the Version 1 library, at the command line, enter `drivelib` or `driveline`.

Accessing the Version 1 Examples

To view a list of the Version 1 example models, do one of the following:

- In the Help browser, on the Version 1 SimDriveline product roadmap page, click the product examples link.
- At the command line, enter `help drivedemos`.

If you use the command line, the examples list appears at the command line. If you click a linked individual example model name, information about that model appears at the command line.

Accessing the Version 1 Documentation

To access the Version 1 documentation, access the online version of the Version 2 release notes through the Help browser or at the MathWorks Web site, `www.mathworks.com`.