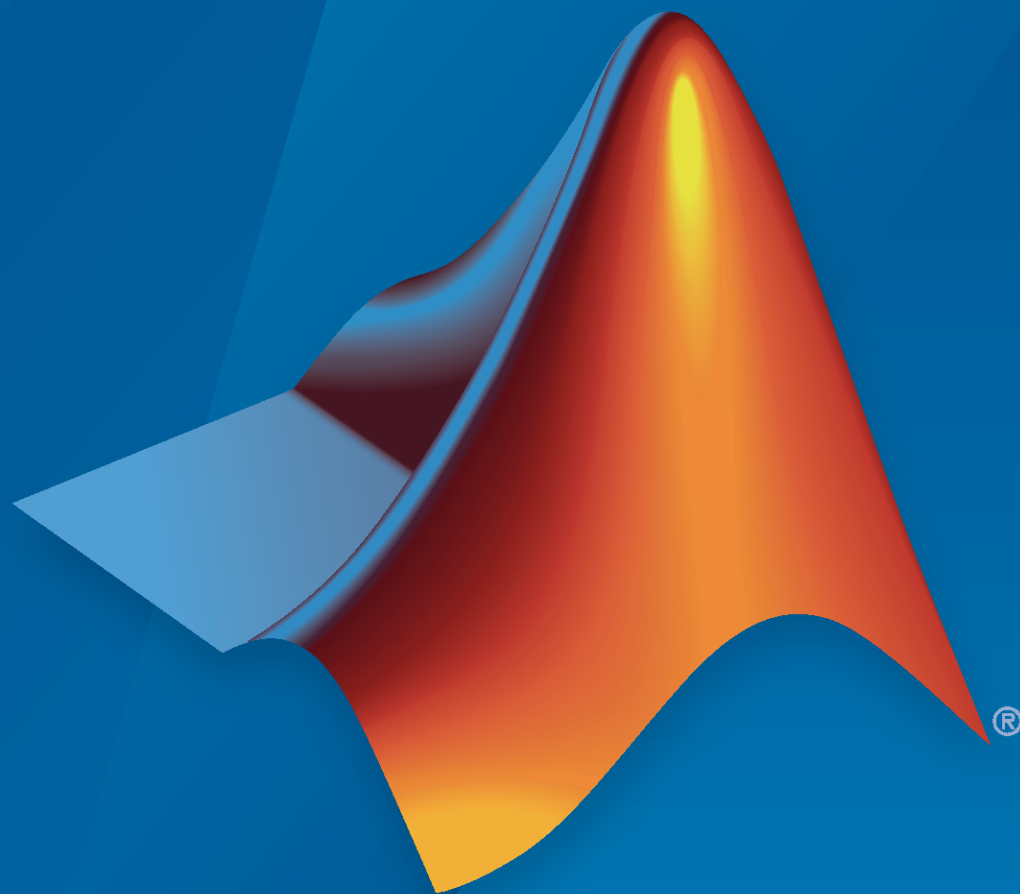


Vehicle Dynamics Blockset™ Release Notes



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Vehicle Dynamics Blockset™ Release Notes

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R2020b

Vehicles and Trailers: Implement 6DOF trailers and vehicles with three axles	1-2
Simulation 3D Blocks: Visualize tractors and trailers in the Unreal Engine 3D environment	1-2
Camera Views: Usability improvements, including controls for visualizing vehicle acceleration, pitch, and roll	1-2
Smooth Transition Between Views	1-2
Cycle Through Vehicles in Scene	1-3
Vehicle Acceleration and Rotation	1-3
Vehicle Pitch and Roll	1-4
Camera Distance	1-4
Free-Camera Views	1-5
Driver Blocks: Implement Stanley method for lateral control	1-5
Hitches: Implement hitch forces, moments, and lateral offsets in all vehicle and trailer blocks	1-5
Scene Customization Workflows: Place cameras and animate actors in Unreal Editor	1-6

R2020a

Vehicle and Trailer Blocks: Implement 3DOF trailers and vehicles with three axles	2-2
Drive Cycle Fault Tracking: Identify drive cycle faults specified by standardized tests	2-2
Driver Blocks: Configure inputs to control acceleration, deceleration, and steering commands	2-2
Headless Mode: Run 3D simulations without opening the Unreal Engine 3D visualization display	2-3
Inertial Measurement Unit Block: Implement a three-axis inertial block to measure accelerations and angular rates	2-3

3D Simulation Version Upgrade: Run 3D simulations using Unreal Engine, Version 4.23	2-3
Simulation 3D Scene Configuration Block: Improved parameter options for using customized scenes	2-3
New Vehicle Type: Implement a box truck vehicle in 3D simulations	2-4

R2019b

Simulation 3D Blocks: Visualize simulations and communicate with the Unreal Engine 3D visualization environment	3-2
Vehicle Blocks: Implement vehicles in the Unreal Engine 3D visualization environment	3-3
Scene Interrogation Reference Application: Interactive vehicle control and enhanced dynamics	3-3

R2019a

Kinematics and Compliance Virtual Test Laboratory: Generate mapped suspension calibration parameters from spreadsheet data	4-2
Active Damping: Implement damping as a function of duty cycle and suspension velocity in suspension blocks	4-2
New Fiala Tire Block: Implement a simplified tire with lateral and longitudinal slip capability	4-2
Constant Radius Test: Use maneuver reference application to characterize steering and lateral vehicle dynamics	4-2
Fiala and Longitudinal Wheel Blocks: Configure blocks for ISO 28580 rolling resistance calculation	4-3
Vehicle Body Blocks: Configuration options for external inputs, including forces, moments, and air temperature	4-3
Differential Blocks: Account for efficiency as a function of torque, temperature, and driveshaft speed	4-4
Maneuver Reference Applications: Position vehicle in scene-specific recommended locations	4-5

Active Differential Block: Model a spur or dual planetary active differential gear for applications such as torque vectoring	5-2
Vehicle Body 6DOF Block: Include additional loads on the vehicle body such as passengers, powertrain components, and cargo	5-2
Kinematics and Compliance Virtual Test Laboratory: Use a reference application to calibrate suspension parameters	5-2
Unreal Engine 4 Interface: Use support package to customize and install additional 3D scenes	5-2
Driver Blocks: Implement predictive driver control to generate commands that track lateral reference and longitudinal speed, including reverse	5-4
Maneuver Reference Applications: Use 3D environment ray tracing to determine ground location under tires during vehicle maneuver	5-5
Virtual Calibration: Use Model-Based Calibration Toolbox to calibrate SI and CI mapped engine blocks	5-6
Maneuver Reference Applications: Display ISO 15037-1:2006 standard measurement signals after you run a maneuver	5-6

Introducing Vehicle Dynamics Blockset	6-2
Preassembled vehicle dynamics models for passenger cars and trucks	6-2
Preassembled maneuvers for common ride and handling tests, including a double-lane change	6-3
3D environment for visualizing simulations and communicating scene information to Simulink	6-4
Libraries of propulsion, steering, suspension, vehicle body, brake, and tire components	6-4
Combined longitudinal and lateral slip dynamic tire models	6-4
Predictive driver model for generating steering commands that track a predefined path	6-5

Prebuilt 3D scenes, including straight roads, curved roads, and parking lots	6-5
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R2020b

Version: 1.5

New Features

Bug Fixes

Vehicles and Trailers: Implement 6DOF trailers and vehicles with three axles

The Vehicle Body block library now contains blocks that implement a six degree-of-freedom (DOF) trailer and a six DOF vehicle with three axles. To analyze the vehicle dynamics under different loading conditions, you can use the block **Inertial Loads** parameters.

- Vehicle Body 6DOF Three Axles — Models a three-axle vehicle body.
- Trailer Body 6DOF — Models a two- or three-axle trailer body.

For examples that use the blocks, see “Three-Axle Tractor Towing a Three-Axle Trailer” and “Two-Axle Tractor Towing a Two-Axle Trailer”.

Simulation 3D Blocks: Visualize tractors and trailers in the Unreal Engine 3D environment

Use the blocks to visualize tractors and trailers in the Unreal Engine® 3D environment when you develop control algorithms for standard maneuvers like the split-friction test. This table provides the block descriptions.

Block	Description
Simulation 3D Tractor	Implements a three-axle conventional or cab-over tractor in the 3D simulation environment.
Simulation 3D Trailer	Implements a two- or three- axle trailer in the 3D visualization environment.

For an example that uses the blocks, see “Three-Axle Tractor Towing a Three-Axle Trailer”.

For the minimum hardware required to use the blocks, see “3D Visualization Engine Requirements and Limitations”.

Camera Views: Usability improvements, including controls for visualizing vehicle acceleration, pitch, and roll

The camera views in the Unreal Engine 3D visualization environment include these usability improvements.

Smooth Transition Between Views

Press the keyboard keys 0-9 to transition smoothly between vehicle camera views.



Cycle Through Vehicles in Scene

Press the **Tab** key to cycle the view between all vehicles in the scene.



Vehicle Acceleration and Rotation

Press the **L** key to toggle a camera lag effect on or off. When you enable the lag effect, the camera view includes:

- Position lag, based on the vehicle translational acceleration
- Rotation lag, based on the vehicle rotational velocity

This lag enables improved visualization of overall vehicle acceleration and rotation.



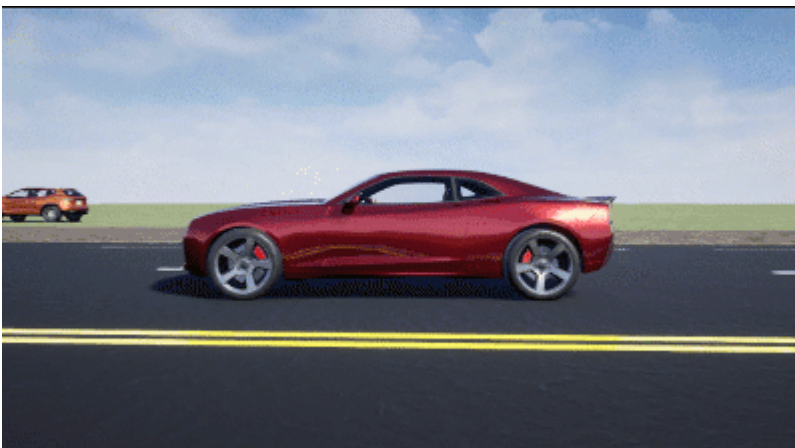
Vehicle Pitch and Roll

The views lock the camera pitch and roll to the horizon, providing improved visualization of the vehicle pitch and roll.



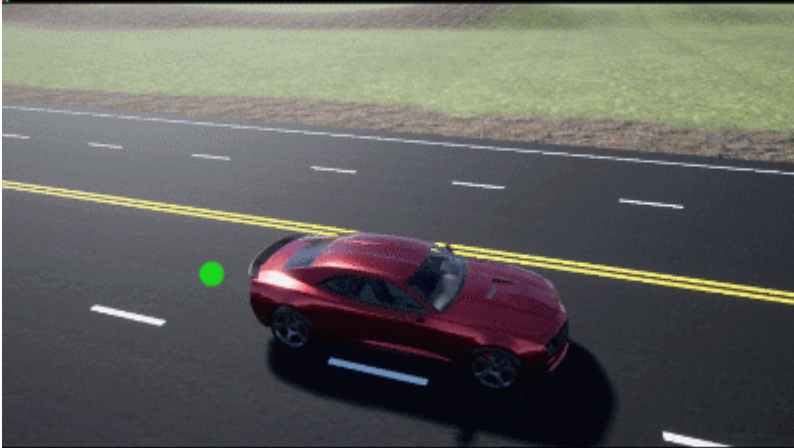
Camera Distance

To control the camera distance from the vehicle, use the mouse scroll-wheel.



Free-Camera Views

Press the **F** key to toggle the free camera mode on or off. When you enable the free camera mode, you can use the mouse to change the pitch and yaw of the camera. This mode enables you to orbit the camera around the vehicle.



Driver Blocks: Implement Stanley method for lateral control

The Lateral Driver and Predictive Driver blocks include an option to implement the Stanley method for lateral control. This method uses a control law that minimizes the difference between the vehicle position and angle and a reference vehicle position and angle.

To configure the blocks to use the Stanley method, set **Lateral control type, controlTypeLat** to Stanley. On the **Reference Control** pane, use the **Include dynamics** parameter to specify the type of model for the controller to use.

Setting	Implementation
off	Controller uses a kinematic bicycle model that is suitable for path following in low-speed environments such as parking lots, where inertial effects are minimal.
on	Controller uses a dynamic bicycle model that is suitable for path following in high-speed environments such as highways, where inertial effects are more pronounced.

Hitches: Implement hitch forces, moments, and lateral offsets in all vehicle and trailer blocks

On the **Input signals** pane parameter of the vehicle body and trailer blocks, you can select **Hitch forces** and **Hitch moments** to create input ports for the hitch forces and moments. Additionally, you can specify a lateral hitch offset.

Input Signals Pane Parameter	Input Port	Description
Hitch forces	Fh	Hitch force applied to the body at the hitch location, Fh_x , Fh_y , and Fh_z , in the vehicle-fixed frame
Hitch moments	Mh	Hitch moment at the hitch location, Mh_x , Mh_y , and Mh_z , about the vehicle-fixed frame

This table summarizes the vehicle and trailer block changes to implement the hitch force and moment input.

Block	Hitch Force and Moment Input Change
Vehicle Body 3DOF	<i>New — Option available in R2020b</i>
Vehicle Body 6DOF	
Vehicle Body 3DOF Three Axles	<i>None — Option available when blocks were introduced in R2020a</i>
Trailer Body 3DOF	
Vehicle Body 6DOF Three Axles	<i>New — Option available for new blocks introduced in R2020b</i>
Trailer Body 6DOF	

Scene Customization Workflows: Place cameras and animate actors in Unreal Editor

R2020b includes these workflows for customizing scenes and communicating with the Unreal® Editor.

Workflow	Description
“Install Support Package and Configure Environment”	To customize the scenes, start by following this workflow to install the Vehicle Dynamics Blockset™ Interface for Unreal Engine 4 Projects support package.
“Get Started Communicating with the Unreal Engine Visualization Environment”	Send and receive data from the Unreal Editor by using the Simulation 3D Message Get and Simulation 3D Message Set blocks.
“Animate Custom Actors in the Unreal Editor”	Animate a bicycle actor in the Unreal Editor by using the Simulation 3D Actor Transform Set block.
“Place Cameras on Actors in the Unreal Editor”	Place the Simulation 3D Camera Get block on static and custom actors in the Unreal Editor.

R2020a

Version: 1.4

New Features

Bug Fixes

Compatibility Considerations

Vehicle and Trailer Blocks: Implement 3DOF trailers and vehicles with three axles

The Vehicle Body block library now contains blocks that implement a three degree-of-freedom (DOF) trailer and a three DOF vehicle with three axles.

- Vehicle Body 3DOF Three Axles — Models a three-axle vehicle body with longitudinal, lateral, and yaw motion. Configure for a single or dual track.
- Trailer Body 3DOF — Models a trailer body with longitudinal, lateral, and yaw motion. Configure a two-axle or three-axle trailer with a single or dual track.

For an example that uses the blocks, see Three-Axle Tractor Towing a Trailer.

Drive Cycle Fault Tracking: Identify drive cycle faults specified by standardized tests

Use the Drive Cycle Source block to identify drive cycle faults during component, sizing, fuel economy, and emissions analysis. You can set parameters that identify the faults within tolerances specified by standardized tests, including:

- EPA dynamometer driving schedules
- Worldwide Harmonised Light Vehicle Test Procedure laboratory tests

On the Drive Cycle Source block **Fault Tracking** tab, use the parameters to specify the fault tolerances. If the vehicle speed or time tolerance is not within the allowable range, the block sets a fault condition.

Driver Blocks: Configure inputs to control acceleration, deceleration, and steering commands

The Lateral Driver, Longitudinal Driver, and Predictive Driver blocks include input options that allow you to configure simulations of standard test maneuvers, including maximum forward speed (MFS). Use the **External action** parameters to create input ports for external signals that control the accelerator, decelerator, and steering commands.

Block	External Actions
Longitudinal Driver	<ul style="list-style-type: none"> • Disable the acceleration or deceleration commands. • Hold the acceleration or deceleration commands at the current values. • Override the acceleration or deceleration commands with input commands.
Lateral Driver	<ul style="list-style-type: none"> • Disable the steering command. • Hold the steering command at the current value. • Override the steering command with an input command.
Predictive Driver	<ul style="list-style-type: none"> • Disable the acceleration, deceleration, or steering commands. • Hold the acceleration, deceleration, or steering commands at the current values. • Override the acceleration, deceleration, or steering commands with input commands.

Compatibility Considerations

R2020a renames the Longitudinal Driver block and Lateral Driver block gear command output ports from Gear to GearCmd. Models that use the blocks might have compatibility issues, including disconnected line errors. Consider replacing the blocks with the R2020a version.

Headless Mode: Run 3D simulations without opening the Unreal Engine 3D visualization display

You can run simulations in the 3D environment without visualizing the results, that is, in headless mode. To run 3D simulations in headless mode, open the Simulation 3D Scene Configuration block in a model. Clear **Display 3D simulation**. By default, the block is not configured for headless mode.

Consider running in headless mode if you want to:

- Run multiple 3D simulations in parallel to test models in different Unreal Engine scenarios.
- Optimize model parameters without visualizing the results in the Unreal Engine environment. For example, consider using headless mode if you want to tune vehicle suspension parameters over a terrain scenario defined in Unreal Engine.

Inertial Measurement Unit Block: Implement a three-axis inertial block to measure accelerations and angular rates

The Sensor block library now includes a Three-axis Inertial Measurement Unit block that contains a three-axis accelerometer and gyroscope. Use this block to measure vehicle accelerations from the accelerometer and vehicle angular rates from the gyroscope.

3D Simulation Version Upgrade: Run 3D simulations using Unreal Engine, Version 4.23

The 3D visualization engine that comes installed with Vehicle Dynamics Blockset has been updated to Unreal Engine, Version 4.23. Previously, the toolbox used Unreal Engine, Version 4.19.

For information about using Unreal Engine to create custom scenes, see Support Package for Customizing Scenes.

Compatibility Considerations

If your Simulink® model uses an Unreal Engine executable or project developed using a prior release of the *Vehicle Dynamics Blockset Interface for Unreal Engine 4 Projects* support package, the simulation will error. To migrate the project so that it is compatible with the R2020a version of the support package, see *Migrate Projects Developed Using Prior Support Packages*.

Simulation 3D Scene Configuration Block: Improved parameter options for using customized scenes

The Simulation 3D Scene Configuration block now provides improved parameter options for simulating driving scenarios within your own customized scenes. The customized scenes must be created using the Unreal Editor and must be compatible with Version 4.23.

This table summarizes the Simulation 3D Scene Configuration block parameter updates in R2020a.

To	New Parameter Settings (R2020a)	Old Parameter Settings (R2019b)
Simulate in one of the default, prebuilt scenes provided with Vehicle Dynamics Blockset.	Scene source — Default Scenes Scene name — <i>Name of prebuilt scene</i>	On the Co-Simulation tab, Co-Simulation format — Executable On the Simulation Configuration tab, Scene description — <i>Name of prebuilt scene</i>
Simulate in a scene that is part of an Unreal Engine executable file.	Scene source — Unreal Executable File name — VehicleSimulation.exe (default) or <i>Path to the executable file</i> Scene — <i>Path to the scene within the executable file</i>	On the Co-Simulation tab, Co-Simulation format — Executable On the Simulation Configuration tab: <ul style="list-style-type: none"> • Scene description — Custom • Project name — <i>Path to the executable file, followed by the path to the scene within the file</i>
Simulate in a scene that is part of an Unreal Engine project (.uproject) file and is open in the Unreal Editor.	Scene source — Unreal Editor Project — <i>Path to project file</i>	On the Co-Simulation tab, Co-Simulation format — Editor

To use customized scenes, you must install the Vehicle Dynamics Blockset Interface for Unreal Engine 4 Projects support package. For details, see Support Package for Customizing Scenes.

New Vehicle Type: Implement a box truck vehicle in 3D simulations

You can configure the Simulation 3D Vehicle and Simulation 3D Vehicle with Ground Following blocks to implement a box truck in 3D simulations. To configure the vehicle blocks, set **Type** to Box truck. For the vehicle dimensions see, Box Truck.

R2019b

Version: 1.3

New Features

Bug Fixes

Compatibility Considerations

Simulation 3D Blocks: Visualize simulations and communicate with the Unreal Engine 3D visualization environment

The Vehicle Scenarios > Sim3D > Sim3D Core block library contains new blocks and updates to existing blocks. Use the blocks to visualize simulations and communicate scene information with the Unreal Engine 3D visualization environment. This table summarizes the updates.

Block	Update
Simulation 3D Message Get	<p><i>New</i></p> <p>The block retrieves data from the Unreal Engine 3D visualization environment. To use the block:</p> <ul style="list-style-type: none"> • Install the Support Package for Customizing Scenes. • In the Unreal Engine environment, set up blueprint or C++ actor classes that can send the data to Simulink.
Simulation 3D Message Set	<p><i>New</i></p> <p>The block sends data to the Unreal Engine 3D visualization environment. To use the block:</p> <ul style="list-style-type: none"> • Install the Support Package for Customizing Scenes. • In the Unreal Engine environment, set up blueprint or C++ actor classes that can receive the Simulink data.
Simulation 3D Scene Configuration	<p>Block renamed from Simulation 3D Config.</p> <p>In R2019b, the block does not include these output ports:</p> <ul style="list-style-type: none"> • State — Visualization engine state • Ts — Visualization engine sample time
Simulation 3D Actor Transform Get	<p>Parameters that allow you to get the position, rotation, and scale for scene actors, including vehicles.</p> <p>Previously, you had to specify a vehicle or camera actor type. In R2019b, use the Simulation 3D Camera Get block to configure a scene camera and get the camera image.</p>
Simulation 3D Actor Transform Set	<p>Parameters that allow you to set the position, rotation, and scale for scene actors, including vehicles.</p> <p>Previously, you had to specify a vehicle or camera actor type. In R2019b, use the:</p> <ul style="list-style-type: none"> • Simulation 3D Camera Get block to configure a scene camera and get the camera image. • Simulation 3D Vehicle with Ground Following or Simulation 3D Vehicle block to configure a vehicle.
Simulation 3D Camera Get	<p>Mounting parameters that allow you to specify the location of the camera in the 3D visualization environment.</p>

For the minimum hardware required to use the blocks, see 3D Visualization Engine Requirements.

Compatibility Considerations

Models that use these simulation 3D blocks might have compatibility issues, including disconnected line errors. Consider replacing the blocks with the R2019b version.

Vehicle Blocks: Implement vehicles in the Unreal Engine 3D visualization environment

The Vehicle Scenarios > Sim3D > Sim3D Vehicle block library includes blocks that implement vehicles in the Unreal Engine 3D visualization environment. This table summarizes the new vehicle blocks.

Block	Description
Simulation 3D Vehicle with Ground Following	<i>New</i> Implements a vehicle with four wheels that follows the ground in the 3D visualization environment. The block uses the vehicle position to adjust the vehicle elevation, roll, and pitch so that the vehicle follows the ground terrain. It determines the vehicle velocity and heading and adjusts the steering angle and rotation for each wheel. You can select the type of vehicle, color, and initial position and rotation.
Simulation 3D Vehicle	<i>New</i> Implements a vehicle in the 3D visualization environment. The block uses the vehicle translation and rotation to place a vehicle with four wheels in the visualization environment. You can select the type of vehicle, color, and initial position.

For the minimum hardware required to use the blocks, see 3D Visualization Engine Requirements.

Scene Interrogation Reference Application: Interactive vehicle control and enhanced dynamics

The scene interrogation with camera and ray tracing reference application includes:

- Dials and gauges to control the vehicle steering, braking, and throttle in the 3D visualization environment.
- Powertrain, driveline, and steering models.
- Vehicle dynamics model for a 3 degree-of-freedom (DOF) vehicle.

Use the reference application to integrate a 3-DOF vehicle in the 3D visualization environment. The 3D visualization environment uses the Unreal Engine by Epic Games®.

To create and open a working copy of the camera and ray tracing reference application project, enter `vdynblksSceneCameraRayStart`

For the minimum hardware required to run the reference application, see 3D Visualization Engine Requirements.

For more information about the reference application, see Scene Interrogation in 3D Environment.

R2019a

Version: 1.2

New Features

Bug Fixes

Compatibility Considerations

Kinematics and Compliance Virtual Test Laboratory: Generate mapped suspension calibration parameters from spreadsheet data

In the kinematics and compliance virtual test laboratory, select **Generate Mapped Suspension from Spreadsheet Data** to generate mapped suspension calibration parameters from measured vertical force and suspension geometry data. The virtual test lab uses Model-Based Calibration Toolbox™ to fit camber angle, toe angle, and vertical forces to generate calibrated suspension parameters for the mapped suspension blocks.

For more information, see Kinematics and Compliance Virtual Test Laboratory.

Active Damping: Implement damping as a function of duty cycle and suspension velocity in suspension blocks

During open-loop and closed-loop suspension feedback control algorithm development, you can configure the Independent Suspension - Double Wishbone and Independent Suspension - MacPherson suspension blocks to implement active damping. Use the **Enable active damping** parameter.

Enable Active Damping Setting	Damping Implementation
off	Constant
on	Lookup table as a function of active damper duty cycle and actuator velocity

New Fiala Tire Block: Implement a simplified tire with lateral and longitudinal slip capability

Use the Fiala Wheel 2DOF block to implement a simplified tire with lateral and longitudinal slip capability. The block uses a translational friction model to calculate the forces and moments during combined longitudinal and lateral slip, requiring fewer parameters than the Combined Slip Wheel 2DOF block. If you do not have the tire coefficients needed by the Magic Formula, consider using this block for studies that do not involve extensive nonlinear combined lateral slip or lateral dynamics. If your study does require nonlinear combined slip or lateral dynamics, consider using the Combined Slip Wheel 2DOF block.

Constant Radius Test: Use maneuver reference application to characterize steering and lateral vehicle dynamics

This reference application represents a full vehicle dynamics model undergoing a constant radius test maneuver. You can create your own versions, establishing a framework to test that your vehicle meets the design requirements under normal and extreme driving conditions. Use this reference application in ride and handling studies and chassis controls development to characterize the steering and lateral vehicle dynamics. For information about the similar maneuvers, see standards SAE J266_199601 and ISO 4138:2012.

To create and open a working copy of the constant radius reference application, enter

```
vdynblksConstRadiusStart
```

For more information about the maneuver, see Constant Radius Maneuver.

Fiala and Longitudinal Wheel Blocks: Configure blocks for ISO 28580 rolling resistance calculation

To help your models comply with ISO 28580:2018, *Passenger car, truck and bus tyre rolling resistance measurement method — Single point test and correlation of measurement results*, you can configure the Fiala Wheel 2DOF and Longitudinal Wheel blocks to use the ISO 28580:2018 rolling resistance calculation.

To configure the blocks for the ISO calculation, set the **Rolling Resistance** parameter to ISO 28580.

Vehicle Body Blocks: Configuration options for external inputs, including forces, moments, and air temperature

The vehicle body blocks have new options for configuring the block with external inputs. The options provide more flexibility when you incorporate your blocks into full vehicle models. The table summarizes the settings.

Block	New External Input Ports	Block Option Setting		Description
Vehicle Body 1DOF Longitudinal	FExt	External forces		External force applied to vehicle CG in vehicle-fixed frame.
	MExt	External moments		External moment about vehicle CG in vehicle-fixed frame.
	AirTemp	Air temperature		Ambient air temperature. Consider this option if you want to vary the temperature during runtime.
	WindXYZ	Wind X,Y,Z		Wind speed along earth-fixed X-, Y-, and Z-axes. If you do not select this option, the block implements input port WindX — Longitudinal wind speed along the earth-fixed X-axis.
Vehicle Body 3DOF Longitudinal	FExt	External forces		External force applied to vehicle CG in vehicle-fixed frame.
	MExt	External moments		External moment about vehicle CG in vehicle-fixed frame.
	AirTemp	Air temperature		Ambient air temperature. Consider this option if you want to vary the temperature during runtime.
Vehicle Body 3DOF	X_o	Input signals pane	Initial longitudinal position	Initial vehicle CG displacement along earth-fixed X-axis, in m

Block	New External Input Ports	Block Option Setting	Description	
<i>R2018a included block options to input the external forces, moments, friction, steering angles, and wind speed</i>	Y_o		Initial lateral position	Initial vehicle CG displacement along earth-fixed Y-axis, in m
	xdot_o		Initial longitudinal velocity	Initial vehicle CG velocity along vehicle-fixed x-axis, in m/s
	ydot_o		Initial lateral velocity	Initial vehicle CG velocity along vehicle-fixed y-axis, in m/s
	psi_o		Initial yaw angle	Initial rotation of vehicle-fixed frame about earth-fixed Z-axis (yaw), in rad
	r_o		Initial yaw rate	Initial vehicle angular velocity about the vehicle-fixed z-axis (yaw rate), in rad/s
	AirTemp		Air temperature	Ambient air temperature. Consider this option if you want to vary the temperature during runtime.
Vehicle Body 6DOF	AirTemp	Environment pane	Air temperature	Ambient air temperature. Consider this option if you want to vary the temperature during runtime.

Compatibility Considerations

Models that use the vehicle body blocks might have disconnected line errors. Consider replacing the blocks with the R2019a version.

Differential Blocks: Account for efficiency as a function of torque, temperature, and driveshaft speed

To account for Open Differential and Limited Slip Differential block power and energy losses, you can use the **Efficiency factors** parameter. This table summarizes the block implementation for each setting.

Setting	Implementation
Constant	Constant efficiency that you can set with the Constant efficiency factor, eta parameter.

Setting	Implementation
Driveshaft torque, temperature and speed	<p>Efficiency as a function of base gear input torque, air temperature, and driveshaft speed. Use these parameters to specify the lookup table and breakpoints:</p> <ul style="list-style-type: none"> • Efficiency lookup table, eta_tbl • Efficiency torque breakpoints, Trq_bpts • Efficiency speed breakpoints, omega_bpts • Efficiency temperature breakpoints, Temp_bpts <p>For the air temperature, you can either:</p> <ul style="list-style-type: none"> • Select Input temperature to create an input port. • Set a Ambient temperature, Tamb parameter value.

Maneuver Reference Applications: Position vehicle in scene-specific recommended locations

When you run the maneuver reference applications in the 3D visualization environment, you can initially position the vehicle in locations that are recommended for the scene. After you open the reference applications for these maneuvers:

- Double-Lane Change Maneuver
 - Slowly Increasing Steering Maneuver
 - Swept-Sine Steering Maneuver
- 1 In the Visualization subsystem, open the 3D Engine block. Set these parameters.
 - **3D Engine** to **Enabled**.
 - **Scene** to one of the scenes.
 - 2 To position the vehicle in the scene:
 - a Select the position initialization method:
 - **Recommended for scene** — Set the initial vehicle position to values recommended for the scene
 - **User-specified** — Set your own initial vehicle position
 - b Select **Apply** to modify the initial vehicle position parameters.
 - c Click **Update the model workspaces with the initial values** to overwrite the initial vehicle position in the model workspace with the applied values.

R2018b

Version: 1.1

New Features

Bug Fixes

Active Differential Block: Model a spur or dual planetary active differential gear for applications such as torque vectoring

R2018b includes an Active Differential block that can model the active differential as an open differential coupled to either a spur or planetary differential gear set. The block uses external pressure signals to regulate the clutch pressure to either speed up or slow down each axle rotation.

Use the block in hardware-in-the-loop (HIL) and optimization workflows to dynamically couple the driveshaft to the wheel axles when you want to direct the transmission torque to a specific axle. For detailed front-wheel driving studies, use the block to couple the driveshaft to universal joints. The block is suitable to use in system-level closed-loop control studies, for example, yaw stability and torque vectoring.

Vehicle Body 6DOF Block: Include additional loads on the vehicle body such as passengers, powertrain components, and cargo

To analyze the vehicle dynamics under different loading conditions, use the Vehicle Body 6DOF block **Inertial Loads** parameters. Specifically, you can specify these loads:

- Powertrain components
- Front and rear row passengers
- Overhead cargo
- Rear cargo

Kinematics and Compliance Virtual Test Laboratory: Use a reference application to calibrate suspension parameters



If you have Model-Based Calibration Toolbox and Simscape™ Multibody™, you can use the kinematics and compliance virtual test laboratory to generate optimized suspension parameters for the Independent Suspension - Mapped and Solid Axle Suspension - Mapped blocks.

Using Model-Based Calibration Toolbox, the reference application performs a Sobol sequence design of experiments (DoE) on the suspension height, handwheel angle, chirp minimum and maximum frequency, chirp amplitude, and simulation time. At each operating point, the reference application stimulates the Simscape Multibody suspension system. The reference application then uses the data to fit the suspension force and camber angle to a Gaussian process model (GPM). Finally, the reference application uses the GPM to generate suspension parameters for the suspension blocks.

For more information, see Kinematics and Compliance Virtual Test Laboratory.

Unreal Engine 4 Interface: Use support package to customize and install additional 3D scenes

To customize and install additional scenes, use the Vehicle Dynamics Blockset Interface for Unreal Engine 4 Projects support package. The support package includes these scenes:

Scene	
US H	
US Ci	

For information about installing the support package, see Supporting Scene, Drive Cycle, and Maneuver Data.

Driver Blocks: Implement predictive driver control to generate commands that track lateral reference and longitudinal speed, including reverse

You can configure the Longitudinal Driver and Predictive Driver blocks to generate acceleration and braking commands that track lateral reference and longitudinal speed, including reverse. The blocks include these control type options.

Control Type Setting	Block Implementation
PI	Proportional-integral (PI) control with tracking windup and feed-forward gains.
Scheduled PI	PI control with tracking windup and feed-forward gains that are a function of vehicle velocity.
Predictive	Optimal single-point preview (look ahead) control model. The model represents driver steering control behavior during path-following and obstacle avoidance maneuvers. Drivers preview (look ahead) to follow a predefined path. To implement the MacAdam model, the block: <ul style="list-style-type: none"> • Represents the dynamics as a linear single track (bicycle) vehicle • Minimizes the previewed error signal at a single point T^* seconds ahead in time • Accounts for the driver lag deriving from perceptual and neuromuscular mechanisms

The blocks include these shift type options.

Shift Type Options	Block Implementation
None	No transmission. Block outputs a constant gear of 1. Use this setting to minimize the number of parameters you need to generate acceleration and braking commands to track forward vehicle motion. This setting does not allow reverse vehicle motion.
Reverse, Neutral, Drive	Block uses a Stateflow [®] chart to model reverse, neutral, and drive gear shift scheduling. Use this setting to generate acceleration and braking commands to track forward and reverse vehicle motion using simple reverse, neutral, and drive gear shift scheduling. Depending on the vehicle state and vehicle velocity feedback, the block uses the initial gear and time required to shift the vehicle up into drive or down into reverse or neutral. For neutral gears, the block uses braking commands to control the vehicle speed. For reverse gears, the block uses an acceleration command to generate torque and a brake command to reduce vehicle speed.

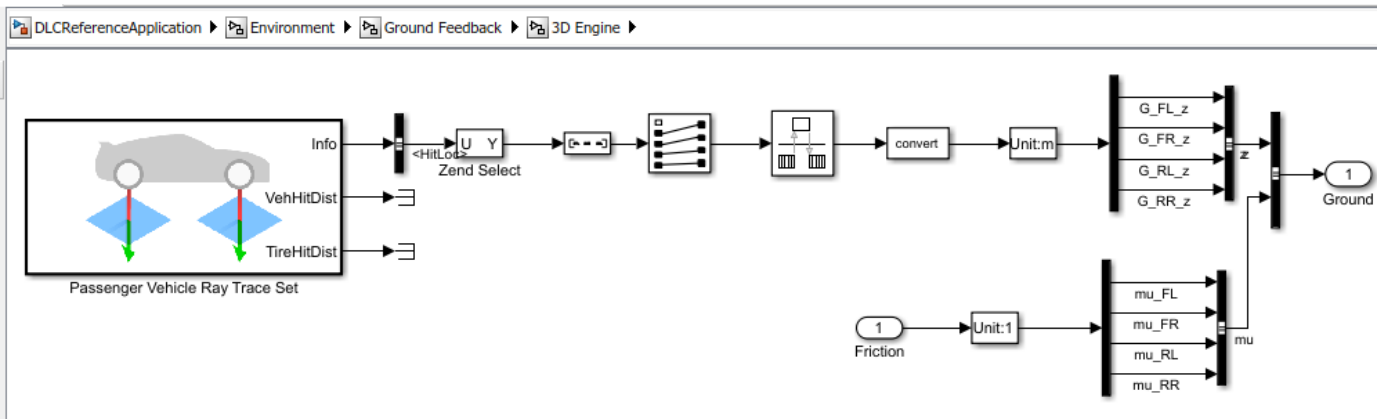
Shift Type Options	Block Implementation
Scheduled	<p>Block uses a Stateflowchart to model reverse, neutral, park, and N-speed gear shift scheduling.</p> <p>Use this setting to generate acceleration and braking commands to track forward and reverse vehicle motion using reverse, neutral, park, and N-speed gear shift scheduling. Depending on the vehicle state and vehicle velocity feedback, the block uses these parameters to determine the gear:</p> <ul style="list-style-type: none"> • Initial gear • Upshift and downshift accelerator pedal positions • Upshift and downshift velocity • Timing for shifting and engaging forward and reverse from neutral <p>For neutral gears, the block uses braking commands to control the vehicle speed. For reverse gears, the block uses an acceleration command to generate torque and a brake command to reduce vehicle speed.</p>
External	<p>Block uses the input gear, vehicle state, and velocity feedback to generate acceleration and braking commands to track forward and reverse vehicle motion.</p> <p>For neutral gears, the block uses braking commands to control the vehicle speed. For reverse gears, the block uses an acceleration command to generate torque and a brake command to reduce vehicle speed.</p>

Maneuver Reference Applications: Use 3D environment ray tracing to determine ground location under tires during vehicle maneuver

To detect the terrain below the tires in the 3D visualization environment, you can configure the maneuver reference applications to use the Vehicle Terrain Sensor block. The reference application uses the terrain feedback to determine the friction forces acting on the vehicle during the maneuver.

- 1 Open the maneuver reference application. For example, to create and open a working copy of the double-lane change maneuver reference application, enter

```
vdynblksDbllLaneChangeStart
```
- 2 In the Visualization subsystem, open the 3D Engine block. Set these parameters.
 - **3D Engine** to **Enabled**.
 - **Scene description** to one of the scenes, for example `Straight road`.
- 3 In the Environment subsystem, open the Ground Feedback subsystem. The 3D Engine variant uses the Vehicle Terrain Sensor block to determine the ground location under the tires during a vehicle maneuver.



For more information about the maneuver reference applications, see:

- Double-Lane Change Maneuver
- Slowly Increasing Steering Maneuver
- Swept-Sine Steering Maneuver

Virtual Calibration: Use Model-Based Calibration Toolbox to calibrate SI and CI mapped engine blocks

If you have the Model-Based Calibration Toolbox, you can use measured engine data to calibrate these parameters for the Mapped CI Engine and Mapped SI Engine blocks:

- Power
- Air mass flow
- Fuel flow
- Exhaust temperature
- Efficiency
- Emissions

Maneuver Reference Applications: Display ISO 15037-1:2006 standard measurement signals after you run a maneuver

You can configure the maneuver applications to display ISO 15037-1:2006 standard measurement signals in the Simulation Data Inspector, including steering wheel angle and torque, longitudinal and lateral velocity, and sideslip angle.

To configure the ISO signal display, in the reference application Visualization subsystem, open the ISO 15037-1:2006 block. Select **Enabled**. After you run the maneuver, the Simulation Data Inspector opens with ISO standard signal measurements. For more information, see ISO 15037-1:2006 Standard Measurement Signals.

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Version: 1.0

New Features

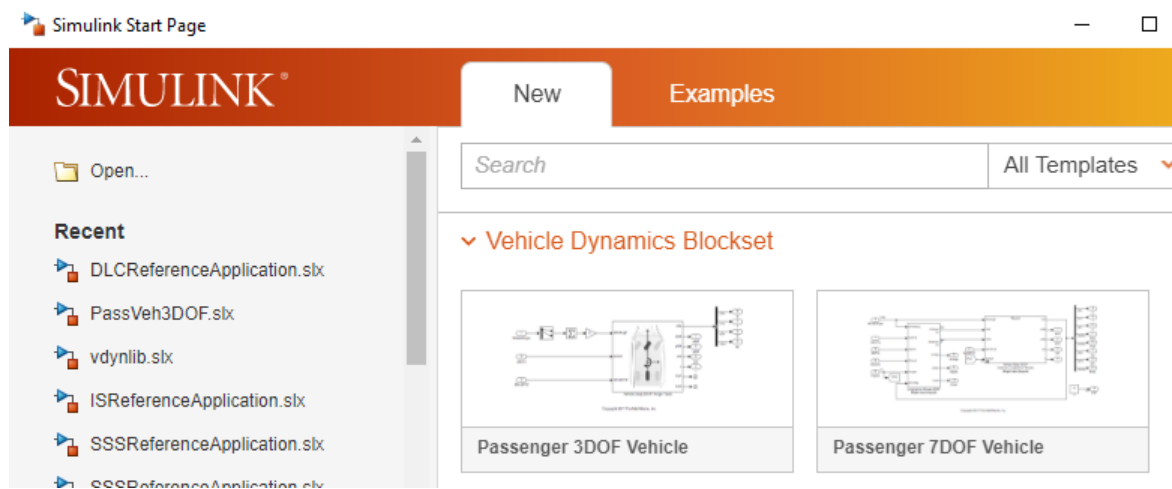
Introducing Vehicle Dynamics Blockset

Vehicle Dynamics Blockset provides fully assembled reference application models that simulate driving maneuvers in a 3D environment. You can use the prebuilt scenes to visualize roads, traffic signs, trees, buildings, and other objects around the vehicle. You can customize the reference models by using your own data or by replacing a subsystem with your own model. The blockset includes a library of components for modeling propulsion, steering, suspension, vehicle bodies, brakes, and tires.

Vehicle Dynamics Blockset provides a standard model architecture that can be used throughout the development process. It supports ride and handling analyses, chassis controls development, software integration testing, and hardware-in-the-loop testing. By integrating vehicle dynamics models with a 3D environment, you can test ADAS and automated driving perception, planning, and control software. These models let you test your vehicle with standard driving maneuvers such as a double lane change or with your own custom scenarios.

Preassembled vehicle dynamics models for passenger cars and trucks

Vehicle Dynamics Blockset provides preassembled vehicle dynamics models that you can use to analyze the dynamic system response to common ride and handling tests. Open project files that contain the vehicle models from the Simulink start page.



Vehicle Model	Description	Vehicle Body Degrees-of-Freedom (DOFs)				Wheel DOFs			
		Translational		Rotational		Translational		Rotational	
Passenger 14DOF Vehicle	<ul style="list-style-type: none"> Vehicle with four wheels Available as model variant in the maneuver reference applications 	Six				Two per wheel - eight total			
		Longitudinal	✓	Pitch	✓	Vertical	✓	Rolling	✓
		Lateral	✓	Yaw	✓				
		Vertical	✓	Roll	✓				

Vehicle Model	Description	Vehicle Body Degrees-of-Freedom (DOFs)				Wheel DOFs	
Passenger 7DOF Vehicle	<ul style="list-style-type: none"> Vehicle with four wheels Available as model variant in the maneuver reference applications 	Three				One per wheel - four total	
		Translational		Rotational		Rotational	
		Longitudinal	✓	Pitch		Rolling	✓
		Lateral	✓	Yaw	✓		
		Vertical		Roll			
Passenger 3DOF Vehicle	<ul style="list-style-type: none"> Vehicle with ideal tire 	Three				None	
		Translational		Rotational			
		Longitudinal	✓	Pitch			
		Lateral	✓	Yaw	✓		
		Vertical		Roll			

Preassembled maneuvers for common ride and handling tests, including a double-lane change

Vehicle Dynamics Blockset provides fully assembled reference applications of vehicle models running driving maneuvers in a 3D environment that is integrated with Simulink. You can create your own versions of these maneuver applications, providing a framework to test your vehicle model and subsystems.

- Double-Lane Change Maneuver
- Slowly Increasing Steering Maneuver
- Swept-Sine Steering Maneuver

To analyze the vehicle ride and handling and develop chassis controls, use the maneuvers to test your vehicle model and subsystems. Specifically, use the maneuvers to perform vehicle studies, including:

- Friction, speed, and steering sweeps
- Yaw stability
- Understeer and oversteer
- Steering sensitivity
- Lateral acceleration limit
- Split-mu
- Driveline comparisons

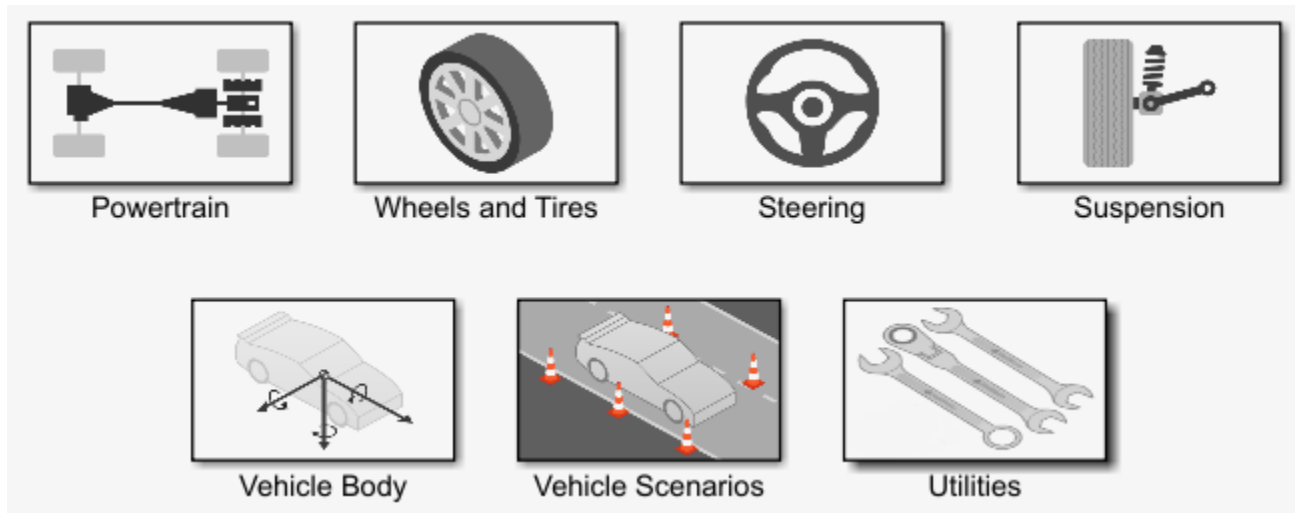
3D environment for visualizing simulations and communicating scene information to Simulink

Vehicle Dynamics Blockset integrates the 3D simulation environment with Simulink so that you can query the world around the vehicle for virtually testing perception, control, and planning algorithms. The Vehicle Dynamics Blockset visualization environment uses Unreal Engine by Epic Games.

Topic	See
How Simulink communicates with the 3D environment	Vehicle Dynamics Blockset Communication with 3D Visualization Software
3D visualization engine platform requirements, hardware recommendations, and limitations	3D Visualization Engine
Configuring the reference applications for the 3D environment	Scene Interrogation

Libraries of propulsion, steering, suspension, vehicle body, brake, and tire components

The Vehicle Dynamics Blockset provides blocks that you can use to simulate vehicles, scenarios, and scenes with vehicle body, powertrain, steering, suspension, tires, and scenario blocks. To open the block library, at the MATLAB® command-line, type `vdynlib`.

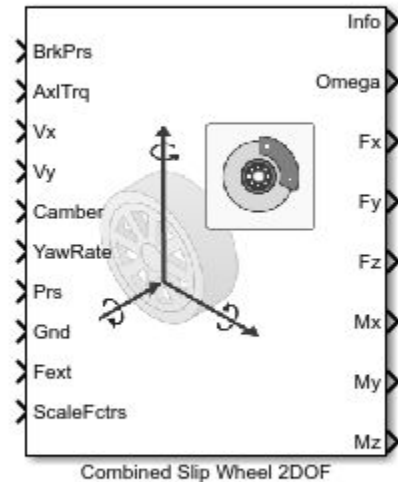
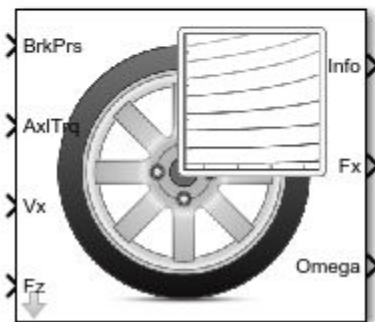
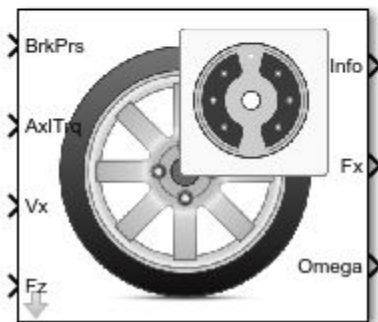
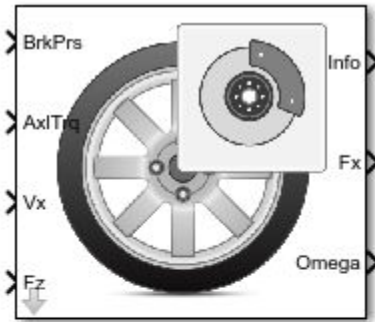
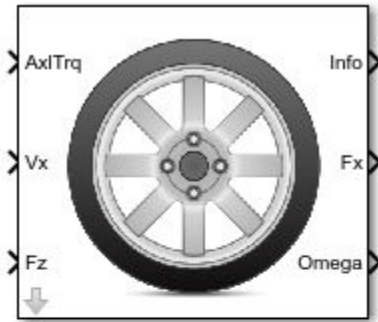


Combined longitudinal and lateral slip dynamic tire models

The Vehicle Dynamics Blockset has these tire blocks:

- Combined Slip Wheel 2DOF — Longitudinal and lateral tire dynamics. Use the **Brake Type** parameter to specify disc, drum, mapped, or no brakes.
- Longitudinal Wheel — Longitudinal tire dynamics with disc, drum, mapped, or no brakes.

To open the block library, at the MATLAB command-line, type `vdynlib`. Open **Wheels and Tires**.



Predictive driver model for generating steering commands that track a predefined path

The Predictive Driver block implements a controller that generates normalized steering, acceleration, and braking commands to track longitudinal velocity and a lateral reference displacement. Use the block to:

- Close the loop between a predefined path and actual vehicle motion.
- Generate steering commands that track predefined paths. You can connect the Predictive Driver block output to steering block inputs.
- Generate braking and acceleration commands that track a longitudinal drive cycle.

Prebuilt 3D scenes, including straight roads, curved roads, and parking lots

You can simulate driving maneuvers in prebuilt 3D scenes, including straight roads, curved roads, and parking lots. To configure the scene for a reference application driving maneuver:

- 1 Open a reference application. For example, open the double lane change reference application.
`vdynblksDbllLaneChangeStart`
- 2 In the Visualization subsystem, set the 3D Engine block parameter **Scene description** to one of the scenes, for example `Straight road`.

