Simulink®

Simulation and Model-Based Design

- ■ Modeling

- ■ Simulation

- ■ Implementation

Simulink® Reference

Version 6

The MathWorks

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Blocks — By Category

What Each Block Reference Page Contains

Blocks appear in alphabetical order and contain some or all of this information:

- The block name, icon, and block library that contains the block

- The purpose of the block

- A description of the block's use

- The data types and numeric type (complex or real) accepted and generated by the block

- The block dialog box and parameters

- The rules for some or all of these topics, as they apply to blocks with fixed-point capabilities:

  - Converting block parameters from double-precision numbers to fixed-point data types

  - Converting the input data type(s) to the output data type

  - Performing block operations between inputs and parameters

- The block characteristics, including some or all of these, as they apply to the block:

  - Direct Feedthrough - Whether the block or any of its ports has direct feedthrough. For more information, see "Algebraic Loops".

  - Sample Time - How the block's sample time is determined, whether by the block itself (as is the case with discrete and continuous blocks) or inherited from the block that drives it or is driven by it. For more information, see "Sample Time Propagation".

  - Scalar Expansion - Whether or not scalar values are expanded to arrays. Some blocks expand scalar inputs and/or parameters as appropriate. For more information, see "Scalar Expansion of Inputs and Parameters".

  - States - The number of discrete and continuous states.

  - Dimensionalized - Whether the block accepts and/or generates multidimensional signal arrays. For more information, see "Signal Basics".

- Zero Crossings - Whether the block detects zero-crossing events. For more information, see "Zero Crossing Detection".

To view a table that summarizes the data types supported by the blocks in the Simulink® block libraries, execute the following command at the MATLAB® command line:

```
showblockdatatypetable
```

Block Categories

Commonly Used

Bus Creator   Create a signal bus

Bus Selector   Select signals from an incoming bus

Constant   Generate a constant value

Data Type Conversion	Convert an input signal to a specified data type
Demux	Extract and output the elements of a bus or vector signal
Discrete-Time Integrator	Perform discrete-time integration or accumulation of a signal
Gain	Multiply the input by a constant
Ground	Ground an unconnected input port
Inport	Create an input port for a subsystem or an external input
Integrator	Integrate a signal
Logical Operator	Perform the specified logical operation on the input
Mux	Combine several input signals into a vector
Outport	Create an output port for a subsystem or an external output
Product	Multiply or divide inputs
Relational Operator	Perform the specified relational operation on the inputs
Saturation	Limit the range of a signal
Scope, Floating Scope, Signal Viewer Scope	Display signals generated during a simulation
Subsystem, Atomic Subsystem, CodeReuse Subsystem	Represent a system within another system
Sum, Add, Subtract, Sum of Elements	Add or subtract inputs
Switch	Switch output between the first input and the third input based on the value of the second input

Terminator	Terminate an unconnected output port
Unit Delay	Delay a signal one sample period

Continuous

Derivative	Output the time derivative of the input
Integrator	Integrate a signal
State-Space	Implement a linear state-space system
Transfer Fcn	Model a linear system by a transfer function
Transport Delay	Delay the input by a given amount of time
Variable Time Delay, Variable Transport Delay	Delay the input by a variable amount of time
Zero-Pole	Model a system by a zero-pole-gain transfer function

Discontinuities

Backlash	Model the behavior of a system with play
Coulomb and Viscous Friction	Model discontinuity at zero, with linear gain elsewhere
Dead Zone	Provide a region of zero output
Dead Zone Dynamic	Set inputs within the bounds to zero
Hit Crossing	Detect crossing point
Quantizer	Discretize input at a specified interval

Rate Limiter   Limit the rate of change of a signal

Rate Limiter Dynamic   Limit the rising and falling rates of the signal

Relay   Switch output between two constants

Saturation   Limit the range of a signal

Saturation Dynamic   Bound the range of the input

Wrap To Zero   Set output to zero if input is above threshold

Discrete

Difference   Calculate the change in a signal over one time step

Discrete Derivative   Compute a discrete time derivative

Discrete Filter   Model IIR and FIR filters

Discrete State-Space   Implement a discrete state-space system

Discrete Transfer Fcn   Implement a discrete transfer function

Discrete Zero-Pole   Model a system defined by the zeros and poles of a discrete transfer function

Discrete-Time Integrator   Perform discrete-time integration or accumulation of a signal

First-Order Hold   Implement a first-order sample-and-hold

Integer Delay   Delay a signal N sample periods

Memory   Output the input from the previous time step

Tapped Delay	Delay a scalar signal multiple sample periods and output all the delayed versions
Transfer Fcn First Order	Implement a discrete-time first order transfer function
Transfer Fcn Lead or Lag	Implement a discrete-time lead or lag compensator
Transfer Fcn Real Zero	Implement a discrete-time transfer function that has a real zero and no pole
Unit Delay	Delay a signal one sample period
Weighted Moving Average	Implement a weighted moving average
Zero-Order Hold	Implement a zero-order hold of one sample period

Logic and Bit Operations

Bit Clear	Set the specified bit of the stored integer to zero
Bit Set	Set the specified bit of the stored integer to one
Bitwise Operator	Perform the specified bitwise operation on the inputs
Combinatorial Logic	Implement a truth table
Compare To Constant	Determine how a signal compares to the specified constant
Compare To Zero	Determine how a signal compares to zero
Detect Change	Detect a change in a signal's value
Detect Decrease	Detect a decrease in a signal's value

Detect Fall Negative	Detect a falling edge when the signal's value decreases to a strictly negative value, and its previous value was nonnegative
Detect Fall Nonpositive	Detect a falling edge when the signal's value decreases to a nonpositive value, and its previous value was strictly positive
Detect Increase	Detect an increase in a signal's value
Detect Rise Nonnegative	Detect a rising edge when a signal's value increases to a nonnegative value, and its previous value was strictly negative
Detect Rise Positive	Detect a rising edge when a signal's value increases to a strictly positive value, and its previous value was nonpositive
Extract Bits	Output a selection of contiguous bits from the input signal
Interval Test	Determine if a signal is in a specified interval
Interval Test Dynamic	Determine if a signal is in a specified interval
Logical Operator	Perform the specified logical operation on the input
Relational Operator	Perform the specified relational operation on the inputs
Shift Arithmetic	Shift the bits and/or binary point of a signal

Lookup Tables

Cosine	Implement a cosine function in fixed-point using a lookup table approach that exploits quarter wave symmetry
Direct Lookup Table (n-D)	Index into an N-dimensional table to retrieve an element, column, or 2-D matrix
Interpolation (n-D) Using PreLookup	Perform high-performance constant or linear interpolation, mapping N input values to a sampled representation of a function in N variables via output from PreLookup Index Search block
Lookup Table	Approximate a one-dimensional function using the specified lookup method
Lookup Table (2-D)	Approximate a two-dimensional function using a selected lookup method
Lookup Table (n-D)	Perform constant, linear, or spline interpolated mapping of N input values to a sampled representation of a function in N variables
Lookup Table Dynamic	Approximate a one-dimensional function using a selected lookup method and a dynamically specified table

PreLookup Index Search | First stage of high-performance constant or linear interpolation that performs index search and interval fraction calculation for input on a breakpoint set

Sine | Implement a sine wave in fixed-point using a lookup table approach that exploits quarter wave symmetry

Math Operations

Abs | Output the absolute value of the input

Algebraic Constraint | Constrain the input signal to zero

Assignment | Assign values to specified elements of a signal

Bias | Add a bias to the input

Complex to Magnitude-Angle | Compute the magnitude and/or phase angle of a complex signal

Complex to Real-Imag | Output the real and imaginary parts of a complex input signal

Concatenate | Concatenate input signals of the same data type to create a contiguous output signal.

Divide | Multiply or divide inputs

Dot Product | Generate the dot product of two vectors

Gain | Multiply the input by a constant

Magnitude-Angle to Complex | Convert a magnitude and/or a phase angle signal to a complex signal

Math Function | Perform a mathematical function

MinMax	Output the minimum or maximum input value
MinMax Running Resettable	Determine the minimum or maximum of a signal over time
Polynomial	Perform evaluation of polynomial coefficients on input values
Product	Multiply or divide inputs
Product of Elements	Multiply or divide inputs
Real-Imag to Complex	Convert real and/or imaginary inputs to a complex signal
Reshape	Change the dimensionality of a signal
Rounding Function	Apply a rounding function to a signal
Sign	Indicate the sign of the input
Sine Wave Function	Generate a sine wave, using an external signal as a time source.
Slider Gain	Vary a scalar gain using a slider
Sum, Add, Subtract, Sum of Elements	Add or subtract inputs
Trigonometric Function	Perform a trigonometric function
Unary Minus	Negate the input
Weighted Sample Time Math	Support calculations involving sample time

Model Verification

Assertion	Check whether a signal is nonzero
Check Discrete Gradient	Check that the absolute value of the difference between successive samples of a discrete signal is less than an upper bound

Check Dynamic Gap — Check that a gap of possibly varying width occurs in the range of a signal's amplitudes

Check Dynamic Lower Bound — Check that one signal is always less than another signal

Check Dynamic Range — Check that a signal falls inside a range of amplitudes that varies from time step to time step

Check Dynamic Upper Bound — Check that one signal is always greater than another signal

Check Input Resolution — Check that the input signal has a specified resolution

Check Static Gap — Check that a gap exists in a signal's range of amplitudes

Check Static Lower Bound — Check that a signal is greater than (or optionally equal to) a static lower bound

Check Static Range — Check that a signal falls inside a fixed range of amplitudes

Check Static Upper Bound — Check that a signal is greater than (or optionally equal to) a static lower bound

Model-Wide Utilities

DocBlock — Create text that documents the model and save the text with the model

Model Info — Display revision control information in a model

Time-Based Linearization	Generate linear models in the base workspace at specific times
Trigger-Based Linearization	Generate linear models in the base workspace when triggered

Ports & Subsystems

Action Port	Implement the Action subsystems used by `if` and `switch` control flow statements in Simulink
Configurable Subsystem	Represent any block selected from a user-specified library of blocks
Enable	Add an enabling port to a subsystem
Enabled and Triggered Subsystem	Represent a subsystem whose execution is enabled and triggered by external input
Enabled Subsystem	Represent a subsystem whose execution is enabled by external input
For Iterator Subsystem	Represent a subsystem that executes repeatedly during a simulation time step
Function-Call Generator	Execute a function-call subsystem a specified number of times at a specified rate
Function-Call Subsystem	Represent a subsystem that can be invoked as a function by another block
If	Model `if-else` control flow
If Action Subsystem	Represent a subsystem whose execution is triggered by an If block
Inport	Create an input port for a subsystem or an external input

Model	Include a model as a block in another model.
Outport	Create an output port for a subsystem or an external output
Subsystem, Atomic Subsystem, CodeReuse Subsystem	Represent a system within another system
Switch Case	Implement a C-like `switch` control flow statement
Switch Case Action Subsystem	Represent a subsystem whose execution is triggered by a Switch Case block
Trigger	Add a trigger port to a subsystem or function-call model
Triggered Subsystem	Represent a subsystem whose execution is triggered by external input
While Iterator Subsystem	Represent a subsystem that executes repeatedly while a condition is satisfied during a simulation time step

Signal Attributes

Data Type Conversion	Convert an input signal to a specified data type
Data Type Conversion Inherited	Convert from one data type to another using inherited data type and scaling
Data Type Duplicate	Force all inputs to the same data type
Data Type Propagation	Set the data type and scaling of the propagated signal based on information from the reference signals

Data Type Scaling Strip	Remove scaling and map to a built in integer
IC	Set the initial value of a signal
Probe	Output a signal's attributes, including width, dimensionality, sample time, and/or complex signal flag
Rate Transition	Handle transfer of data between blocks operating at different rates
Signal Conversion	Convert a signal to a new type without altering signal values.
Signal Specification	Specify the desired dimensions, sample time, data type, numeric type, and other attributes of a signal.
Weighted Sample Time	Support calculations involving sample time
Width	Output the width of the input vector

Signal Routing

Bus Assignment	Assign values to specified elements of a bus.
Bus Creator	Create a signal bus
Bus Selector	Select signals from an incoming bus
Data Store Memory	Define a data store
Data Store Read	Read data from a data store
Data Store Write	Write data to a data store
Demux	Extract and output the elements of a bus or vector signal
Environment Controller	Create branches of a block diagram that apply only to simulation or only to code generation.

From	Accept input from a Goto block
Goto	Pass block input to From blocks
Goto Tag Visibility	Define scope of Goto block tag
Index Vector	Switch output between different inputs based on the value of the first input
Manual Switch	Switch between two inputs
Merge	Combine multiple signals into a single signal
Multiport Switch	Choose between multiple block inputs
Mux	Combine several input signals into a vector
Selector	Select input elements from a vector or matrix signal
Switch	Switch output between the first input and the third input based on the value of the second input

Sinks

Display	Show the value of the input
Outport	Create an output port for a subsystem or an external output
Scope, Floating Scope, Signal Viewer Scope	Display signals generated during a simulation
Stop Simulation	Stop the simulation when the input is nonzero
Terminator	Terminate an unconnected output port
To File	Write data to a file

To Workspace	Write data to the workspace
XY Graph	Display an X-Y plot of signals using a MATLAB figure window

Sources

Band-Limited White Noise	Introduce white noise into a continuous system
Chirp Signal	Generate a sine wave with increasing frequency
Clock	Display and provide the simulation time
Constant	Generate a constant value
Counter Free-Running	Count up and overflow back to zero after the maximum value possible is reached for the specified number of bits
Counter Limited	Count up and wrap back to zero after outputting the specified upper limit
Digital Clock	Output simulation time at the specified sampling interval
From File	Read data from a MAT file.
From Workspace	Read data from the workspace
Ground	Ground an unconnected input port
Inport	Create an input port for a subsystem or an external input
Pulse Generator	Generate square wave pulses at regular intervals
Ramp	Generate constantly increasing or decreasing signal
Random Number	Generate normally distributed random numbers

Repeating Sequence	Generate an arbitrarily shaped periodic signal
Repeating Sequence Interpolated	Output discrete-time sequence and repeat, interpolating between data points
Repeating Sequence Stair	Output and repeat the discrete time sequence
Signal Builder	Create and generate interchangeable groups of signals whose waveforms are piecewise linear
Signal Generator	Generate various waveforms
Sine Wave	Generate a sine wave
Step	Generate a step function
Uniform Random Number	Generate uniformly distributed random numbers

User-Defined Functions

Embedded MATLAB Function	Include MATLAB code in models that generate embeddable C code.
Fcn	Apply a specified expression to the input
Level-2 M-File S-Function	Use a Level-2 M-file S-function in a model.
MATLAB Fcn	Apply a MATLAB function or expression to the input
S-Function	Include an S-function in a model.
S-Function Builder	Create an S-function from C code that you provide

Additional Math & Discrete

Additional Discrete

Fixed-Point State-Space	Implement discrete-time state space
Transfer Fcn Direct Form II	Implement a Direct Form II realization of a transfer function
Transfer Fcn Direct Form II Time Varying	Implement a time varying Direct Form II realization of a transfer function
Unit Delay Enabled	Delay a signal one sample period, if the external enable signal is on
Unit Delay Enabled External IC	Delay a signal one sample period, if the external enable signal is on, with an external initial condition
Unit Delay Enabled Resettable	Delay a signal one sample period, if the external enable signal is on, with an external Boolean reset
Unit Delay Enabled Resettable External IC	Delay a signal one sample period, if the external enable signal is on, with an external Boolean reset and initial condition
Unit Delay External IC	Delay a signal one sample period, with an external initial condition
Unit Delay Resettable	Delay a signal one sample period, with an external Boolean reset
Unit Delay Resettable External IC	Delay a signal one sample period, with an external Boolean reset and initial condition
Unit Delay With Preview Enabled	Output the signal and the signal delayed by one sample period, if the external enable signal is on

Unit Delay With Preview Enabled Resettable	Output the signal and the signal delayed by one sample period, if the external enable signal is on, with an external Boolean reset
Unit Delay With Preview Enabled Resettable External RV	Output the signal and the signal delayed by one sample period, if the external enable signal is on, with an external RV reset
Unit Delay With Preview Resettable	Output the signal and the signal delayed by one sample period, with an external Boolean reset
Unit Delay With Preview Resettable External RV	Output the signal and the signal delayed by one sample period, with an external RV reset

Additional Math: Increment — Decrement

Decrement Real World	Decrease the real world value of the signal by one
Decrement Stored Integer	Decrease the stored integer value of a signal by one
Decrement Time To Zero	Decrease the real-world value of the signal by the sample time, but only to zero.
Decrement To Zero	Decreases the real-world value of a signal by one, but only to zero.
Increment Real World	Increase the real world value of the signal by one
Increment Stored Integer	Increase the stored integer value of a signal by one

Blocks — Alphabetical List

This chapter is a reference for the blocks in Simulink. Blocks are listed alphabetically.

Abs
Action Port
Algebraic Constraint
Assertion
Assignment
Backlash
Bad Link
Band-Limited White Noise
Bias
Bit Clear
Bit Set
Bitwise Operator
Bus Assignment
Bus Creator
Bus Selector
Check Discrete Gradient
Check Dynamic Gap
Check Dynamic Lower Bound
Check Dynamic Range
Check Dynamic Upper Bound
Check Input Resolution
Check Static Gap
Check Static Lower Bound
Check Static Range
Check Static Upper Bound
Chirp Signal

Clock
Combinatorial Logic
Compare To Constant
Compare To Zero
Complex to Magnitude-Angle
Complex to Real-Imag
Concatenate
Configurable Subsystem
Constant
Cosine
Coulomb and Viscous Friction
Counter Free-Running
Counter Limited
Data Store Memory
Data Store Read
Data Store Write
Data Type Conversion
Data Type Conversion Inherited
Data Type Duplicate
Data Type Propagation
Data Type Scaling Strip
Dead Zone
Dead Zone Dynamic
Decrement Real World
Decrement Stored Integer
Decrement Time To Zero
Decrement To Zero
Demux
Derivative
Detect Change
Detect Decrease
Detect Fall Negative
Detect Fall Nonpositive
Detect Increase
Detect Rise Nonnegative
Detect Rise Positive
Difference

Digital Clock
Direct Lookup Table (n-D)
Discrete Derivative
Discrete Filter
Discrete State-Space
Discrete Transfer Fcn
Discrete Zero-Pole
Discrete-Time Integrator
Display
Divide
DocBlock
Dot Product
Embedded MATLAB Function
Enable
Enabled and Triggered Subsystem
Enabled Subsystem
Environment Controller
Extract Bits
Fcn
First-Order Hold
Fixed-Point State-Space
For Iterator
For Iterator Subsystem
From
From File
From Workspace
Function-Call Generator
Function-Call Subsystem
Gain
Goto
Goto Tag Visibility
Ground
Hit Crossing
IC
If
If Action Subsystem
Increment Real World

Increment Stored Integer
Index Vector
Inport
Integer Delay
Integrator
Interpolation (n-D) Using PreLookup
Interval Test
Interval Test Dynamic
Level-2 M-File S-Function
Logical Operator
Lookup Table
Lookup Table (2-D)
Lookup Table (n-D)
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Model Info
Multiport Switch
Mux
Outport
Polynomial
PreLookup Index Search
Probe
Product
Product of Elements
Pulse Generator
Quantizer
Ramp
Random Number
Rate Limiter

Rate Limiter Dynamic
Rate Transition
Real-Imag to Complex
Relational Operator
Relay
Repeating Sequence
Repeating Sequence Interpolated
Repeating Sequence Stair
Reshape
Rounding Function
S-Function
S-Function Builder
Saturation
Saturation Dynamic
Scope, Floating Scope, Signal Viewer Scope
Selector
Shift Arithmetic
Sign
Signal Builder
Signal Conversion
Signal Generator
Signal Specification
Sine
Sine and Cosine
Sine Wave
Sine Wave Function
Slider Gain
State-Space
Step
Stop Simulation
Subsystem, Atomic Subsystem, CodeReuse Subsystem
Sum, Add, Subtract, Sum of Elements
Switch
Switch Case
Switch Case Action Subsystem
Tapped Delay
Terminator

Time-Based Linearization
To File
To Workspace
Transfer Fcn
Transfer Fcn Direct Form II
Transfer Fcn Direct Form II Time Varying
Transfer Fcn First Order
Transfer Fcn Lead or Lag
Transfer Fcn Real Zero
Transport Delay
Trigger
Trigger-Based Linearization
Triggered Subsystem
Trigonometric Function
Unary Minus
Uniform Random Number
Unit Delay
Unit Delay Enabled
Unit Delay Enabled External IC
Unit Delay Enabled Resettable
Unit Delay Enabled Resettable External IC
Unit Delay External IC
Unit Delay Resettable
Unit Delay Resettable External IC
Unit Delay With Preview Enabled
Unit Delay With Preview Enabled Resettable
Unit Delay With Preview Enabled Resettable External RV
Unit Delay With Preview Resettable
Unit Delay With Preview Resettable External RV
Variable Time Delay, Variable Transport Delay
Weighted Moving Average
Weighted Sample Time
Weighted Sample Time Math
While Iterator
While Iterator Subsystem
Width
Wrap To Zero

XY Graph
Zero-Order Hold
Zero-Pole

Abs

Purpose   Output the absolute value of the input

Library   Math Operations

Description   The Abs block outputs the absolute value of the input.

For signed data types, the absolute value of the most negative value is problematic since it is not representable by the data type. In this case, the behavior of the block is controlled by the **Saturate on integer overflow** check box. If checked, the absolute value of the data type saturates to the most positive representable value. If not checked, the absolute value of the most negative value represented by the data type has no effect.

For example, suppose the block input is an 8-bit signed integer. The range of this data type is from -128 to 127, and the absolute value of -128 is not representable. If you select the **Saturate on integer overflow** check box, then the absolute value of -128 is 127. If it is not selected, then the absolute value of -128 remains at -128.

Data Type Support   The Abs block accepts real signals of any data type supported by Simulink, except `Boolean`. The Abs block supports real fixed-point data types. The block also accepts complex `single` and `double` inputs. Outputs are a real value of the same data type as the input.

For a discussion on the data types supported by Simulink, see "Data Types Supported by Simulink" in the "Working with Data" chapter of the Using Simulink documentation.

**Parameters
and
Dialog
Box**
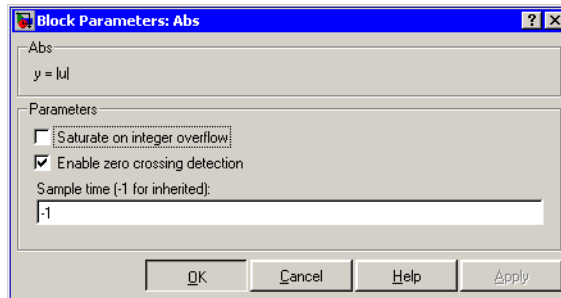
Saturate on integer overflow

When selected, the block maps signed integer input elements corresponding to the most negative value of that data type to the most positive value of that data type:

- For 8-bit integers, -128 maps to to 127.

- For 16-bit integers, -32768 maps to 32767.

- For 32-bit integers, -2147483648 maps to 2147483647.

  When not selected, the block does not act on signed integer input elements corresponding to the most negative value of that data type.

- For 8-bit integers, -128 remains -128.

- For 16-bit integers, -32768 remains -32768.

- For 32-bit integers, -2147483648 remains -2147483648.

Enable zero crossing detection

Select to enable zero crossing detection. For more information, see "Zero-Crossing Detection" in the "How Simulink Works" chapter of the Using Simulink documentation.

Sample time (-1 for inherited)

Specify the time interval between samples. To inherit the sample time, set this parameter to -1. See "Specifying Sample Time"

Abs

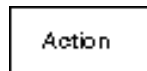in the "How Simulink Works" chapter of the Using Simulink documentation.

Characteristics

Direct Feedthrough	Yes
Sample Time	Specified in the **Sample time** parameter
Dimensionalized	Yes
Zero Crossing	Yes, if enabled

Action Port

Purpose   Implement the Action subsystems used by `if` and `switch` control flow
statements in Simulink

Library   Ports & Subsystems

Description   Action Port blocks implement Action subsystems used in `if` and `switch`
control flow statements. The Action Port block is available in the If
Action Subsystem and the Switch Case Action Subsystem. See the
references for the If and Switch Case blocks for examples using Action
Port blocks.

Action

Use Action Port blocks to create Action subsystems as follows:

1 Place a subsystem in the system containing the If or Switch Case
block.

You can use an ordinary subsystem or an atomic subsystem. In either
case, the resulting Action subsystem is atomic.

2 Add an Action Port to the new subsystem.

This adds an input port named Action to the subsystem, which is
now an Action subsystem.

Action subsystems execute their programming in response to the
conditional outputs of an If or Switch Case block. Use Action
subsystems as follows:

1 Create an Action subsystem for each output port configured for an
If or Switch Case block.

2 Connect each output port (if, else, or elseif ports for the If block; case
or default ports for the Switch Case block) to the Action port on an
Action subsystem.

When the connection is made, the icon for the subsystem and the
Action Port block it contains are changed to the name of the output

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Action Port

port for the If or Switch Case block (i.e., `if{ }`, `else{ }`, `elseif{ }`, `case{ }`, or `default{ }`).

3 Open the new subsystem and add the diagram that you want to execute in response to the condition this subsystem covers.

The Action Port block has only the **States when execution is resumed** parameter in its parameters dialog. If you set this field to `held` (the default value) for an Action Port block, the states of its Action subsystem are retained between calls even if other member Action subsystems of an `if-else` or `switch` control flow statement are called. If you set the **States when execution is resumed** field to `reset`, the states of a member Action subsystem are reset to initial values when it is reenabled.

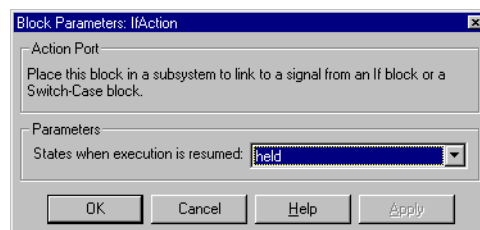
Note All blocks in an Action subsystem driven by an If or Switch Case block must run at the same rate as the driving block.

Data Type Support

There are no data inputs or outputs for Action Port blocks.

Parameters and Dialog Box

States when execution is resumed
Specifies how to handle internal states when the subsystem of this Action Port block is reenabled.

Set this field to `held` (the default value) to make sure that the Action subsystem states retain their previous values when the subsystem is reenabled. Otherwise, set this field to `reset` if you want the states of the Action subsystem to be reinitialized when the subsystem is reenabled.

Reenablement of a subsystem occurs when it is called and the condition of the call is true after having been previously false. In the following example, the Action Port blocks for both Action subsystems A and B have the **States when execution is resumed** parameter set to `reset`.
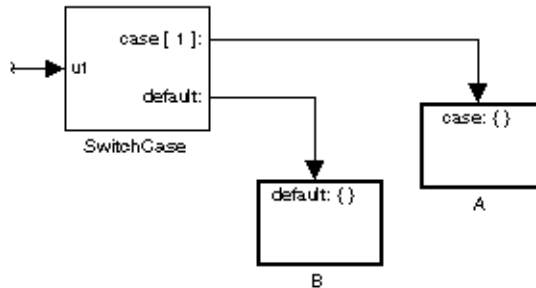
If case[1] is true, Action subsystem A is called. This implies that the default condition is false. When B is later called for the default condition, its states are reset. In the same way, Action subsystem A's states are reset when it is called right after Action subsystem B is called.

Repeated calls to a case's Action subsystem do not reset its states. If A is called again right after a previous call to A, this does not reset A's states because its condition, case[1], was not previously false. The same applies to B.

Characteristics	Sample Time	Inherited from driving If or Switch Case block

Algebraic Constraint

Purpose   Constrain the input signal to zero

Library   Math Operations
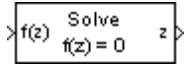
Description   The Algebraic Constraint block constrains the input signal f(z) to zero and outputs an algebraic state z. The block outputs the value necessary to produce a zero at the input. The output must affect the input through some feedback path. This enables you to specify algebraic equations for index 1 differential/algebraic systems (DAEs).

By default, the **Initial guess** parameter is zero. You can improve the efficiency of the algebraic loop solver by providing an **Initial guess** for the algebraic state z that is close to the solution value.

For example, the following model solves these equations.

```
z2 + z1 = 1
z2 - z1 = 1
```

The solution is z2 = 1, z1 = 0, as the Display blocks show.
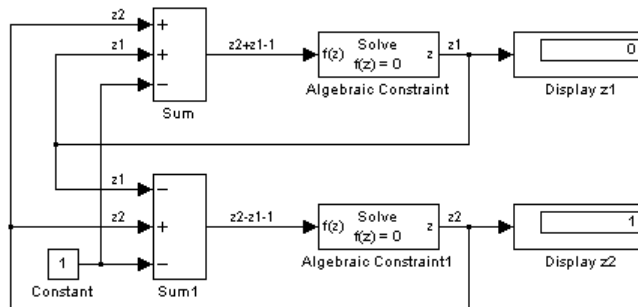
Data Type Support   The Algebraic Constraint block accepts and outputs real values of type `double`.

Parameters and Dialog Box
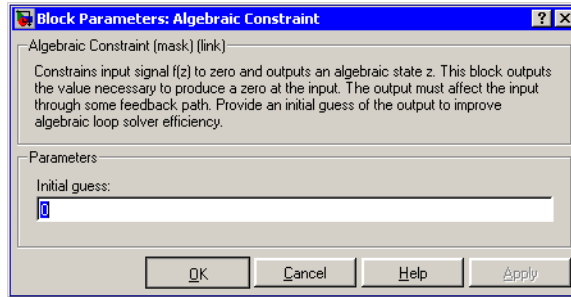
Initial guess

> An initial guess for the solution value. The default is 0.

Characteristics

Direct Feedthrough	Yes
Sample Time	Inherited from driving block
Scalar Expansion	No
Dimensionalized	Yes
Zero-Crossing	No

Assertion

Purpose   Check whether a signal is nonzero

Library   Model Verification

Description   The Assertion block checks whether any of the elements of the signal at its input is nonzero. If all elements are nonzero, the block does nothing. If any element is zero, the block halts the simulation, by default, and displays an error message. The block's parameter dialog box allows you to

- Specify that the block should display an error message when the assertion fails but allow the simulation to continue.
- Specify an M-expression to be evaluated when the assertion fails.
- Enable or disable the assertion.

You can also use the **Model Verification block enabling** setting on the **Data Validity** diagnostics pane of the **Configuration Parameters** dialog box to enable or disable all Assertion blocks in a model.

The Assertion block and its companion blocks in the Model Verification library are intended to facilitate creation of self-validating models. For example, you can use model verification blocks to test that signals do not exceed specified limits during simulation. When you are satisfied that a model is correct, you can turn error checking off by disabling the verification blocks. You do not have to physically remove them from the model. If you need to modify a model, you can temporarily turn the verification blocks back on to ensure that your changes do not break the model.

Data Type Support   The Assertion block accepts input signals of any dimensions and any data type supported by Simulink, including fixed-point data types.

For a discussion on the data types supported by Simulink, see "Data Types Supported by Simulink" in the "Working with Data" chapter of the Using Simulink documentation.

Parameters and Dialog Box

Enable Assertion

Unchecking this option disables the Assertion block, that is, causes the model to behave as if the Assertion block did not exist. The **Model Verification block enabling** setting on the **Data Validity** diagnostics pane of the **Configuration Parameters** dialog box allows you to enable or disable all Assertion blocks in a model regardless of the setting of this option.
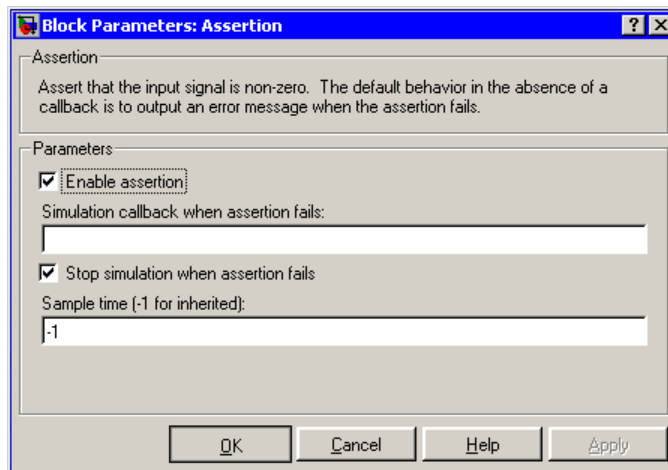
Simulation callback when assertion fails

An M-expression to be evaluated when the assertion fails.

Stop simulation when assertion fails

If checked, this option causes the Assertion block to halt the simulation when the block's input is zero and display an error message in the **Simulation Diagnostics** viewer. Otherwise, the block displays a warning message in the MATLAB Command Window and continues the simulation.

Sample time (-1 for inherited)

Specify the time interval between samples. To inherit the sample time, set this parameter to -1. See "Specifying Sample Time"

Assertion

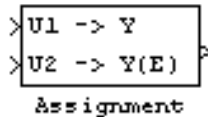in the "How Simulink Works" chapter of the Using Simulink documentation.

Characteristics

Direct Feedthrough	No
Sample Time	Inherited from driving block
Scalar Expansion	No
Dimensionalized	Yes
Zero Crossing	No

Purpose   Assign values to specified elements of a signal

Library   Math Operations

Description   The Assignment block assigns values to specified elements of the signal.

```
U1 -> Y
U2 -> Y(E)
Assignment
```

You can specify the indices of the elements to be assigned values either by entering the indices in the block's dialog box or by connecting an external indices source or sources to the block. The signal at the block's data port, labeled U2 in most modes, specifies values to be assigned to Y. The block replaces the specified elements of Y with elements from the data signal, leaving unassigned elements unchanged from their initial values. If the assignment indices source is internal or is external and the `Initialize using input` option is selected, the Assignment block uses the signal at the block's initialization port, labeled U1, to initialize the elements of the output signal before assigning them values from U2.

Note The Assignment block's data port is labeled U2 in all modes except external mode with no initialization, in which case the port is labeled U1 as there is no initialization port. The rest of this section refers to the data port as U2 in order to avoid unnecessarily complicating the explanation of the block's usage.

You can use the block to assign values to vector, or matrix signals.

Assigning Values to a Vector Signal

To assign values to a scalar or vector signal, set the block's **Input Type** parameter to `Vector`. The block's dialog box displays a **Source of element indices** parameter. You can specify the indices source as `Internal` or `External`. If you select `Internal`, the block dialog box displays an **Elements** field. Use this field to enter the element indices. If you specify `External` as the source of element indices, the block displays an input port named E. Connect an external index source to this port. Use **Index mode** to specify whether `0` or `1` indicates the first element of Y.

Assignment

The index source can specify any of the following values as indices:

- -1 (internal source only)

  Assigns every element of U2 to the corresponding element of Y.

- Index of a single element specified as a nonnegative integer

  If **Use index as starting value** option is not selected, the block assigns U2, which must be a scalar, to the specified element of Y.

  If **Use index as starting value** is selected, the block assigns U2 to a range of elements of Y, starting at the specified index. For example, suppose that U1 is a 5-element vector, U2 is a 3-element vector, the index mode is one-based, and the starting index is 3. In this case, the Assignment block assigns U2(1:3) to Y(3:5).

- A set of indices specified as a vector

  Assigns U2 to a specified set of elements of Y.

  The width of the values signal connected to U2 must be the same as the width of the indices vector. For example, if the indices vector contains two indices, U2 must be a two-element vector of values. The block assigns the first element of U2 to the element of Y specified by the first index, the second element of U2 to the Y element specified by the second index, and so on.

  If U2 is a scalar, it is assigned to the specified elements of the output vector.

Assigning Values to a Matrix Signal

To assign values to a matrix signal, set the **Input Type** parameter to `Matrix`. If you specify the **Input Type** of the Assignment block as `Matrix`, the block's dialog box displays a **Source of row indices** parameter and a **Source of column indices** parameter. You can specify either or both of these parameters as `Internal` or `External`. If you specify the row and/or column index source as internal, the block displays a **Rows** and/or **Columns** field. Enter the row or column indices of the elements of Y to be assigned values into the corresponding

field. If you specify the row and/or column index source as External, the block displays an input port labeled R and/or an input port labeled C. Connect an external source of indices to each indices port.

A row or column indices source can have any of the following values:

- -1 (internal source only)

  Specifies all rows or columns of Y.

- Single row or column index value

  If **Use index as starting value** option is not selected, the block assigns values to the specified row or column. If **Use index as starting value** is selected, the block assigns values from U2 to a range of rows or columns of Y, starting at the specified row or column index. For example, suppose that U1 is a 5 x 5 matrix, U2 is a 3 x 3 matrix, the indexing mode is one-based, and the starting row and column indices are both 3. In this case, the Assignment block assigns U2(1:3, 1:3) to Y(3:5,3:5).

- Vector of row or column indices

  Specifies a set of rows or columns of Y.

  The block assigns values from U2 to the specified elements of Y in column-major order. In particular, the block assigns the first element of the first row of U2 to the first specified element in the first specified row in Y. It assigns the second element of the first row of U2 to the second specified element of the first specified row of Y, and so on.

  To enable all specified elements to be assigned values, U2 must be an N-by-M matrix where N is the width of the row indices vector and M is the width of the column indices vector. For example, suppose that you specify a vector of row indices of size 2 and a vector of column indices of size 4. Then U2 must be a 2-by-4 matrix signal.

  When determining the dimensions of U2, count a scalar index as a vector of size 1 and -1 as equivalent to a vector of indices of the same width as the row or dimension size of Y. For example, suppose your

Assignment

row and column index sources are a scalar and a two-element vector, respectively. Then U2 must by a 1-by-2 matrix.

If U2 is a scalar, the Assignment block assigns the scalar to the specified elements of the output signal.


Note An Assignment block whose **Input type** is Matrix accepts only matrix signals at its U1 port and only a matrix signal or a one-element vector signal at its U2 port. Simulink displays an error dialog box if you update or simulate a model that violates this constraint.

Iterated Assignment

You can use the Assignment block to assign values computed in a For or While Iterator loop to successive elements of a vector or matrix signal in a single time step. For example, the following model uses a For Iterator block to create a vector signal each of whose elements equals 3*i where i is the index of the element.
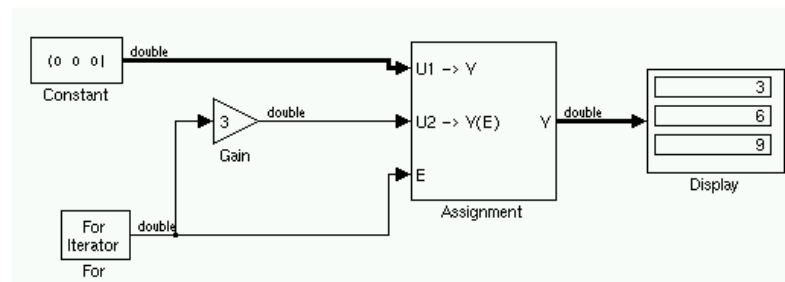
Iterated assignment uses an iterator (For or While) block to generate the indices required by the Assignment block. On the first iteration of an iterated assignment, the Assignment block copies the first input (U1) to the output (Y) and assigns the second input (U2) to the output $Y(E_0)$. On successive iterations, the Assignment block simply assigns the current value of U2 to $Y(E_i)$, i.e., without first copying U1 to Y. All of this occurs in a single time step.

Assignment

Data Type Support

The data and initialization ports of the Assignment block accept signals of any data type supported by Simulink, including fixed-point data types. The external indices port accepts any data type, except boolean and fixed-point data types.

For a discussion on the data types supported by Simulink, see "Data Types Supported by Simulink" in the "Working with Data" chapter of the Using Simulink documentation.

Parameters and Dialog Box
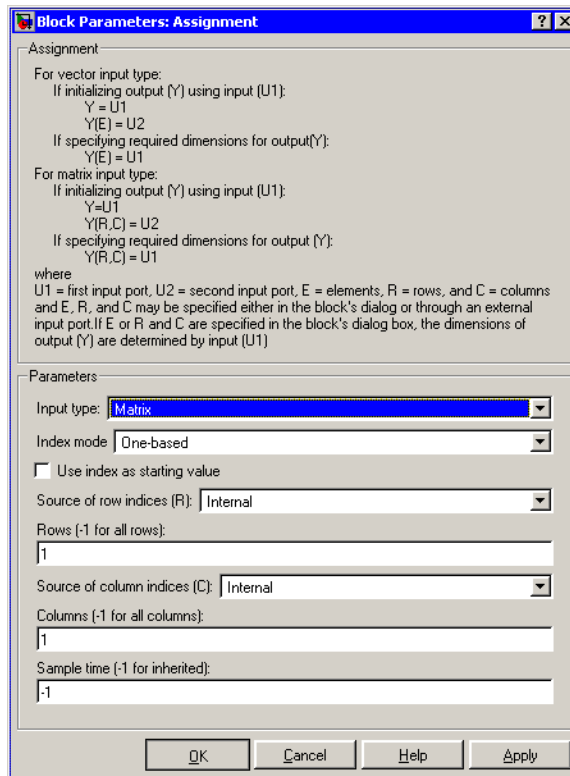
Input Type

You can select either Vector or Matrix input. If you select Vector, the **Source of element indices** field appears. If you select

Assignment

Matrix, the **Source of row indices** and **Source of column indices** fields appear.

Index mode
> Specifies whether the index corresponding to the first element of a vector or the first row or column of a matrix is `0` or `1`.

Use index as starting value
> Specifies that the value in the Elements (or Row or Column) field is the starting index of a range of elements (or rows or columns).

Source of element indices
> You can specify either `Internal` (the default) or `External` as the source for the indices of the elements to be assigned values. If you select Internal, the block dialog box displays an **Elements** field (see following). Use this field to enter the element indices. If you select `External`, the block displays an input port labeled E. Connect the external index source to this port.

Elements
> This field appears only if you selected `Internal` for the **Source of element indices** field. It specifies the indices of elements in Y to be assigned values from elements in U2. The value of this parameter can be `-1`, a nonnegative integer specifying a single index, or a vector of nonnegative integers specifying a set of indices (e.g., `[1,3,5,6]`).

Source of row indices
> Either `Internal` (the default) or `External`. If you select `Internal`, the **Rows** field appears. Enter the indices of the rows to be assigned values in this field. If you select `External`, the block displays an input port labeled R. Connect an external source of row indices to this port.

Rows
> This field appears only if you select `Internal` for the **Source of row indices** field. Valid values are `-1` (all rows), a single row index, or a vector of row indices (e.g., `[1,3,5,6]`).

Source of column indices

Either `Internal` (the default) or `External`. If you select `Internal`, the **Columns** field appears. Enter the indices of the columns to be assigned values in this field. If you select `External`, the block displays an input port labeled C. Connect an external source of column indices to this port.

Columns

This field appears only if you selected `internal` for the **Source of column indices** field. Valid values are -1 (all columns), a single column index, or a vector of column indices (e.g., [1,3,5,6]).

Output (Y)

This control appears only if the source of assignment indices is external or, in the case of matrix assignment, the source of either the row or column indices, or both, is external. The options are `Initialize using input (U1)` (the default) or `Specify required dimensions`. The first option causes the Assignment block to display an initialization port labeled U1 and to use the signal at this port to initialize the output signal (Y) before assigning it values from the data port (U2) as specified by the external indices signal (E). The second option does not initialize Y before assigning values from the block's data input port (labeled U1 in this case) to it. This option requires that the block's U1 and E inputs assign values to every element of Y. Further, it requires that you specify the dimensions of the output signal (see next control).

Output dimensions

This control appears only if you specify the `Specify required dimensions` option of the **Output (Y)** control. It specifies the dimensions of the Assignment block's output signal.

Diagnostic if not all required dimensions are populated

This control appears only if you specify the `Specify required dimensions` option of the **Output (Y)** control. It specifies the diagnostic action that Simulink should take if the block's data (U1) and external indices (E) inputs do not assign a value to every element of the block's output (Y). The options are to display an

Assignment

error message and halt the simulation (Error), display a warning message (Warning) and continue the simulation, or continue the simulation (None). If you choose Warning or None, the values of the unassigned elements of the output are undefined.

Sample time (-1 for inherited)
Specify the time interval between samples. To inherit the sample time, set this parameter to -1. See "Specifying Sample Time" in the "How Simulink Works" chapter of the Using Simulink documentation.

Characteristics

| Direct Feedthrough	Yes
Sample Time	Inherited from driving block
Scalar Expansion	Yes
Dimensionalized	Yes
Zero Crossing	No

Purpose   Model the behavior of a system with play

Library   Discontinuities

Description   The Backlash block implements a system in which a change in input causes an equal change in output. However, when the input changes direction, an initial change in input has no effect on the output. The amount of side-to-side play in the system is referred to as the *deadband*. The deadband is centered about the output. This figure shows the block's initial state, with the default deadband width of 1 and initial output of 0.
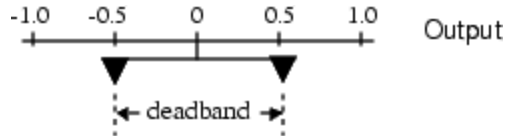
A system with play can be in one of three modes:

• Disengaged - In this mode, the input does not drive the output and the output remains constant.

• Engaged in a positive direction - In this mode, the input is increasing (has a positive slope) and the output is equal to the input *minus* half the deadband width.

• Engaged in a negative direction - In this mode, the input is decreasing (has a negative slope) and the output is equal to the input *plus* half the deadband width.

If the initial input is outside the deadband, the **Initial output** parameter value determines whether the block is engaged in a positive or negative direction, and the output at the start of the simulation is the input plus or minus half the deadband width.

For example, the Backlash block can be used to model the meshing of two gears. The input and output are both shafts with a gear on one end, and the output shaft is driven by the input shaft. Extra space

between the gear teeth introduces *play*. The width of this spacing is the **Deadband width** parameter. If the system is disengaged initially, the output (the position of the driven gear) is defined by the **Initial output** parameter.

The following figures illustrate the block's operation when the initial input is within the deadband. The first figure shows the relationship between the input and the output while the system is in disengaged mode (and the default parameter values are not changed).
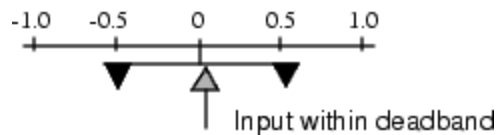
The next figure shows the state of the block when the input has reached the end of the deadband and engaged the output. The output remains at its previous value.
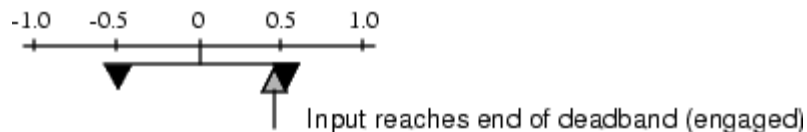
The final figure shows how a change in input affects the output while they are engaged.
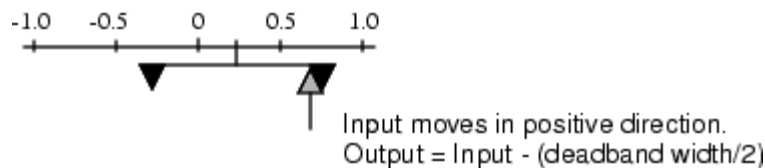
If the input reverses its direction, it disengages from the output. The output remains constant until the input either reaches the opposite end of the deadband or reverses its direction again and engages at the same end of the deadband. Now, as before, movement in the input causes equal movement in the output.

For example, if the deadband width is 2 and the initial output is 5, the output, y, at the start of the simulation is as follows:

- 5 if the input, u, is between 4 and 6

- $u + 1$ if $u < 4$

- $u - 1$ if $u > 6$

This sample model and the plot that follows it show the effect of a sine wave passing through a Backlash block.
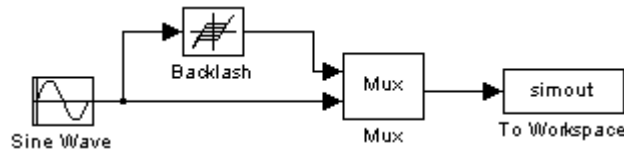
The Backlash block parameters are unchanged from their default values (the deadband width is 1 and the initial output is 0). Notice in the plotted output following that the Backlash block output is zero until the input reaches the end of the deadband (at 0.5). Now the input and output are engaged and the output moves as the input does until the input changes direction (at 1.0). When the input reaches 0, it again engages the output at the opposite end of the deadband.

Backlash
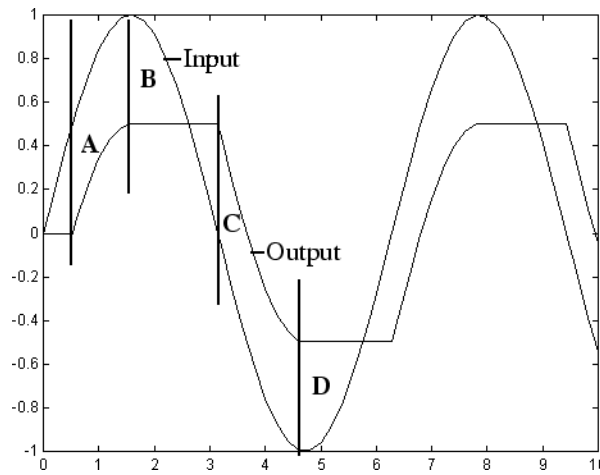
A Input engages in positive direction. Change in input causes equal change in output.

B Input disengages. Change in input does not affect output.

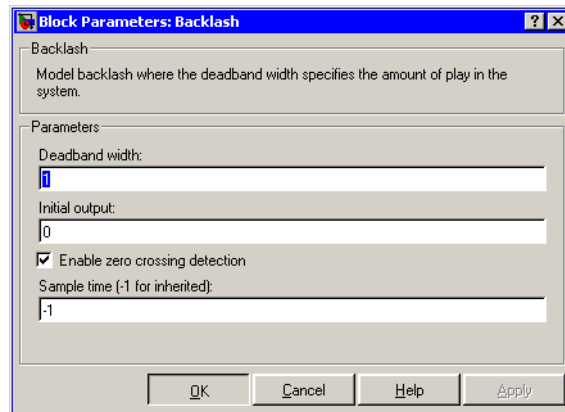C Input engages in negative direction. Change in input causes equal change in output.

D Input disengages. Change in input does not affect output.

Data Type Support

The Backlash block accepts and outputs real values of single, double, and built-in integer data types.

Parameters and Dialog Box

Deadband width

Specify the width of the deadband. The default is 1.

Initial output

> Specify the initial output value. The default value is 0. This parameter is tunable. Simulink does not allow the initial output of this block to be inf or NaN.

Enable zero-crossing detection

> Select to enable use of zero-crossing detection to detect engagement with lower and upper thresholds. For more information, see "Zero-Crossing Detection" in the "How Simulink Works" chapter of the Using Simulink documentation.

Sample time (-1 for inherited)

> Specify the time interval between samples. To inherit the sample time, set this parameter to -1. See "Specifying Sample Time" in the "How Simulink Works" chapter of the Using Simulink documentation.

Characteristics

Direct Feedthrough	Yes
Sample Time	Specified in the **Sample time** parameter
Scalar Expansion	Yes
Dimensionalized	Yes
Zero Crossing	Yes, if you select **Enable zero crossing detection**

Bad Link

Purpose   Indicate an unresolved reference to a library block.

Description   This block indicates an unresolved reference to a library block (see "Creating a Library Link"). You can use this block's parameter dialog box to fix the reference to point to the actual location of the library block.
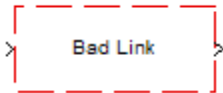
> Bad Link >

Parameters and Dialog Box
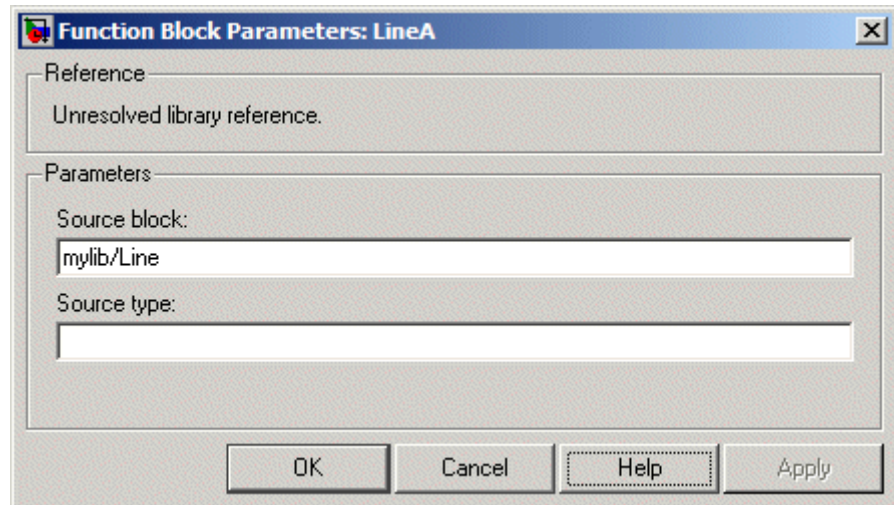
Source block
Path of the library block that this link represents. To fix a bad link, edit this field to reflect the actual path of the library block. Then select Apply or OK to apply the fix and close the dialog box.

Source type
Type of library block that this link represents.

Purpose   Introduce white noise into a continuous system

Library   Sources

Description   The Band-Limited White Noise block generates normally distributed
random numbers that are suitable for use in continuous or hybrid
systems.

The primary difference between this block and the Random Number
block is that the Band-Limited White Noise block produces output at a
specific sample rate, which is related to the correlation time of the noise.

Theoretically, continuous white noise has a correlation time of 0, a flat
power spectral density (PSD), and a covariance of infinity. In practice,
physical systems are never disturbed by white noise, although white
noise is a useful theoretical approximation when the noise disturbance
has a correlation time that is very small relative to the natural
bandwidth of the system.

In Simulink, you can simulate the effect of white noise by using a
random sequence with a correlation time much smaller than the
shortest time constant of the system. The Band-Limited White Noise
block produces such a sequence. The correlation time of the noise is the
sample rate of the block. For accurate simulations, use a correlation
time much smaller than the fastest dynamics of the system. You can get
good results by specifying

$$t_c \approx \frac{1}{100}\frac{2\pi}{f_{max}}$$

where f_{max} is the bandwidth of the system in rad/sec.

The Algorithm Used in the Block Implementation

To produce the correct intensity of this noise, the covariance of the noise
is scaled to reflect the implicit conversion from a continuous PSD to a
discrete noise covariance. The appropriate scale factor is $1/tc$, where
tc is the correlation time of the noise. This scaling ensures that the
response of a continuous system to the approximate white noise has the
same covariance as the system would have to true white noise. Because

Band-Limited White Noise

of this scaling, the covariance of the signal from the Band-Limited White Noise block is not the same as the **Noise power** (intensity) dialog box parameter. This parameter is actually the height of the PSD of the white noise. While the covariance of true white noise is infinite, the approximation used in this block has the property that the covariance of the block output is the **Noise Power** divided by *tc*.

Data Type Support

The Band-Limited White Noise block outputs real values of type double.
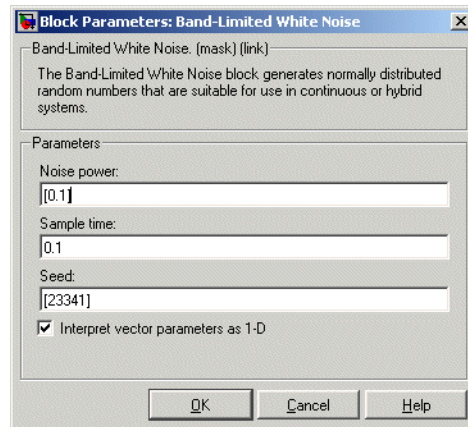
Parameters and Dialog Box

Opening this dialog box causes a running simulation to pause. See "Changing Source Block Parameters" in the "Working with Blocks" chapter of the Using Simulink documentation.

Noise power

The height of the PSD of the white noise. The default value is 0.1.

Sample time

The correlation time of the noise. The default value is 0.1. See "Specifying Sample Time" in the "How Simulink Works" chapter of the Using Simulink documentation.

Seed

> The starting seed for the random number generator. The default value is 23341.

Interpret vector parameters as 1-D

> Output a 1-D array if the block's parameters are vectors. Otherwise, output a 2-D array one of whose dimensions is 1. See "Determining the Output Dimensions of Source Blocks" in the "Working with Signals" chapter of the Using Simulink documentation.

Characteristics

Sample Time	Specified in the **Sample time** parameter
Scalar Expansion	Yes, of **Noise power** and **Seed** parameters and output
Dimensionalized	Yes
Zero Crossing	No

Bias

Purpose	Add a bias to the input
Library	Math Operations

Description
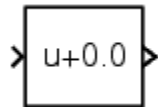
The Bias block adds a bias, or offset, to the input signal according to

$$Y = U + Bias$$

where *U* is the block input and *Y* is the output.

Data Type Support

The Bias block accepts and outputs real or complex values of any data type supported by Simulink, except Boolean. The Bias block supports fixed-point data types.

For a discussion on the data types supported by Simulink, see "Data Types Supported by Simulink" in the "Working with Data" chapter of the Using Simulink documentation.

Parameters and Dialog Box
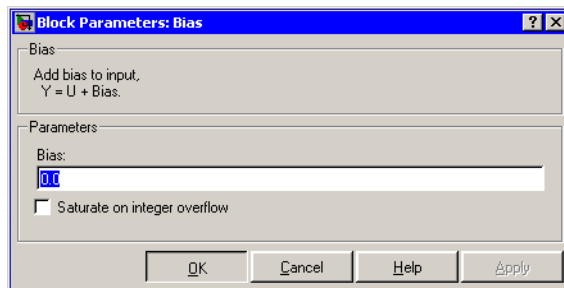
Bias
    Specify the value of the offset to add to the input signal.

Saturate on integer overflow

If the input (and hence the output) is an integer data type (for example, int8) and the data type cannot accommodate the output signal, selecting this option causes the block to output the maximum value allowed by the data type. Otherwise, in this case, the block outputs the result of using twos-complement arithmetic to add the input to the output, i.e., the value is the result of adding the bias to the input modulo the maximum representable value of the data type.

Characteristics

Direct Feedthrough	Yes
Sample Time	Inherited from the driving block
Scalar Expansion	Yes
States	0
Dimensionalized	Yes
Zero Crossing	No

Bit Clear

Purpose   Set the specified bit of the stored integer to zero

Library   Logic and Bit Operations

Description   The Bit Clear block sets the specified bit, given by its index, of the stored integer to zero. Scaling is ignored.
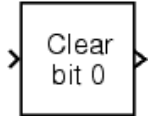
> Clear
> bit 0

You can specify the bit to be set to zero with the **Index of bit** parameter, where bit zero is the least significant bit.

Data Type Support   The Bit Clear block supports Simulink integer, fixed-point, and Boolean data types. True floating-point data types are not supported.

Parameters and Dialog Box
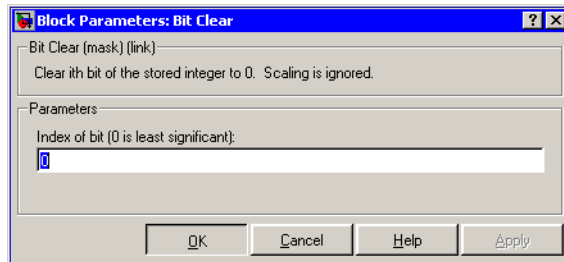
Index of bit
        Index of bit where bit 0 is the least significant bit.

Examples   If the Bit Clear block is turned on for bit 2, bit 2 is set to 0. A vector of constants 2.^[0 1 2 3 4] is represented in binary as [00001 00010 00100 01000 10000]. With bit 2 set to 0, the result is [00001 00010 00000 01000 10000], which is represented in decimal as [1 2 0 8 16].

Characteristics

Direct Feedthrough	Yes
Scalar Expansion	Yes

See Also   Bit Set

Bit Set

Purpose   Set the specified bit of the stored integer to one

Library   Logic and Bit Operations

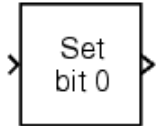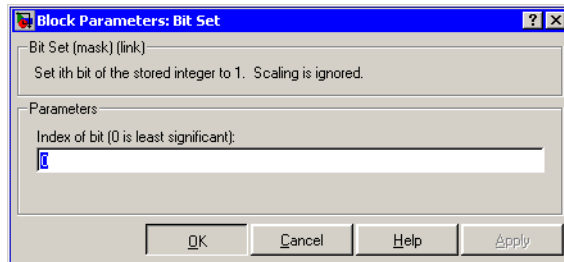**Description**   The Bit Set block sets the specified bit of the stored integer to one. Scaling is ignored.

```
  Set
  bit 0
```

You can specify the bit to be set to one with the **Index of bit** parameter, where bit zero is the least significant bit.

Data Type Support   The Bit Set block supports Simulink integer, fixed-point, and Boolean data types. True floating-point data types are not supported.

Parameters and Dialog Box

> **Block Parameters: Bit Set**
>
> ─ Bit Set (mask) (link) ──────────────────────────────
> Set ith bit of the stored integer to 1. Scaling is ignored.
>
> ─ Parameters ─────────────────────────────────────
> Index of bit (0 is least significant):
> [0   ]
>
> [OK]   [Cancel]   [Help]   [Apply]

Index of bit
> Index of bit where bit 0 is the least significant bit.

Examples   If the Bit Set block is turned on for bit 2, bit 2 is set to 1. A vector of constants 2.^[0 1 2 3 4] is represented in binary as [00001 00010 00100 01000 10000]. With bit 2 set to 1, the result is [00101 00110 00100 01100 10100], which is represented in decimal as [5 6 4 12 20].

Characteristics

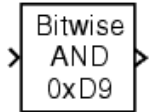| Direct Feedthrough	Yes
Scalar Expansion	Yes

See Also   Bit Clear

Bitwise Operator

Purpose   Perform the specified bitwise operation on the inputs

Library   Logic and Bit Operations

Description   The Bitwise Operator block performs the specified bitwise operation on its operands.

Unlike the logic operations performed by the Logical Operator block, bitwise operations treat the operands as a vector of bits rather than a single number. You select the bitwise Boolean operation from the **Operator** parameter list. The supported operations are given below.

Operation	Description
AND	TRUE if the corresponding bits are all TRUE
OR	TRUE if at least one of the corresponding bits is TRUE
NAND	TRUE if at least one of the corresponding bits is FALSE
NOR	TRUE if no corresponding bits are TRUE
XOR	TRUE if an odd number of corresponding bits are TRUE
NOT	TRUE if the input is FALSE (available only for single input)

The Bitwise Operator block does not support shift operations. For shift operations, see the Shift Arithmetic block.

The size of the output of the Bitwise Operator block depends on the number of inputs, their vector size, and the selected operator:

- The NOT operator accepts only one input, which can be a scalar or a vector. If the input is a vector, the output is a vector of the same size containing the bitwise logical complements of the input vector elements.

- For a single vector input, the block applies the operation (except the NOT operator) to all elements of the vector. If a bit mask is not specified, then the output is a scalar. If a bit mask is specified, then the output is a vector.

- For two or more inputs, the block performs the operation between all of the inputs. If the inputs are vectors, the operation is performed between corresponding elements of the vectors to produce a vector output.

When configured as a multi-input XOR gate, this block performs an addition- modulo-two operation as mandated by the IEEE Standard for Logic Elements.

If you do not select the **Use bit mask** check box, then the block can accept multiple inputs. You select the number of input ports from the **Number of input ports** parameter. The input data types must be identical.

If you select the **Use bit mask** check box, then a single input is associated with the bit mask you specify from the **Bit Mask** parameter. You specify the bit mask using any valid MATLAB expression. For example, you can specify the bit mask 00100101 as `2^5+2^2+2^0`. Alternatively, you can use strings to specify a hexadecimal bit mask such as `{'FE73','12AC'}`. If the bit mask is larger than the input signal data type, then it is ignored.

Note The output data type, which is inherited from the driving block, should represent zero exactly. Data types that satisfy this condition include signed and unsigned integers and any floating-point data type.

The **Treat mask as** parameter list controls how the mask is treated. The possible values are `Real World Value` and `Stored Integer`. In terms of the general encoding scheme described in the "Scaling" section of the Simulink Fixed Point documentation, `Real World Value` treats

the mask as $V = SQ + B$ where S is the slope and B is the bias. `Stored Integer` treats the mask as a stored integer, Q.

You can use the bit mask to perform a bit set or a bit clear on the input. To perform a bit set, set the **Operator** parameter list to `OR` and create a bit mask with a 1 for each corresponding input bit that you want to set to 1. To perform a bit clear, set the **Operator** parameter list to `AND` and create a bit mask with a 0 for each corresponding input bit that you want to set to 0.

For example, suppose you want to perform a bit set on the fourth bit of an 8-bit input vector. The bit mask would be 00010000, which you can specify as `2^4` in the **Bit mask** parameter. To perform a bit clear, the bit mask would be 11101111, which you can specify as `2^7+2^6+2^5+2^3+2^2+2^1+2^0` in the **Bit mask** parameter.

Data Type Support

The Bitwise Operator block supports Simulink integer, fixed-point, and Boolean data types. The block does not support true floating-point data types.

Parameters and Dialog Box
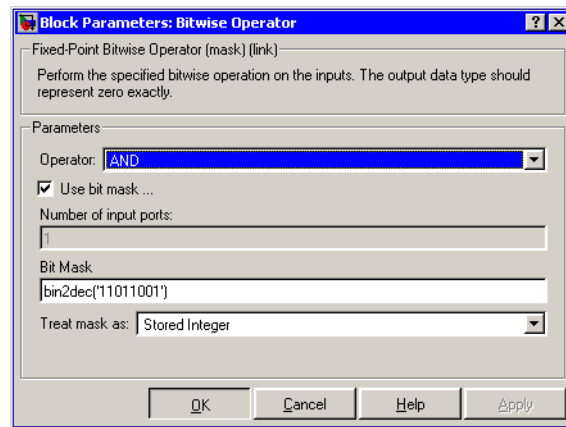
Operator

The bitwise logical operator associated with the specified operands.

Use bit mask

Specify if the bit mask is used (single input only).

Number of input ports

The number of inputs.

Bit Mask

The bit mask to associate with a single input. The **Bit Mask** parameter is converted from a double to the input data type offline using round-to-nearest and saturation.

Treat mask as

Treat the mask as a real-world value or as a stored integer.

Examples   To help you understand the Bitwise Operator block logic operations, consider the fixed-point model shown below.
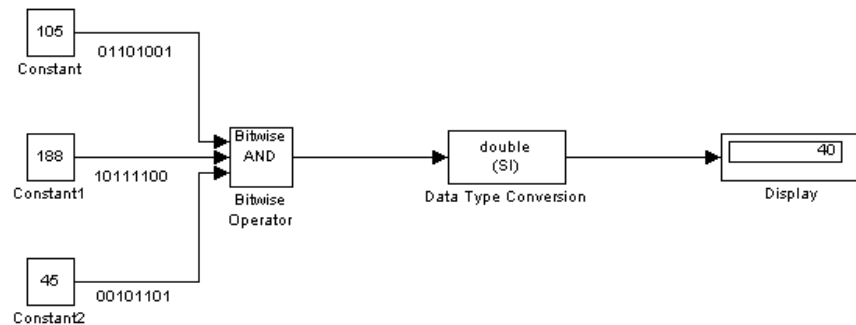
The Constant blocks are configured to output an 8-bit unsigned integer (`uint(8)`). The results for all logic operations are shown below.

Operation	Binary Value	Decimal Value
AND	00101000	40
OR	11111101	253
NAND	11010111	215
NOR	00000010	2

Bitwise Operator

Operation	Binary Value	Decimal Value
XOR	11111000	248
NOT	N/A	N/A

Characteristics

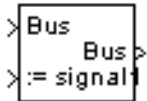|	
Direct Feedthrough	No
Scalar Expansion	Yes, of inputs

Purpose   Assign values to specified elements of a bus.

Library   Signal Routing

Description   The Bus Assignment block assigns values, specified by signals connected
to its assignment (:=) input ports, to specified elements of the bus
connected to its Bus input port. Use the block's dialog box to specify the
bus elements to be assigned values. The block displays an assignment
input port for each bus element to be assigned a signal. The signal
connected to the assignment port must have the same structure (i.e.,
vector, matrix, bus), data type, and numeric (i.e., real or complex) type
as the bus element to which it corresponds.

> **Note** If an associated bus object (see Bus Creator and Simulink.Bus)
> defines the bus to be assigned values, all of the assignment signals
> must have the same sample time, even if the elements of the bus object
> associated with the bus specify inherited sample times.

**Data Type
Support**   The bus input port of the Bus Assignment block accepts and outputs real
or complex values of any data type supported by Simulink, including
fixed-point data types. The assignment input ports accept the same
data and numeric types as the bus elements to which they correspond.

For a discussion on the data types supported by Simulink, see "Data
Types Supported by Simulink" in the "Working with Data" chapter of
the Using Simulink documentation.

Bus Assignment

Parameters and Dialog Box
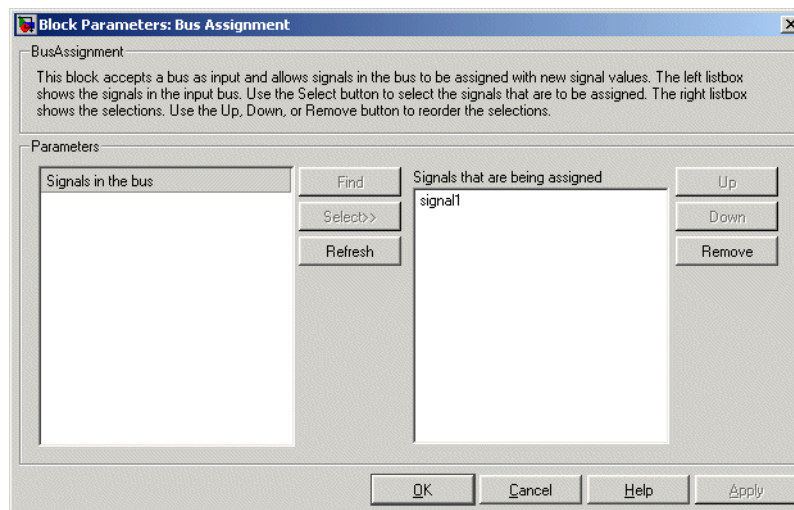
Signals in the bus

Displays the names of the signals contained by the bus at the block's Bus input port. Click any item in the list to select it. To find the source of the selected signal, click the adjacent **Find** button. Simulink opens the subsystem containing the signal source, if necessary, and highlights the source's icon. Use the **Select>>** button to move the currently selected signal into the adjacent list of signals to be assigned values (see **Signals that are being assigned** below). To refresh the display (e.g., to reflect modifications to the bus connected to the block), click the adjacent **Refresh** button.

Signals that are being assigned

Lists the names of bus elements to be assigned values. This block displays an assignment input port for each bus element in this list. The label of the corresponding input port contains the name of the element. You can order the signals by using the **Up**, **Down**, and **Remove** buttons. Port connectivity is maintained when the signal order is changed.

Three question marks (???) before the name of a bus element indicate that the input bus no longer contains an element of that name, for example, because the bus has changed since the last time you refreshed the Bus Assignment block's input and bus element assignment lists. You can fix the problem either by modifying the bus to include a signal of the specified name or by removing the name from the list of bus elements to be assigned values.

Bus Creator

Purpose   Create a signal bus

Library   Signal Routing

Description   The Bus Creator block combines a set of signals into a bus, i.e., a group of signals represented by a single line in a block diagram. The Bus Creator block, when used in conjunction with the Bus Selector block, allows you to reduce the number of lines required to route signals from one part of a diagram to another. This makes your diagram easier to understand.

To bundle a group of signals with a Bus Creator block, set the block's **Number of inputs** parameter to the number of signals in the group. The block displays the number of ports that you specify. Connect the signals to be grouped to the resulting input ports. You can connect any type of signal to the inputs, including other bus signals. To ungroup the signals, connect the block's output port to a Bus Selector port.

**Note** Simulink hides the name of a Bus Creator block when you copy it from the Simulink library to a model.

Naming Signals

The Bus Creator block assigns a name to each signal on the bus that it creates. This allows you to refer to signals by name when searching for their sources (see "Browsing Bus Signals" on page 2-51) or selecting signals for connection to other blocks. The block offers two bus signal naming options. You can specify that each signal on the bus inherit the name of the signal connected to the bus (the default) or that each input signal must have a specific name.

To specify that bus signals inherit their names from input ports, select `Inherit bus signal names from input ports` from the list box on the block's parameter dialog box. The names of the inherited bus signals appear in the **Signals in bus** list box.
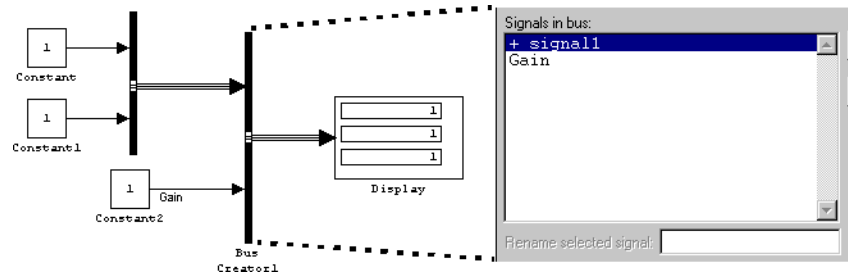
The Bus Creator block generates names for bus signals whose corresponding inputs do not have names. The names are of the form `signaln` where n is the number of the port to which the input signal is connected.

You can change the name of any signal by editing its name on the block diagram or in the **Signal Properties** dialog box. If you change a name in this way while the Bus Creator block's dialog box is open, you must close and reopen the dialog box or click the **Refresh** button next to the **Signals in bus** list to update the name in the dialog box.

To specify that the bus inputs must have specific names, select `Require input signal names to match signals below` from the list box on the block's parameter dialog box. The block's parameter dialog box displays the names of the signals currently connected to its inputs or a generated name (for example, signal2) for an anonymous input. You can now use the parameter dialog box to change the required names of the block's inputs. To change the required signal name, select the signal in the **Signals in bus** list. The selected signal's name appears in the **Rename selected signal** field. Edit the name in the field and click the parameter dialog box's **Apply** button to apply your edits or the **OK** button to apply the edits and close the dialog box.

Browsing Bus Signals

The **Signals in bus** list on a Bus Creator block's parameter dialog displays a list of the signals entering the block. A plus sign (+) next to a signal indicates that the signal is itself a bus. You can display its contents by clicking the plus sign. If the expanded input includes bus signals, plus signs appear next to the names of those bus signals. You

Bus Creator

can expand them as well. In this way, you can view all signals entering the block, including those entering via buses. To find the source of any signal entering the block, select the signal in the **Signals in bus** list and click the adjacent **Find** button. Simulink opens the subsystem containing the signal source, if necessary, and highlights the source's icon.

Data Type Support

The Bus Creator block accepts and outputs real or complex values of any data type supported by Simulink, including fixed-point data types.

For a discussion on the data types supported by Simulink, refer to "Data Types Supported by Simulink" in the "Working with Data" chapter of the Using Simulink documentation.

Parameters and Dialog Box
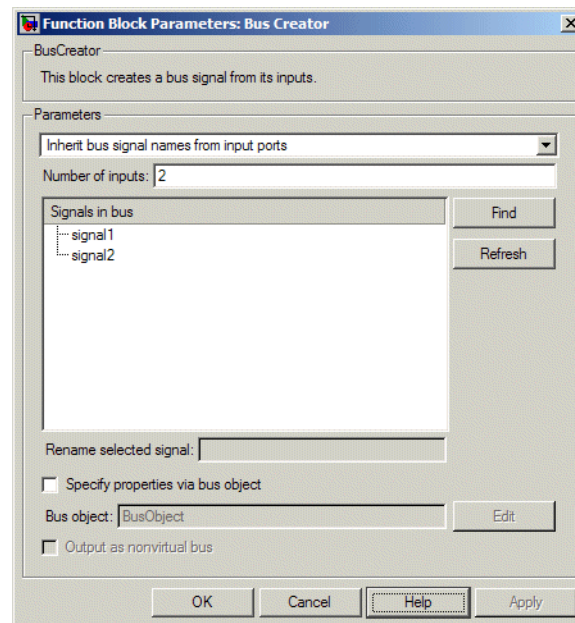
Signal naming options

Select `Inherit bus signal names from input ports` to assign input signal names to the corresponding bus signals. Select `Require input signal names to match signals below` to specify that inputs must have the names listed in the **Signals in bus** list. Selecting this option enables the **Rename selected signal** field.

Number of inputs

Specifies the number of input ports on this block.

Signals in bus

The **Signals in bus list box** shows the signals in the output bus. A plus sign (+) next to a signal name indicates that the signal is itself a bus. Click the plus sign to display the subsidiary bus signals. Click the **Refresh** button to update the list after editing the name of an input signal. Click the **Find** button to highlight the source of the currently selected signal.

Rename selected signal

Lists the name of the signal currently selected in the **Signals in bus** list when you select the `Require input signal names to match signals below` option. Edit this field to change the name of the currently selected signal.

Specify properties via bus object

Select this option to use a bus object to define the structure of the bus created by this block (see "Working with Data Objects" in the "Working with Data" chapter of the Using Simulink documentation and the `Simulink.Bus` class in the online Simulink reference to learn how to create bus objects).

Bus object

This option is enabled only if you select the **Specify properties via bus object** option. It specifies the name of bus object used to define the structure of the bus created by this block. At the beginning of a simulation or when you update the model's diagram, Simulink checks whether the signals connected to this

Bus Creator block have the specified structure. If not, Simulink displays an error message.

Note If you select this option, all of the signals entering the Bus Creator block must have the same sample time, even if the elements of the associated bus object specify inherited sample times.

Output as nonvirtual bus

This option is enabled only if you select the **Specify properties via bus object** option. If this option is selected, this block outputs a nonvirtual bus; otherwise, it outputs a virtual bus (see "Virtual Versus Nonvirtual Buses" in the "Working with Signals" chapter of the Using Simulink documentation). Select this option if you want code generated from this model to use a C structure to define the structure of the bus signal output by this block.

Purpose   Select signals from an incoming bus

Library   Signal Routing

Description   The Bus Selector block outputs a specified subset of the elements of the bus at its input. The block can output the selected elements as multiple standalone signals or as elements of a new bus.

Note Simulink hides the name of a Bus Selector block when you copy it from the Simulink library to a model.
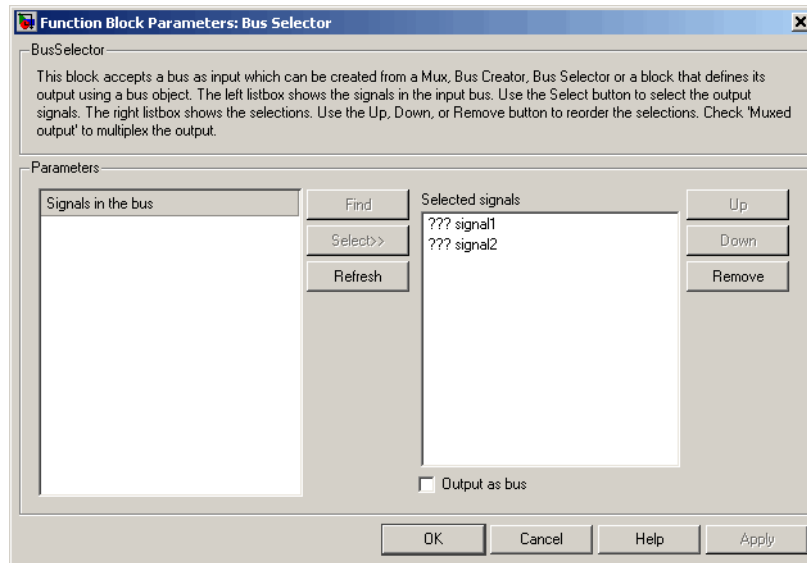

Data Type Support   A Bus Selector block accepts and outputs real or complex values of any data type supported by Simulink, including fixed-point data types.

For a discussion on the data types supported by Simulink, see "Data Types Supported by Simulink" in the "Working with Data" chapter of the Using Simulink documentation.

Bus Selector

Parameters and Dialog Box

Signals in the bus

> The **Signals in the bus** list shows the signals in the input bus. Use the **Select>>** button to select output signals. To find the source of any signal entering the block, select the signal in the **Signals in the bus** list and click the adjacent **Find** button. Simulink opens the subsystem containing the signal source, if necessary, and highlights the source's icon. To refresh the display (e.g., to reflect modifications to the bus connected to the block), click the adjacent **Refresh** button.

Selected signals

> The **Selected signals** list box shows the output signals. You can order the signals by using the **Up**, **Down**, and **Remove** buttons. Port connectivity is maintained when the signal order is changed.

> If an output signal listed in the **Selected signals** list box is not an input to the Bus Selector block, the signal name is preceded by three question marks (???).

Output as bus

> If selected, this option causes the block to output the selected elements as a bus. Otherwise, the block outputs the elements as standalone signals, each from its own output port and labeled with the corresponding element's name.
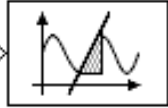
Check Discrete Gradient

Purpose   Check that the absolute value of the difference between successive samples of a discrete signal is less than an upper bound

Library   Model Verification

Description   The Check Discrete Gradient block checks each signal element at its input to determine whether the absolute value of the difference between successive samples of the element is less than an upper bound. The block's parameter dialog box allows you to specify the value of the upper bound (1 by default). If the verification condition is true, the block does nothing. Otherwise, the block halts the simulation, by default, and displays an error message in the Simulation Diagnostics Viewer.

The **Model Verification block enabling** setting under **Debugging** on the **Data Validity** diagnostics pane of the **Configuration Parameters** dialog box lets you enable or disable all model verification blocks, including Check Discrete Gradient blocks, in a model.
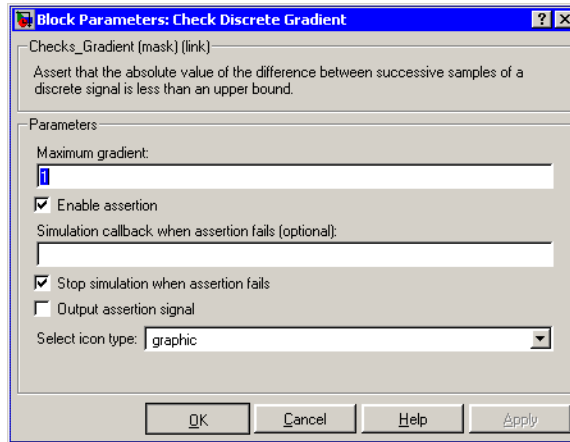
The Check Discrete Gradient block and its companion blocks in the Model Verification library are intended to facilitate creation of self-validating models. For example, you can use model verification blocks to test that signals do not exceed specified limits during simulation. When you are satisfied that a model is correct, you can turn error checking off by disabling the verification blocks. You do not have to physically remove them from the model. If you need to modify a model, you can temporarily turn the verification blocks back on to ensure that your changes do not break the model.

Data Type Support   The Check Discrete Gradient block accepts `single`, `double`, `int8`, `int16`, and `int32` input signals of any dimensions.

Parameters and Dialog Box

Maximum gradient

Upper bound on the gradient of the discrete input signal.

Enable assertion

Unchecking this option disables the Check Discrete Gradient block, that is, causes the model to behave as if the block did not exist. The **Model Verification block enabling** setting under **Debugging** on the **Data Validity** diagnostics pane of the **Configuration Parameters** dialog box allows you to enable or disable all model verification blocks in a model, including Check Discrete Gradient blocks, regardless of the setting of this option.

Simulation callback when assertion fails

An M-expression to be evaluated when the assertion fails.

Stop simulation when assertion fails

If checked, this option causes the Check Discrete Gradient block to halt the simulation when the block's output is zero and display an error message in Simulink's **Simulation Diagnostics** viewer. Otherwise, the block displays a warning message in the MATLAB Command Window and continues the simulation.

Check Discrete Gradient

Output assertion signal
>   If checked, this option causes the Check Discrete Gradient block
>   to output a Boolean signal that is true (1) at each time step if
>   the assertion succeeds and false (0) if the assertion fails. The
>   data type of the output signal is `Boolean` if you have selected
>   the `Implement logic signals as boolean data` option on
>   the **Simulation and code generation** optimization pane of
>   Simulink's **Configuration Parameters** dialog box. Otherwise
>   the data type of the output signal is `double`.

Select icon type
>   Type of icon used to display this block in a block diagram: either
>   `graphic` or `text`. The `graphic` option displays a graphical
>   representation of the assertion condition on the icon. The `text`
>   option displays a mathematical expression that represents
>   the assertion condition. If the icon is too small to display the
>   expression, the text icon displays an exclamation point. To see the
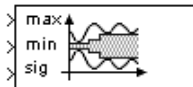>   expression, enlarge the block.

Characteristics

Direct Feedthrough	No
Sample Time	Inherited from driving block
Scalar Expansion	No
Dimensionalized	Yes
Zero Crossing	No

Purpose   Check that a gap of possibly varying width occurs in the range of a signal's amplitudes

Library   Model Verification

Description The Check Dynamic Gap block checks that a gap of possibly varying width occurs in the range of a signal's amplitudes. The test signal is the signal connected to the input labeled *sig*. The inputs labeled *min* and *max* specify the lower and upper bounds of the dynamic gap, respectively. If the verification condition is true, the block does nothing. If not, the block halts the simulation, by default, and displays an error message.

The Check Dynamic Gap block and its companion blocks in the Model Verification library are intended to facilitate creation of self-validating models. For example, you can use model verification blocks to test that signals do not exceed specified limits during simulation. When you are satisfied that a model is correct, you can turn error checking off by disabling the verification blocks. You do not have to physically remove them from the model. If you need to modify a model, you can temporarily turn the verification blocks back on to ensure that your changes do not break the model.

Data Type Support The Check Dynamic Gap block accepts input signals of any dimensions and of any data type supported by Simulink. All three input signals must have the same dimension and data type. If the inputs are nonscalar, the block checks each element of the input test signal to the corresponding elements of the reference signals.

For a discussion on the data types supported by Simulink, see "Data Types Supported by Simulink" in the "Working with Data" chapter of the Using Simulink documentation.

Check Dynamic Gap

Parameters and Dialog Box
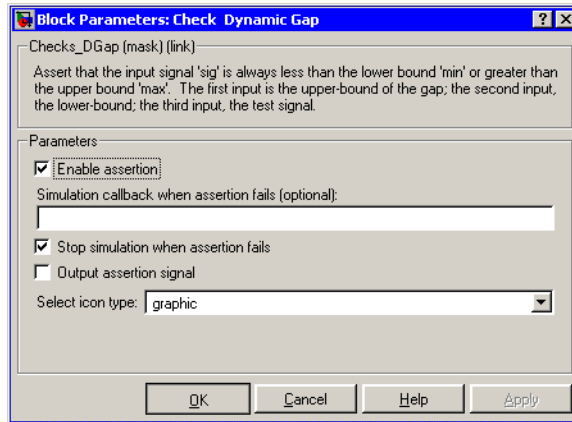
Enable assertion

Unchecking this option disables the Check Dynamic Gap block, that is, causes the model to behave as if the block did not exist. The **Model Verification block enabling** setting under **Debugging** on the **Data Validity** diagnostics pane of the **Configuration Parameters** dialog box allows you to enable or disable all model verification blocks in a model, including Check Dynamic Gap blocks, regardless of the setting of this option.

Simulation callback when assertion fails

An M-expression to be evaluated when the assertion fails.

Stop simulation when assertion fails

If checked, this option causes the Check Dynamic Gap block to halt the simulation when the block's output is zero and display an error message in the **Simulation Diagnostics** viewer. Otherwise, the block displays a warning message in the MATLAB Command Window and continues the simulation.

Output assertion signal

If checked, this option causes the Check Dynamic Gap block to output a Boolean signal that is true (1) at each time step if the assertion succeeds and false (0) if the assertion fails. The data type of the output signal is Boolean if you have selected

the `Implement logic signals as boolean data` option on the **Simulation and code generation** optimization pane of the **Configuration Parameters** dialog box. Otherwise the data type of the output signal is `double`.

Select icon type

Type of icon used to display this block in a block diagram: either `graphic` or `text`. The `graphic` option displays a graphical representation of the assertion condition on the icon. The `text` option displays a mathematical expression that represents the assertion condition. If the icon is too small to display the expression, the text icon displays an exclamation point. To see the expression, enlarge the block.

Characteristics

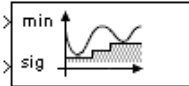|	
Direct Feedthrough	No
Sample Time	Inherited from driving block
Scalar Expansion	No
Dimensionalized	Yes
Zero Crossing	No

Check Dynamic Lower Bound

Purpose   Check that one signal is always less than another signal

Library   Model Verification

Description   The Check Dynamic Lower Bound block checks that the amplitude of a reference signal is less than the amplitude of a test signal at the current time step. The test signal is the signal connected to the input labeled *sig*. If the verification condition is true, the block does nothing. If not, the block halts the simulation, by default, and displays an error message.
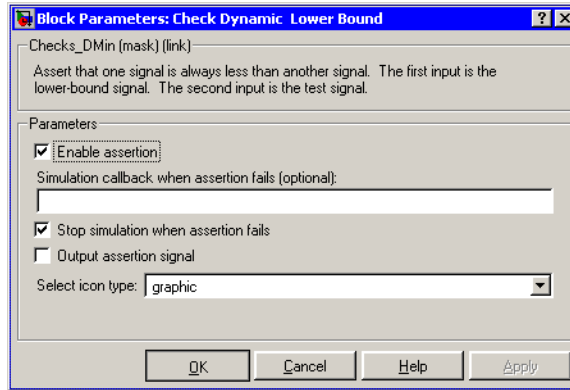
The Check Dynamic Lower Bound block and its companion blocks in the Model Verification library are intended to facilitate creation of self-validating models. For example, you can use model verification blocks to test that signals do not exceed specified limits during simulation. When you are satisfied that a model is correct, you can turn error checking off by disabling the verification blocks. You do not have to physically remove them from the model. If you need to modify a model, you can temporarily turn the verification blocks back on to ensure that your changes do not break the model.

Data Type Support

The Check Dynamic Lower Bound block accepts input signals of any data type supported by Simulink. The test and the reference signals must have the same dimensions and data type. If the inputs are nonscalar, the block checks each element of the input test signal to the corresponding elements of the reference signal.

For a discussion on the data types supported by Simulink, see "Data Types Supported by Simulink" in the "Working with Data" chapter of the Using Simulink documentation.

Parameters and Dialog Box

Enable assertion

Unchecking this option disables the Check Dynamic Lower Bound block, that is, causes the model to behave as if the block did not exist. The **Model Verification block enabling** setting under **Debugging** on the **Data Validity** diagnostics pane of the **Configuration Parameters** dialog box allows you to enable or disable all model verification blocks, including Check Dynamic Lower Bound blocks, in a model regardless of the setting of this option.

Simulation callback when assertion fails

An M-expression to be evaluated when the assertion fails.

Stop simulation when assertion fails

If checked, this option causes the Check Dynamic Lower Bound block to halt the simulation when the block's output is zero and display an error message in the **Simulation Diagnostics** viewer. Otherwise, the block displays a warning message in the MATLAB Command Window and continues the simulation.

Output assertion signal

If checked, this option causes the Check Dynamic Lower Bound block to output a Boolean signal that is true (1) at each time step if the assertion succeeds and false (0) if the assertion fails. The data type of the output signal is Boolean if you have selected

Check Dynamic Lower Bound

the `Implement logic signals as boolean data` option on the **Simulation and code generation** optimization pane of the **Configuration Parameters** dialog box. Otherwise the data type of the output signal is `double`.

Select icon type

Type of icon used to display this block in a block diagram: either `graphic` or `text`. The `graphic` option displays a graphical representation of the assertion condition on the icon. The `text` option displays a mathematical expression that represents the assertion condition. If the icon is too small to display the expression, the text icon displays an exclamation point. To see the expression, enlarge the block.

Characteristics

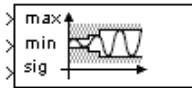| Direct Feedthrough	No
Sample Time	Inherited from driving block
Scalar Expansion	No
Dimensionalized	Yes
Zero Crossing	No

Purpose   Check that a signal falls inside a range of amplitudes that varies from time step to time step

Library   Model Verification

Description   The Check Dynamic Range block checks that a test signal falls inside a range of amplitudes at each time step. The width of the range can vary from time step to time step. The input labeled *sig* is the test signal. The inputs labeled *min* and *max* are the lower and upper bounds of the valid range at the current time step. If the verification condition is true, the block does nothing. If not, the block halts the simulation, by default, and displays an error message.

The Check Dynamic Range block and its companion blocks in the Model Verification library are intended to facilitate creation of self-validating models. For example, you can use model verification blocks to test that signals do not exceed specified limits during simulation. When you are satisfied that a model is correct, you can turn error checking off by disabling the verification blocks. You do not have to physically remove them from the model. If you need to modify a model, you can temporarily turn the verification blocks back on to ensure that your changes do not break the model.
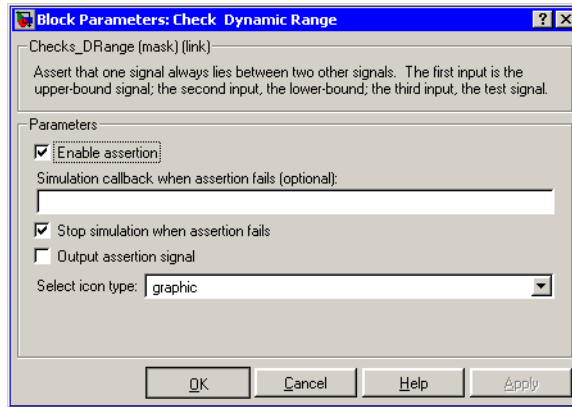
Data Type Support   The Check Dynamic Range block accepts input signals of any dimensions and of any data type supported by Simulink. All three input signals must have the same dimension and data type. If the inputs are nonscalar, the block checks each element of the input test signal to the corresponding elements of the reference signals.

For a discussion on the data types supported by Simulink, see "Data Types Supported by Simulink" in the "Working with Data" chapter of the Using Simulink documentation.

Check Dynamic Range

Parameters and Dialog Box

Enable assertion

Unchecking this option disables the Check Dynamic Range block, that is, causes the model to behave as if the block did not exist. The **Model Verification block enabling** setting under **Debugging** on the **Data Validity** diagnostics pane of the **Configuration Parameters** dialog box allows you to enable or disable all model verification blocks in a model, including Check Dynamic Range blocks, regardless of the setting of this option.

Simulation callback when assertion fails

An M-expression to be evaluated when the assertion fails.

Stop simulation when assertion fails

If checked, this option causes the Check Dynamic Range block to halt the simulation when the block's output is zero and display an error message in the **Simulation Diagnostics** viewer. Otherwise, the block displays a warning message in the MATLAB Command Window and continues the simulation.

Output assertion signal

If checked, this option causes the Check Dynamic Range block to output a Boolean signal that is true (1) at each time step if the assertion succeeds and false (0) if the assertion fails. The data type of the output signal is Boolean if you selected the Implement

logic signals as boolean data option on the **Simulation
and code generation** optimization pane of the **Configuration
Parameters** dialog box. Otherwise the data type of the output
signal is double.

Select icon type
Type of icon used to display this block in a block diagram: either
graphic or text. The graphic option displays a graphical
representation of the assertion condition on the icon. The text
option displays a mathematical expression that represents
the assertion condition. If the icon is too small to display the
expression, the text icon displays an exclamation point. To see the
expression, enlarge the block.

Characteristics

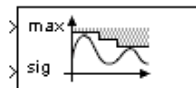| Direct Feedthrough	No
Sample Time	Inherited from driving block
Scalar Expansion	No
Dimensionalized	Yes
Zero Crossing	No

Check Dynamic Upper Bound

Purpose   Check that one signal is always greater than another signal

Library   Model Verification

Description   The Check Dynamic Upper Bound block checks that the amplitude of
                     a reference signal is greater than the amplitude of a test signal at the
                     current time step. The test signal is the signal connected to the input
                     labeled *sig*. If the verification condition is true, the block does nothing.
                     If not, the block halts the simulation, by default, and displays an error
                     message.

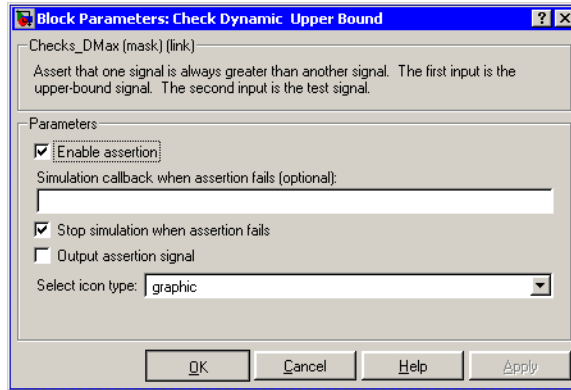   The Check Dynamic Upper Bound block and its companion blocks in
                     the Model Verification library are intended to facilitate creation of
                     self-validating models. For example, you can use model verification
                     blocks to test that signals do not exceed specified limits during
                     simulation. When you are satisfied that a model is correct, you can
                     turn error-checking off by disabling the verification blocks. You do not
                     have to physically remove them from the model. If you need to modify
                     a model, you can temporarily turn the verification blocks back on to
                     ensure that your changes do not break the model.

Data Type   The Check Dynamic Upper Bound block accepts input signals of any
Support   dimensions and of any data type supported by Simulink. The test and
                     the reference signals must have the same dimensions and data type. If
                     the inputs are nonscalar, the block compares each element of the input
                     test signal to the corresponding elements of the reference signal.

                     For a discussion on the data types supported by Simulink, see "Data
                     Types Supported by Simulink" in the "Working with Data" chapter of
                     the Using Simulink documentation.

Parameters and Dialog Box

Enable assertion

Unchecking this option disables the Check Dynamic Upper Bound block, that is, causes the model to behave as if the block did not exist. The **Model Verification block enabling** setting under **Debugging** on the **Data Validity** diagnostics pane of the **Configuration Parameters** dialog box allows you to enable or disable all model verification blocks, including Check Dynamic Upper Bound blocks, in a model regardless of the setting of this option.

Simulation callback when assertion fails

An M-expression to be evaluated when the assertion fails.

Stop simulation when assertion fails

If checked, this option causes the Check Dynamic Upper Bound block to halt the simulation when the block's output is zero and display an error message in the **Simulation Diagnostics** viewer. Otherwise, the block displays a warning message in the MATLAB Command Window and continues the simulation.

Output assertion signal

If checked, this option causes the Check Dynamic Upper Bound block to output a Boolean signal that is true (1) at each time step if the assertion succeeds and false (0) if the assertion fails. The data type of the output signal is Boolean if you have selected

Check Dynamic Upper Bound

the `Implement logic signals as boolean data` option on the **Simulation and code generation** optimization pane of the **Configuration Parameters** dialog box. Otherwise the data type of the output signal is `double`.

Select icon type

Type of icon used to display this block in a block diagram: either `graphic` or `text`. The `graphic` option displays a graphical representation of the assertion condition on the icon. The `text` option displays a mathematical expression that represents the assertion condition. If the icon is too small to display the expression, the text icon displays an exclamation point. To see the expression, enlarge the block.

Characteristics

Direct Feedthrough	No
Sample Time	Inherited from driving block
Scalar Expansion	No
Dimensionalized	Yes
Zero Crossing	No

Purpose   Check that the input signal has a specified resolution

Library   Model Verification
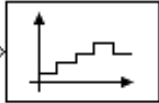
Description   The Check Input Resolution block checks whether the input signal has a specified scalar or vector resolution (see Resolution). If the resolution is a scalar, the input signal must be a multiple of the resolution within a 10e-3 tolerance. If the resolution is a vector, the input signal must equal an element of the resolution vector. If the verification condition is true, the block does nothing. If not, the block halts the simulation, by default, and displays an error message.

The Check Input Resolution block and its companion blocks in the Model Verification library are intended to facilitate creation of self-validating models. For example, you can use model verification blocks to test that signals do not exceed specified limits during simulation. When you are satisfied that a model is correct, you can turn error checking off by disabling the verification blocks. You do not have to physically remove them from the model. If you need to modify a model, you can temporarily turn the verification blocks back on to ensure that your changes do not break the model.
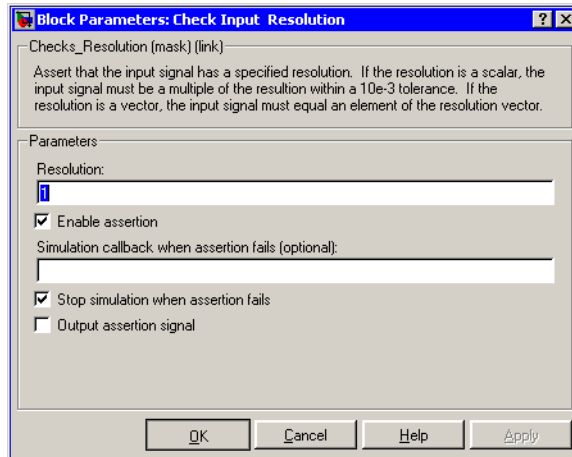
Data Type Support   The Check Input Resolution block accepts input signals of data type `double` and of any dimension. If the input signal is nonscalar, the block checks the resolution of each element of the input test signal.

For a discussion on the data types supported by Simulink, see "Data Types Supported by Simulink" in the "Working with Data" chapter of the Using Simulink documentation.

Check Input Resolution

**Parameters
and
Dialog
Box**

Resolution

Resolution that the input signal must have.

Enable assertion

Unchecking this option disables the Check Input Resolution
block, that is, causes the model to behave as if the block did
not exist. The **Model Verification block enabling** setting
under **Debugging** on the **Data Validity** diagnostics pane of the
Configuration Parameters dialog box allows you to enable or
disable all model verification blocks in a model, including Check
Input Resolution blocks, regardless of the setting of this option.

Simulation callback when assertion fails

An M-expression to be evaluated when the assertion fails.

Stop simulation when assertion fails

If checked, this option causes the Check Input Resolution block to
halt the simulation when the block's output is zero and display
an error message in the **Simulation Diagnostics** viewer.
Otherwise, the block displays a warning message in the MATLAB
Command Window and continues the simulation.

Output assertion signal

> If checked, this option causes the Check Input Resolution block to output a Boolean signal that is true (1) at each time step if the assertion succeeds and false (0) if the assertion fails. The data type of the output signal is Boolean if you have selected the Implement logic signals as boolean data option on the **Simulation and code generation** optimization pane of the **Configuration Parameters** dialog box. Otherwise the data type of the output signal is double.

Characteristics

Direct Feedthrough	No
Sample Time	Inherited from driving block
Scalar Expansion	No
Dimensionalized	Yes
Zero Crossing	No

Check Static Gap

Purpose   Check that a gap exists in a signal's range of amplitudes

Library   Model Verification

Description
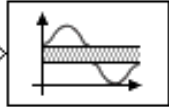
The Check Static Gap block checks that each element of the input signal is less than (or optionally equal to) a static lower bound or greater than (or optionally equal to) a static upper bound at the current time step. If the verification condition is true, the block does nothing. If not, the block halts the simulation, by default, and displays an error message.

The Check Static Gap block and its companion blocks in the Model Verification library are intended to facilitate creation of self-validating models. For example, you can use model verification blocks to test that signals do not exceed specified limits during simulation. When you are satisfied that a model is correct, you can turn error checking off by disabling the verification blocks. You do not have to physically remove them from the model. If you need to modify a model, you can temporarily turn the verification blocks back on to ensure that your changes do not break the model.

Data Type Support

The Check Static Gap block accepts input signals of any dimensions and of any data type supported by Simulink.

For a discussion on the data types supported by Simulink, see "Data Types Supported by Simulink" in the "Working with Data" chapter of the Using Simulink documentation.

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**Parameters
and
Dialog
Box**

Upper bound

    Upper bound of the gap in the input signal's range of amplitudes.

Inclusive upper bound

    If checked, this option specifies that the gap includes the upper bound.

Lower bound

    Lower bound of the gap in the input signal's range of amplitudes.

Inclusive lower bound

    If checked, this option specifies that the gap includes the lower bound.

Enable assertion

    Unchecking this option disables the Check Static Gap block, that is, causes the model to behave as if the block did not exist. The **Model Verification block enabling** setting under **Debugging** on the **Data Validity** diagnostics pane of the **Configuration Parameters** dialog box allows you to enable or disable all model

Check Static Gap

verification blocks in a model, including Check Static Gap blocks, regardless of the setting of this option.

Simulation callback when assertion fails
An M-expression to be evaluated when the assertion fails.

Stop simulation when assertion fails
If checked, this option causes the Check Static Gap block to halt the simulation when the block's output is zero and display an error message in the **Simulation Diagnostics** viewer. Otherwise, the block displays a warning message in the MATLAB Command Window and continues the simulation.

Output assertion signal
If checked, this option causes the Check Static Gap block to output a Boolean signal that is true (1) at each time step if the assertion succeeds and false (0) if the assertion fails. The data type of the output signal is Boolean if you have selected the Implement logic signals as boolean data option on the **Simulation and code generation** optimization pane of the **Configuration Parameters** dialog box. Otherwise the data type of the output signal is double.

Select icon type
Type of icon used to display this block in a block diagram: either graphic or text. The graphic option displays a graphical representation of the assertion condition on the icon. The text option displays a mathematical expression that represents the assertion condition. If the icon is too small to display the expression, the text icon displays an exclamation point. To see the expression, enlarge the block.

Characteristics

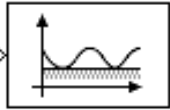| Direct Feedthrough	No
Sample Time	Inherited from driving block
Scalar Expansion	No

Dimensionalized	Yes
Zero Crossing	No

Check Static Lower Bound

Purpose
Check that a signal is greater than (or optionally equal to) a static lower bound

Library
Model Verification

Description

The Check Static Lower Bound block checks that each element of the input signal is greater than (or optionally equal to) a specified lower bound at the current time step. The block's parameter dialog box allows you to specify the value of the lower bound and whether the lower bound is inclusive. If the verification condition is true, the block does nothing. If not, the block halts the simulation, by default, and displays an error message.

The Check Static Lower Bound block and its companion blocks in the Model Verification library are intended to facilitate creation of self-validating models. For example, you can use model verification blocks to test that signals do not exceed specified limits during simulation. When you are satisfied that a model is correct, you can turn error checking off by disabling the verification blocks. You do not have to physically remove them from the model. If you need to modify a model, you can temporarily turn the verification blocks back on to ensure that your changes do not break the model.

Data Type Support

The Check Static Lower Bound block accepts input signals of any dimensions and of any data type supported by Simulink.

For a discussion on the data types supported by Simulink, see "Data Types Supported by Simulink" in the "Working with Data" chapter of the Using Simulink documentation.

Parameters and Dialog Box

Lower bound

Lower bound on the range of amplitudes that the input signal can have.

Inclusive boundary

Checking this option makes the range of valid input amplitudes include the lower bound.

Enable assertion

Unchecking this option disables the Check Static Lower Bound block, that is, causes the model to behave as if the block did not exist. The **Model Verification block enabling** setting under **Debugging** on the **Data Validity** diagnostics pane of the **Configuration Parameters** dialog box allows you to enable or disable all model verification blocks in a model, including Check Static Lower Bound blocks, regardless of the setting of this option.

Simulation callback when assertion fails

An M-expression to be evaluated when the assertion fails.

Stop simulation when assertion fails

If checked, this option causes the Check Static Lower Bound block to halt the simulation when the block's output is zero and

Check Static Lower Bound

display an error message in the **Simulation Diagnostics** viewer. Otherwise, the block displays a warning message in the MATLAB Command Window and continues the simulation.

Output assertion signal

If checked, this option causes the Check Static Lower Bound block to output a Boolean signal that is true (1) at each time step if the assertion succeeds and false (0) if the assertion fails. The data type of the output signal is Boolean if you have selected the Implement logic signals as boolean data option on the **Simulation and code generation** optimization pane of the **Configuration Parameters** dialog box. Otherwise the data type of the output signal is double.

Select icon type

Type of icon used to display this block in a block diagram: either graphic or text. The graphic option displays a graphical representation of the assertion condition on the icon. The text option displays a mathematical expression that represents the assertion condition. If the icon is too small to display the expression, the text icon displays an exclamation point. To see the expression, enlarge the block.

Characteristics

Direct Feedthrough	No
Sample Time	Inherited from driving block
Scalar Expansion	No
Dimensionalized	Yes
Zero Crossing	No

Purpose   Check that a signal falls inside a fixed range of amplitudes

Library   Model Verification

Description   The Check Static Range block checks that each element of the input
signal falls inside the same range of amplitudes at each time step. The
block's parameter dialog box allows you to specify the upper and lower
bounds of the valid amplitude range and whether the range includes
the bounds. If the verification condition is true, the block does nothing.
If not, the block halts the simulation, by default, and displays an error
message.

The Check Static Range block and its companion blocks in the Model
Verification library are intended to facilitate creation of self-validating
models. For example, you can use model verification blocks to test
that signals do not exceed specified limits during simulation. When
you are satisfied that a model is correct, you can turn error checking
off by disabling the verification blocks. You do not have to physically
remove them from the model. If you need to modify a model, you can
temporarily turn the verification blocks back on to ensure that your
changes do not break the model.

**Data Type
Support**   The Check Static Range block accepts input signals of any dimensions
and of any data type supported by Simulink.

For a discussion on the data types supported by Simulink, see "Data
Types Supported by Simulink" in the "Working with Data" chapter of
the Using Simulink documentation.

Check Static Range

**Parameters
and
Dialog
Box**
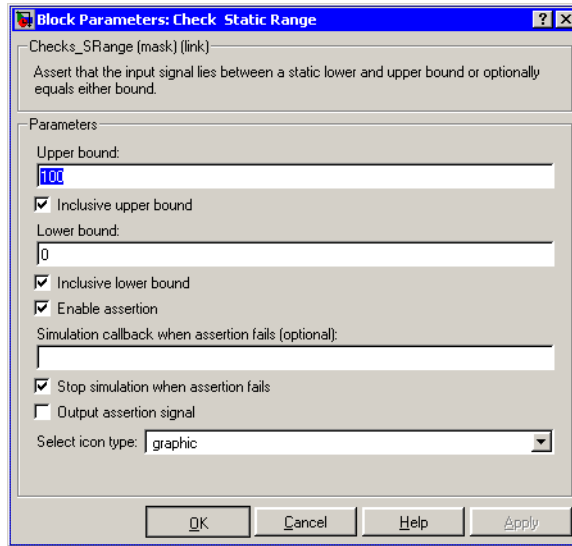
Upper bound

Upper bound of the range of valid input signal amplitudes.

Inclusive upper bound

Checking this option specifies that the valid signal range includes the upper bound.

Lower bound

Lower bound of the range of valid input signal amplitudes.

Inclusive lower bound

Checking this option specifies that the valid signal range includes the lower bound.

Enable assertion

Unchecking this option disables the Check Static Range block, that is, causes the model to behave as if the block did not exist. The **Model Verification block enabling** setting under **Debugging** on the **Data Validity** diagnostics pane of the **Configuration Parameters** dialog box allows you to enable or

disable all model verification blocks in a model, including Check Static Range blocks, regardless of the setting of this option.

Simulation callback when assertion fails
> An M-expression to be evaluated when the assertion fails.

Stop simulation when assertion fails
> If checked, this option causes the Check Static Range block to halt the simulation when the block's output is zero and display an error message in the **Simulation Diagnostics** viewer. Otherwise, the block displays a warning message in the MATLAB Command Window and continues the simulation.

Output assertion signal
> If checked, this option causes the Check Static Range block to output a Boolean signal that is true (1) at each time step if the assertion succeeds and false (0) if the assertion fails. The data type of the output signal is Boolean if you have selected the Implement logic signals as boolean data option on the **Simulation and code generation** optimization pane of the **Configuration Parameters** dialog box. Otherwise the data type of the output signal is double.

Select icon type
> Type of icon used to display this block in a block diagram: either graphic or text. The graphic option displays a graphical representation of the assertion condition on the icon. The text option displays a mathematical expression that represents the assertion condition. If the icon is too small to display the expression, the text icon displays an exclamation point. To see the expression, enlarge the block.

Characteristics

Direct Feedthrough	No
Sample Time	Inherited from driving block
Scalar Expansion	No

Check Static Range

Dimensionalized	Yes
Zero Crossing	No

Check Static Upper Bound

Purpose Check that a signal is greater than (or optionally equal to) a static lower bound

Library Model Verification

Description
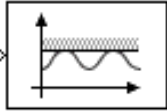
The Check Static Upper Bound block checks that each element of the input signal is less than (or optionally equal to) a specified lower bound at the current time step. The block's parameter dialog box allows you to specify the value of the upper bound and whether the bound is inclusive. If the verification condition is true, the block does nothing. If not, the block halts the simulation, by default, and displays an error message.

The Check Static Upper Bound block and its companion blocks in the Model Verification library are intended to facilitate creation of self-validating models. For example, you can use model verification blocks to test that signals do not exceed specified limits during simulation. When you are satisfied that a model is correct, you can turn error checking off by disabling the verification blocks. You do not have to physically remove them from the model. If you need to modify a model, you can temporarily turn the verification blocks back on to ensure that your changes do not break the model.

Data Type Support

The Check Static Upper Bound block accepts input signals of any dimensions and of any data type supported by Simulink.

For a discussion on the data types supported by Simulink, see "Data Types Supported by Simulink" in the "Working with Data" chapter of the Using Simulink documentation.

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Check Static Upper Bound

Parameters and Dialog Box
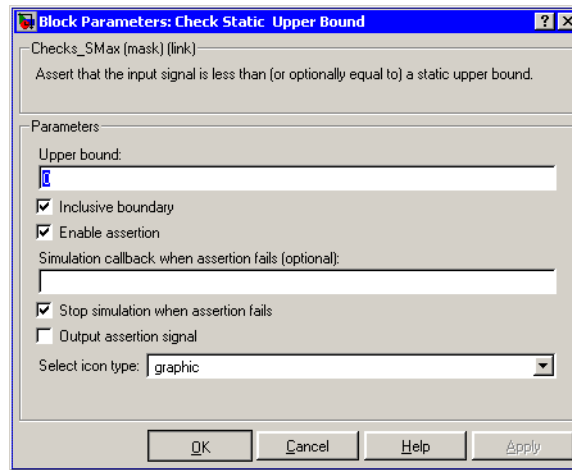
Upper bound

Upper bound on the range of amplitudes that the input signal can have.

Inclusive boundary

Checking this option makes the range of valid input amplitudes include the upper bound.

Enable assertion

Unchecking this option disables the Check Static Upper Bound block, that is, causes the model to behave as if the block did not exist. The **Model Verification block enabling** setting under **Debugging** on the **Data Validity** diagnostics pane of the **Configuration Parameters** dialog box allows you to enable or disable all model verification blocks in a model, including Check Static Upper Bound blocks, regardless of the setting of this option.

Simulation callback when assertion fails

An M-expression to be evaluated when the assertion fails.

Stop simulation when assertion fails

If checked, this option causes the Check Static Upper Bound block to halt the simulation when the block's output is zero and

display an error message in the **Simulation Diagnostics** viewer. Otherwise, the block displays a warning message in the MATLAB Command Window and continues the simulation.

Output assertion signal

If checked, this option causes the Check Static Upper Bound block to output a Boolean signal that is true (1) at each time step if the assertion succeeds and false (0) if the assertion fails. The data type of the output signal is Boolean if you have selected the Implement logic signals as boolean data option on the **Simulation and code generation** optimization pane of the **Configuration Parameters** dialog box. Otherwise the data type of the output signal is double.

Select icon type

Type of icon used to display this block in a block diagram: either graphic or text. The graphic option displays a graphical representation of the assertion condition on the icon. The text option displays a mathematical expression that represents the assertion condition. If the icon is too small to display the expression, the text icon displays an exclamation point. To see the expression, enlarge the block.

Characteristics

Direct Feedthrough	No
Sample Time	Inherited from driving block
Scalar Expansion	No
Dimensionalized	Yes
Zero Crossing	No

Chirp Signal

Purpose   Generate a sine wave with increasing frequency

Library   Sources

Description The Chirp Signal block generates a sine wave whose frequency increases
at a linear rate with time. You can use this block for spectral analysis of
nonlinear systems. The block generates a scalar or vector output.

The parameters, **Initial frequency**, **Target time**, and **Frequency at
target time**, determine the block's output. You can specify any or all
of these variables as scalars or arrays. All the parameters specified
as arrays must have the same dimensions. The block expands scalar
parameters to have the same dimensions as the array parameters. The
block output has the same dimensions as the parameters unless you
select the **Interpret vector parameters as 1-D** option. If you select
this option and the parameters are row or column vectors, the block
outputs a vector (1-D array) signal.

**Data Type
Support**   The Chirp Signal block outputs a real-valued signal of type `double`.
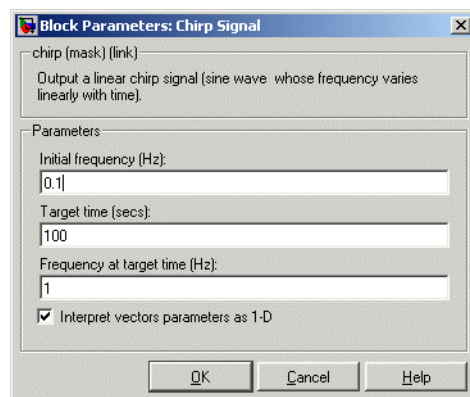
**Parameters
and
Dialog
Box**

Opening this dialog box causes a running simulation to pause. See
"Changing Source Block Parameters" in the "Working with Blocks"
chapter of the Using Simulink documentation.

Initial frequency
> The initial frequency of the signal, specified as a scalar or matrix
> value. The default is 0.1 Hz.

Target time
> The time at which the frequency reaches the **Frequency at
> target time** parameter value, a scalar or matrix value. The
> frequency continues to change at the same rate after this time.
> The default is 100 seconds.

Frequency at target time
> The frequency of the signal at the target time, a scalar or matrix
> value. The default is 1 Hz.

Interpret vector parameters as 1-D
> If selected, column or row matrix values for the **Initial
> frequency**, **Target time**, and **Frequency at target time**
> parameters result in a vector output whose elements are the
> elements of the row or column. See "Determining the Output
> Dimensions of Source Blocks" in the "Working with Signals"
> chapter of the Using Simulink documentation.

Characteristics

Sample Time	Continuous
Scalar Expansion	Yes, of parameters
Dimensionalized	Yes
Zero Crossing	No

Clock

Purpose	Display and provide the simulation time
Library	Sources

Description

The Clock block outputs the current simulation time at each simulation step. This block is useful for other blocks that need the simulation time.

When you need the current time within a discrete system, use the Digital Clock block.

Data Type Support

The Clock block outputs a real-valued signal of type `double`.

Parameters and Dialog Box
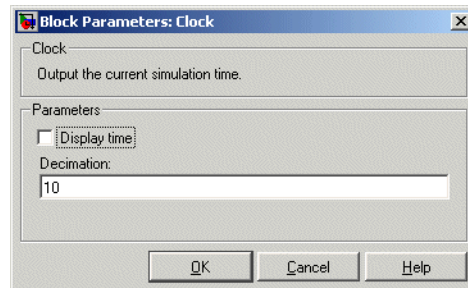
Display time

Use the **Display time** check box to display the current simulation time inside the Clock icon.

Decimation

The **Decimation** parameter value is the increment at which the clock is updated; it can be any positive integer. For example, if the decimation is 1000, then, for a fixed integration step of 1 millisecond, the clock updates at 1 second, 2 seconds, and so on.

Characteristics

Sample Time	Continuous
Scalar Expansion	N/A

Dimensionalized	No
Zero Crossing	No

Combinatorial Logic

Purpose   Implement a truth table

Library   Logic and Bit Operations

Description   The Combinatorial Logic block implements a standard truth table for modeling programmable logic arrays (PLAs), logic circuits, decision tables, and other Boolean expressions. You can use this block in conjunction with Memory blocks to implement finite-state machines or flip-flops.

You specify a matrix that defines all possible block outputs as the **Truth table** parameter. Each row of the matrix contains the output for a different combination of input elements. You must specify outputs for every combination of inputs. The number of columns is the number of block outputs.

The relationship between the number of inputs and the number of rows is

```
number of rows = 2 ^ (number of inputs)
```

Simulink returns a row of the matrix by computing the row's index from the input vector elements. Simulink computes the index by building a binary number where input vector elements having zero values are 0 and elements having nonzero values are 1, then adding 1 to the result. For an input vector, u, of m elements,

```
row index = 1 + u(m)*2^0 + u(m-1)*2^1 + ...  + u(1)*2^(m-1)
```

Example of Two-Input AND Function

This example builds a two-input AND function, which returns 1 when both input elements are 1, and 0 otherwise. To implement this function, specify the **Truth table** parameter value as [0; 0; 0; 1]. The portion of the model that provides the inputs to and the output from the Combinatorial Logic block might look like this.
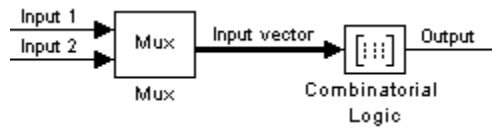
The following table indicates the combination of inputs that generate each output. The input signal labeled "Input 1" corresponds to the column in the table labeled Input 1. Similarly, the input signal "Input 2" corresponds to the column with the same name. The combination of these values determines the row of the Output column of the table that is passed as block output.

For example, if the input vector is [1 0], the input references the third row:

    (2^1*1 + 1)

The output value is 0.

Row	Input 1	Input 2	Output
1	0	0	0
2	0	1	0
3	1	0	0
4	1	1	1

Example of Circuit

This sample circuit has three inputs: the two bits (**a** and **b**) to be summed and a carry-in bit (**c**). It has two outputs: the carry-out bit (**c'**) and the sum bit (**s**). Here are the truth table and the outputs associated with each combination of input values for this circuit.

Combinatorial Logic

Inputs			Outputs	
a	b	c	c'	s
0	0	0	0	0
0	0	1	0	1
0	1	0	0	1
0	1	1	1	0
1	0	0	0	1
1	0	1	1	0
1	1	0	1	0
1	1	1	1	1

To implement this adder with the Combinatorial Logic block, you enter the 8-by-2 matrix formed by columns **c'** and **s** as the **Truth table** parameter.

You can also implement sequential circuits (that is, circuits with states) with the Combinatorial Logic block by including an additional input for the state of the block and feeding the output of the block back into this state input.

Data Type Support

The type of signals accepted by a Combinatorial Logic block depends on whether you selected the Boolean logic signals option (see "Enabling Strict Boolean Type Checking" in the "Working with Data" chapter of the Using Simulink documentation). If this option is enabled, the block accepts real signals of type Boolean or double. The truth table can have Boolean values (0 or 1) of any data type. If the table contains non-Boolean values, the table's data type must be double.

The type of the output is the same as that of the input except that the block outputs double if the input is Boolean and the truth table contains non-Boolean values.

If Boolean compatibility mode is disabled, the Combinatorial Logic block accepts only signals of type Boolean. The block outputs double if

the truth table contains non-Boolean values of type double. Otherwise, the output is Boolean.

Parameters and Dialog Box
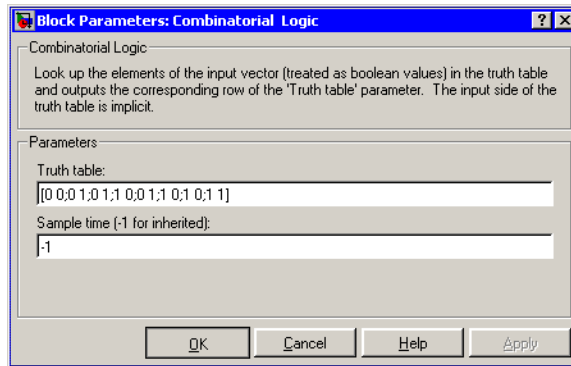
Truth table
> The matrix of outputs. Each column corresponds to an element of the output vector and each row corresponds to a row of the truth table.

Sample time (-1 for inherited)
> Specify the time interval between samples. To inherit the sample time, set this parameter to -1. See "Specifying Sample Time" in the "How Simulink Works" chapter of the Using Simulink documentation.

Characteristics

Direct Feedthrough	Yes
Sample Time	Inherited from driving block
Scalar Expansion	No
Dimensionalized	Yes; the output width is the number of columns of the **Truth table** parameter
Zero Crossing	No

Compare To Constant

Purpose   Determine how a signal compares to the specified constant

Library   Logic and Bit Operations

Description   The Compare To Constant block compares an input signal to a constant. Specify the constant in the **Constant value** parameter. Specify how the input is compared to the constant value with the **Operator** parameter. The **Operator** parameter can have the following values:
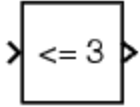
- == — Determine whether the input is equal to the specified constant.

- ~= — Determine whether the input is not equal to the specified constant.

- < — Determine whether the input is less than the specified constant.

- <= — Determine whether the input is less than or equal to the specified constant.

- > — Determine whether the input is greater than the specified constant.

- >= — Determine whether the input is greater than or equal to the specified constant.

The output is 0 if the comparison is false, and 1 if it is true.

Data Type Support   The Compare To Constant block accepts inputs of any data type supported by Simulink, including fixed-point data types. The block output is uint8 or Boolean as specified by the **Output data type mode** parameter.

For a discussion on the data types supported by Simulink, see "Data Types Supported by Simulink" in the "Working with Data" chapter of the Using Simulink documentation.

Parameters and Dialog Box
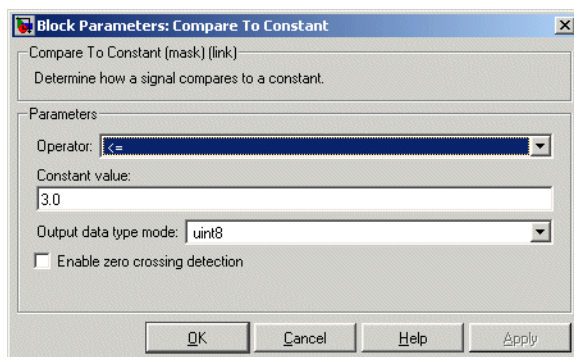
Operator
> Specify how the input is compared to the constant value, as discussed in Description.

Constant value
> Specify the constant value to which the input is compared.

Output data type mode
> Specify the data type of the output, uint8 or boolean.

Enable zero crossing detection
> Select to enable zero-crossing detection. For more information, see "Zero-Crossing Detection" in the "How Simulink Works" chapter of the Using Simulink documentation.

Characteristics

Direct Feedthrough	Yes
Scalar Expansion	Yes
Zero Crossing	Yes, if enabled.

See Also Compare To Zero

Compare To Zero

Purpose   Determine how a signal compares to zero

Library   Logic and Bit Operations

Description   The Compare To Zero block compares an input signal to zero. Specify
how the input is compared to zero with the **Operator** parameter. The
Operator parameter can have the following values:
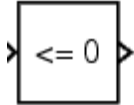
- == — Determine whether the input is equal to zero.

- ~= — Determine whether the input is not equal to zero.

- < — Determine whether the input is less than zero.

- <= — Determine whether the input is less than or equal to zero.

- > — Determine whether the input is greater than zero.

- >= — Determine whether the input is greater than or equal to zero.

The output is 0 if the comparison is false, and 1 if it is true.

Data Type Support   The Compare To Zero block accepts inputs of any data type supported by
Simulink, including fixed-point data types. The block output is uint8 or
Boolean as specified by the **Output data type mode** parameter.

For a discussion on the data types supported by Simulink, see "Data
Types Supported by Simulink" in the "Working with Data" chapter of
the Using Simulink documentation.

Parameters and Dialog Box
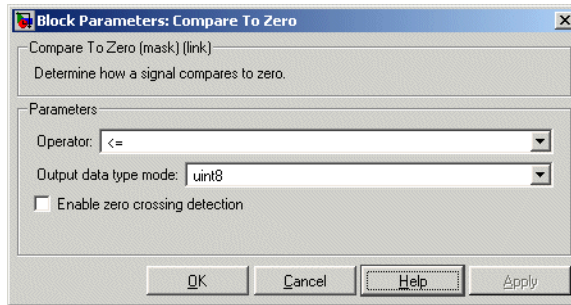
Operator
    Specify how the input is compared to zero, as discussed in Description.

Output data type mode
    Specify the data type of the output, uint8 or boolean.

Enable zero crossing detection
    Select to enable zero-crossing detection. For more information, see "Zero-Crossing Detection" in the "How Simulink Works" chapter of the Using Simulink documentation.

Characteristics

Direct Feedthrough	Yes
Scalar Expansion	Yes
Zero Crossing	Yes, if enabled.

See Also   Compare To Constant

Complex to Magnitude-Angle

Purpose   Compute the magnitude and/or phase angle of a complex signal

Library   Math Operations

Description   The Complex to Magnitude-Angle block accepts a complex-valued signal of type `double`. It outputs the magnitude and/or phase angle of the input signal, depending on the setting of the **Output** parameter. The outputs are real values of type `double`. The input can be an array of complex signals, in which case the output signals are also arrays. The magnitude signal array contains the magnitudes of the corresponding complex input elements. The angle output similarly contains the angles of the input elements.

Data Type Support   See the preceding description.

Parameters and Dialog Box
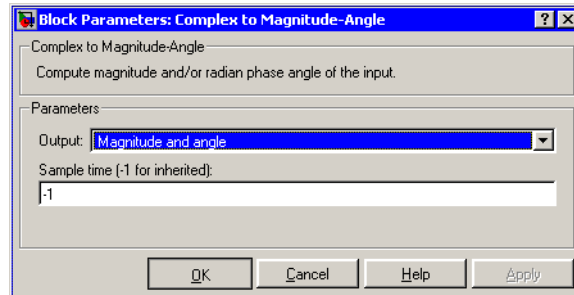
Output

    Determines the output of this block. Choose from the following values: `Magnitude and angle` (outputs the input signal's magnitude and phase angle in radians), `Magnitude` (outputs the input's magnitude), `Angle` (outputs the input's phase angle in radians).

Sample time (-1 for inherited)

    Specify the time interval between samples. To inherit the sample time, set this parameter to `-1`. See "Specifying Sample Time"

in the "How Simulink Works" chapter of the Using Simulink documentation.

Characteristics

Direct Feedthrough	Yes
Sample Time	Inherited from driving block
Scalar Expansion	No
Dimensionalized	Yes
Zero Crossing	No

Complex to Real-Imag

Purpose   Output the real and imaginary parts of a complex input signal

Library   Math Operations

Description   The Complex to Real-Imag block accepts a complex-valued signal of any data type supported by Simulink, including fixed-point data types. It outputs the real and/or imaginary part of the input signal, depending on the setting of the **Output** parameter. The real outputs are of the same data type as the complex input. The input can be an array (vector or matrix) of complex signals, in which case the output signals are arrays of the same dimensions. The real array contains the real parts of the corresponding complex input elements. The imaginary output similarly contains the imaginary parts of the input elements.
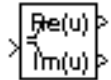
Data Type Support   See the preceding description. For a discussion on the data types supported by Simulink, see "Data Types Supported by Simulink" in the "Working with Data" chapter of the Using Simulink documentation.

Parameters and Dialog Box
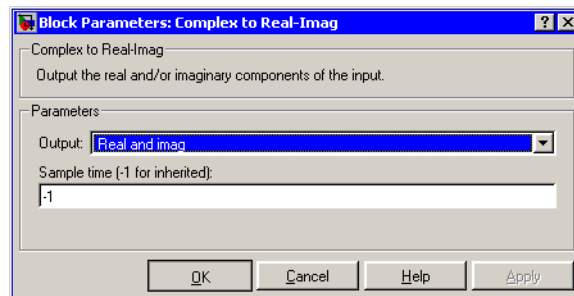
Output
>   Determines the output of this block. Choose from the following values: Real and imag (outputs the input signal's real and imaginary parts), Real (outputs the input's real part), Imag (outputs the input's imaginary part).

Sample time (-1 for inherited)

Specify the time interval between samples. To inherit the sample time, set this parameter to -1. See "Specifying Sample Time" in the "How Simulink Works" chapter of the Using Simulink documentation.

Characteristics

Direct Feedthrough	Yes
Sample Time	Inherited from driving block
Scalar Expansion	No
Dimensionalized	Yes
Zero Crossing	No

Concatenate

Purpose

Concatenate input signals of the same data type to create a contiguous output signal.

Library

Math Operations

Description

The Concatenate block concatenates the signals at its inputs to create an output signal whose elements reside in contiguous locations in memory. This block operates in either vector or matrix concatenation mode, depending on the setting of its **Mode** parameter.
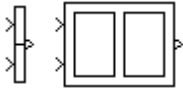
Vector Mode

In vector mode, all input signals must be either vectors or row vectors [1xM matrices] or column vectors [Mx1 matrices] or a combination of vectors and either row or column vectors. The output is a vector if all inputs are vectors.

The output is a row or column vector if any of the inputs are row or column vectors, respectively.

Matrix Mode

Matrix mode accepts vectors and matrices of any size. It treats vector inputs as column vectors. The output is always a matrix. The block's **Mode** parameter allows you to choose either horizontal or vertical matrix concatenation. Horizontal matrix concatenation places the input matrices side-by-side to create the output matrix, e.g.,
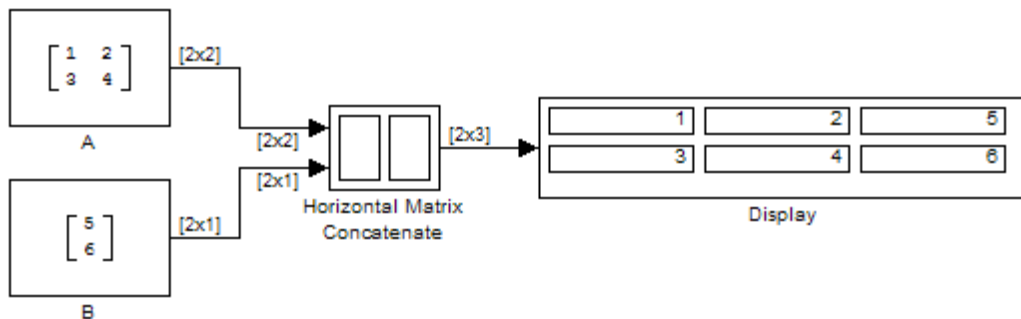
Vertical matrix concatenation stacks the input matrices on top of each other to create the output matrix, e.g.,
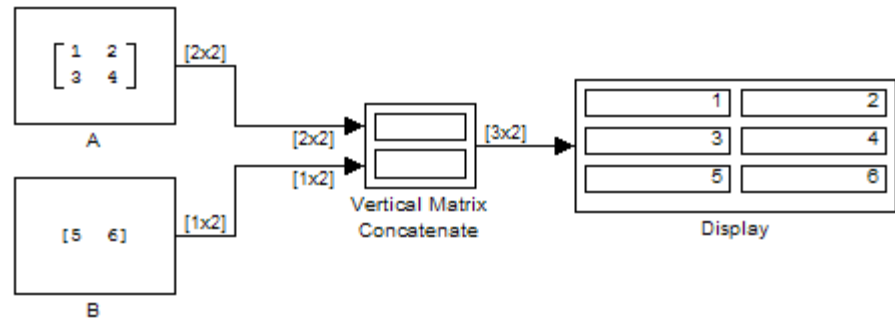
For horizontal concatenation, the input matrices must have the same column dimension; for vertical concatenation, the same row dimension.

Data Type Support

Accepts signals of any data type supported by Simulink. All inputs must be of the same data type. Outputs the same data type as the input.

Concatenate

Parameters and Dialog Box

Function Block Parameters: Vector Concatenate

Concatenate

Concatenate input signals of the same data type to create a contiguous output signal. Select vector or matrix mode.

In vector mode, all input signals must be either vectors or one-row [1xM] matrices or one-column [Mx1] matrices or a combination of vectors and either one-row matrices or one-column matrices. The output is a vector if all inputs are vectors. The output is a one-row or one-column matrix if any of the inputs are one-row or one-column matrices, respectively.

Matrix mode treats vector inputs as one-column matrices. The output is always a matrix.

Parameters

Number of inputs:

2

Mode: Vector concatenation

OK   Cancel   Help   Apply

Number of inputs
>   Number of inputs on this block.

Mode
>   Specifies the type of concatenation performed by this block. Options are:
>
>   - `Vector concatenation` (see "Vector Mode" on page 2-106)
>
>   - `Horizontal matrix concatenation` (see "Matrix Mode" on page 2-106)
>
>   - `Vertical matrix concatenation` (see "Matrix Mode" on page 2-106)

Characteristics

Direct Feedthrough	Yes
Sample Time	Inherited from driving block
Scalar Expansion	No
Dimensionalized	Yes
Zero Crossing	No

Configurable Subsystem

Purpose   Represent any block selected from a user-specified library of blocks

Library   Ports & Subsystems

Description

```
Template
```

The Configurable Subsystem block represents one of a set of blocks contained in a specified library of blocks. The block's context menu lets you choose which block the configurable subsystem represents.

Configurable Subsystem blocks simplify creation of models that represent families of designs. For example, suppose that you want to model an automobile that offers a choice of engines. To model such a design, you would first create a library of models of the engine types available with the car. You would then use a Configurable Subsystem block in your car model to represent the choice of engines. To model a particular variant of the basic car design, a user need only choose the engine type, using the configurable engine block's dialog.

To create a configurable subsystem in a model, you must first create a library containing a master configurable subsystem and the blocks that it represents. You can then create configurable instances of the master subsystem by dragging copies of the master subsystem from the library and dropping them into models.

You can add any type of block to a master configurable subsystem library. Simulink derives the port names for the configurable subsystem by making a unique list from the port names of all the choices. Note that Simulink uses default port names for non-subsystem block choices.

Note that Simulink does not allow you to break library links in a configurable subsystem because Simulink needs the links to reconfigure the subsystem when you choose a new configuration. Breaking links would be useful only if you never intended to reconfigure the subsystem, in which case you could simply replace the configurable subsystem with a nonconfigurable subsystem that implements the permanent configuration.

Creating a Master Configurable Subsystem

To create a master configurable subsystem:

1 Create a library of blocks representing the various configurations of the configurable subsystem.

2 Save the library.

3 Create an instance of the Configurable Subsystem block in the library.

To do this, drag a copy of the Configurable Subsystem block from the Simulink Ports & Subsystems library into the library you created in the preceding step.

4 Display the Configurable Subsystem block's dialog by double-clicking it. The dialog displays a list of the other blocks in the library.

5 Under **List of block choices** in the dialog box, select the blocks that represent the various configurations of the configurable subsystems you are creating.

6 Click the **OK** button to apply the changes and close the dialog box.

7 Select **Block Choice** from the Configurable Subsystem block's context menu.

The context menu displays a submenu listing the blocks that the subsystem can represent.

8 Select the block that you want the subsystem to represent by default.

9 Save the library.

Note If you add or remove blocks from a library, you must recreate any Configurable Subsystem blocks that use the library.

If you modify a library block that is the default block choice for a configurable subsystem, the change does not immediately propagate to the configurable subsystem. To propagate this change, do one of the following:

Configurable Subsystem

- Change the default block choice to another block in the subsystem, then change the default block choice back to the original block.

- Recreate the configurable subsystem block, including the selection of the updated block as the default block choice.

Creating an Instance of a Configurable Subsystem

To create an instance of a configurable subsystem in a model,

1 Open the library containing the master configurable subsystem.

2 Drag a copy of the master into the model.

3 Select **Block Choice** from the copy's context menu.

4 Select the block that you want the configurable subsystem to represent.

The instance of the configurable system displays the icon and parameter dialog box of the block that it represents.

Setting Instance Block Parameters

As with other blocks, you can use the parameter dialog box of a configurable subsystem instance to set the instance's parameters interactively and the set_param command to set the parameters from the MATLAB command line or in an M-file program. If you use set_param, you must specify the full path name of the configurable subsystem's current block choice as the first argument of set_param, e.g.,

```
curr_choice = get_param('mymod/myconfigsys', 'BlockChoice');
curr_choice = ['mymod/myconfigsys/' curr_choice];
set_param(curr_choice, 'MaskValues', ...);
```

Mapping I/O Ports

A configurable subsystem displays a set of input and output ports corresponding to input and output ports in the selected library.

Simulink uses the following rules to map library ports to Configurable Subsystem block ports:

- Map each uniquely named input/output port in the library to a separate input/output port of the same name on the Configurable Subsystem block.

- Map all identically named input/output ports in the library to the same input/output ports on the Configurable Subsystem block.

- Terminate any input/output port not used by the currently selected library block with a Terminator/Ground block.

This mapping allows a user to change the library block represented by a Configurable Subsystem block without having to rewire connections to the Configurable Subsystem block.

For example, suppose that a library contains two blocks A and B and that block A has input ports labeled a, b, and c and an output port labeled d and that block B has input ports labeled a and b and an output port labeled e. A Configurable Subsystem block based on this library would have three input ports labeled a, b, and c, respectively, and two output ports labeled d and e, respectively, as illustrated in the following figure.
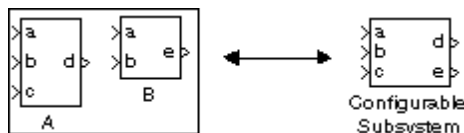
In this example, port a on the Configurable Subsystem block connects to port a of the selected library block no matter which block is selected. On the other hand, port c on the Configurable Subsystem block functions only if library block A is selected. Otherwise, it simply terminates.

Configurable Subsystem

Note A Configurable Subsystem block does not provide ports that correspond to non-I/O ports, such as the trigger and enable ports on triggered and enabled subsystems. Thus, you cannot use a Configurable Subsystem block directly to represent blocks that have such ports. You can do so indirectly, however, by wrapping such blocks in subsystem blocks that have input or output ports connected to the non-I/O ports.

Data Type Support

The Configurable Subsystem block accepts and outputs signals of the same types as are accepted or output by the block that it currently represents. The data types may be any supported by Simulink, including fixed-point data types.

Parameters and Dialog Box
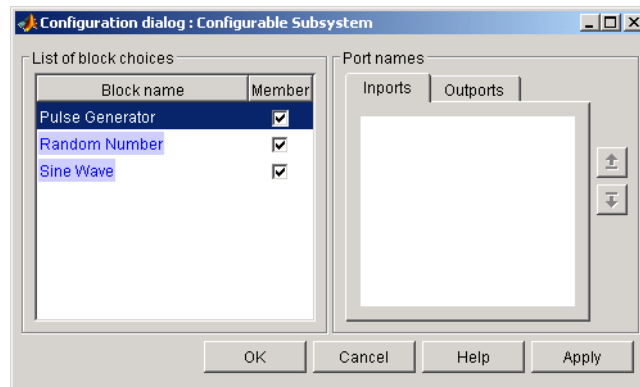
List of block choices

Select the blocks you want to include as members of the configurable subsystem. You can include user-defined subsystems as blocks.

Port information

Lists of input and output ports of member blocks. In the case of multiports, you can rearrange selected port positions by clicking the **Up** and **Down** buttons.

Characteristics   A Configurable Subsystem block has the characteristics of the block
that it currently represents. Double-clicking the block opens the dialog
box for the block that it currently represents.

Constant

Purpose   Generate a constant value

Library   Sources
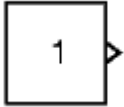
Description   The Constant block generates a real or complex constant value. The block generates scalar (one-element array), vector (1-D array), or matrix (2-D array) output, depending on the dimensionality of the **Constant value** parameter and the setting of the **Interpret vector parameters as 1-D** parameter. Also, the block can generate either a sample-based or frame-based signal, depending on the setting of the **Sampling mode** parameter.

The output of the block has the same dimensions and elements as the **Constant value** parameter. If you specify a vector for this parameter, and you want the block to interpret it as a vector (i.e., a 1-D array), select the **Interpret vector parameters as 1-D** parameter; otherwise, the block treats the **Constant value** parameter as a matrix (i.e., a 2-D array).

Data Type Support   By default, the Constant block outputs a signal whose data type and complexity are the same as that of the block's **Constant value** parameter. However, you can specify the output to be any data type supported by Simulink, including fixed-point data types.

For a discussion on the data types supported by Simulink, see "Data Types Supported by Simulink" in the "Working with Data" chapter of the Using Simulink documentation.

Parameters and Dialog Box

The **Main** pane of the Constant block dialog appears as follows:
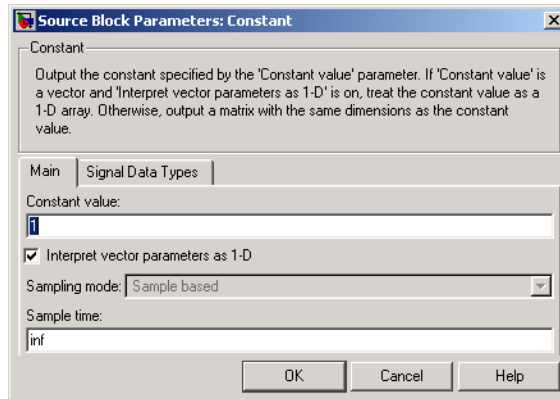
Opening this dialog box causes a running simulation to pause. See "Changing Source Block Parameters" in the "Working with Blocks" chapter of the Using Simulink documentation.

Constant value

Specify the constant value output by the block. You can enter any MATLAB expression in this field, including the Boolean keywords, true or false, that evaluates to a matrix value. The **Constant value** parameter is converted from its data type to the specified output data type offline using round-to-nearest and saturation.

Interpret vector parameters as 1-D

If you select this check box, the Constant block outputs a vector of length N if the **Constant value** parameter evaluates to an N-element row or column vector, i.e., a matrix of dimension 1xN or Nx1. If you uncheck this option, you can interact with the **Sampling mode** parameter. See "Determining the Output Dimensions of Source Blocks" in the "Working with Signals" chapter of the Using Simulink documentation.

Sample time

Specify the interval between times that the Constant block's output can change during simulation (e.g., as a result of tuning

Constant

its **Constant value** parameter). The default sample time is `inf`, i.e., the block's output can never change. This setting speeds simulation and generated code by avoiding the need to recompute the block's output. See "Specifying Sample Time" in the "How Simulink Works" chapter of the Using Simulink documentation.

Sampling mode

Specify whether the output signal is `Sample based` or `Frame based`. For more information about these types of signals, see "Sample-Based Signals" and "Frame-Based Signals" in the Signal Processing Blockset User's Guide.

Note To generate frame-based signals, you must have the Signal Processing Blockset installed.

The **Signal Data Types** pane of the Constant block dialog appears as follows:
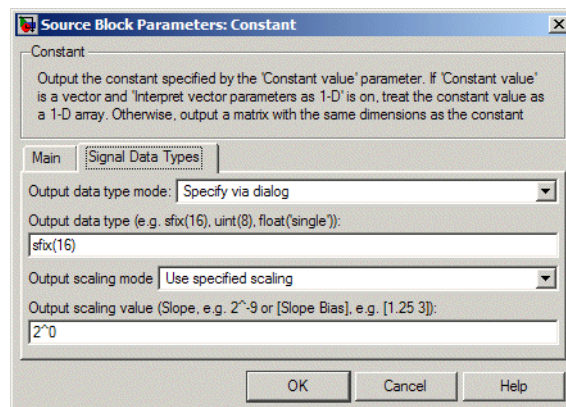
Output data type mode

Specify how the data type of the output is designated. The data type can be inherited through backpropagation, or can be designated in the **Constant value** parameter, for example

int8(29). You can also choose a built-in data type from the list. If you choose Specify via dialog, the following parameters become visible.

Output data type

Specify any data type, including fixed-point data types. This parameter is only visible you select Specify via dialog for the **Output data type mode** parameter.

Output scaling mode

Specify how the scaling of the output is designated. The output can be automatically scaled to maintain best vector-wise precision without overflow, or you can choose to specify the scaling in the dialog via the **Output scaling value** parameter. This parameter is only visible if you select Specify via dialog for the **Output data type mode** parameter.

Output scaling value

Set the output scaling using binary point-only or [Slope Bias] scaling. This parameter is only visible if you select Specify via dialog for the **Output data type mode** parameter and Use specified scaling for the **Output Scaling Mode** parameter.

Characteristics

Direct Feedthrough	N/A
Sample Time	Specified in the **Sample time** parameter
Scalar Expansion	No
Dimensionalized	Yes
Zero Crossing	No

Cosine

Purpose   Implement a cosine function in fixed-point using a lookup table approach that exploits quarter wave symmetry

Library   Lookup Tables

Description   The Cosine block is an implementation of the Sine and Cosine block.
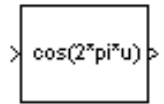
Purpose	Model discontinuity at zero, with linear gain elsewhere
Library	Discontinuities

Description The Coulomb and Viscous Friction block models Coulomb (static) and viscous (dynamic) friction. The block models a discontinuity at zero and a linear gain otherwise. The offset corresponds to the Coulombic friction; the gain corresponds to the viscous friction. The block is implemented as

```
y = sign(u) * (Gain * abs(u) + Offset)
```

where y is the output, u is the input, and Gain and Offset are block parameters.

The block accepts one input and generates one output.

Data Type Support The Coulomb and Viscous Friction block accepts and outputs real signals of type double.

Parameters and Dialog Box
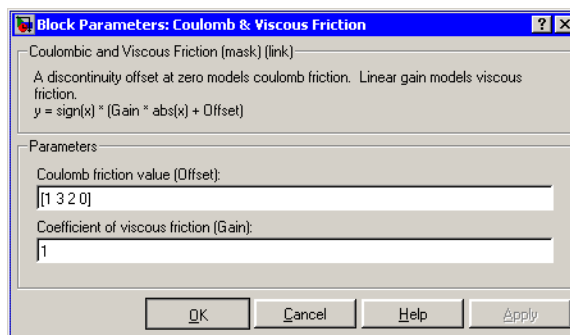
Coulomb friction value
     The offset, applied to all input values. The default is [1 3 2 0].

Coefficient of viscous friction
     The signal gain at nonzero input points. The default is 1.

Coulomb and Viscous Friction

Characteristics

Direct Feedthrough	Yes
Sample Time	Inherited from driving block
Scalar Expansion	No
Dimensionalized	Yes
Zero Crossing	Yes, at the point where the static friction is overcome

Purpose   Count up and overflow back to zero after the maximum value possible is reached for the specified number of bits

Library   Sources

Description   The Counter Free-Running block counts up until the maximum possible value, $2^{Nbits} - 1$, is reached, where Nbits is the number of bits. Then the counter overflows to zero, and restarts counting up. The counter is always initialized to zero.

You can specify the number of bits with the **Number of Bits** parameter.

You can specify the sample time with the **Sample time** parameter.

The output is an unsigned integer. If you select the global doubles override, the Counter Free-Running block does not wrap back to zero.

Data Type   The Counter Free-Running block outputs an unsigned integer.
Support

**Parameters
and
Dialog
Box**

Number of Bits
    Specified number of bits.

Sample time
    Specify the time interval between samples. To inherit the sample time, set this parameter to -1. See "Specifying Sample Time"

Counter Free-Running

in the "How Simulink Works" chapter of the Using Simulink documentation.

Characteristics

Sample Time	Specified in the **Sample time** parameter
Scalar Expansion	No

See Also   Counter Limited

Purpose   Count up and wrap back to zero after outputting the specified upper limit

Library   Sources

Description   The Counter Limited block counts up until the specified upper limit is reached. Then the counter wraps back to zero, and restarts counting up. The counter is always initialized to zero.

You can specify the upper limit with the **Upper limit** parameter.

You can specify the sample time with the **Sample time** parameter. A **Sample time** of -1 means that the sample time is inherited.

The output is an unsigned integer of 8, 16, or 32 bits, with the smallest number of bits needed to represent the upper limit.

Data Type Support   The Counter Limited block outputs an unsigned integer.

Parameters and Dialog Box
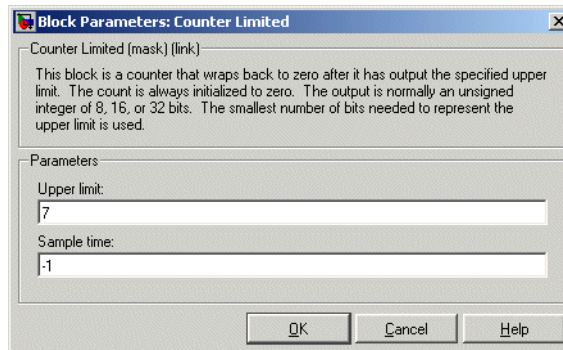
Upper limit
    Upper limit.

Sample time
    Specify the time interval between samples. To inherit the sample time, set this parameter to -1. See "Specifying Sample Time"

Counter Limited

in the "How Simulink Works" chapter of the Using Simulink documentation.

Characteristics

Sample Time	Specified in the **Sample time** parameter
Scalar Expansion	No

See Also Counter Free-Running

Data Store Memory

Purpose Define a data store

Library Signal Routing

Description The Data Store Memory block defines and initializes a named shared data store, which is a memory region usable by Data Store Read and Data Store Write blocks with the same data store name.

The location of the Data Store Memory block that defines a data store determines the Data Store Read and Data Store Write blocks that can access the data store:

• If the Data Store Memory block is in the *top-level system*, the data store can be accessed by Data Store Read and Data Store Write blocks located anywhere in the model.

• If the Data Store Memory block is in a *subsystem*, the data store can be accessed by Data Store Read and Data Store Write blocks located in the same subsystem or in any subsystem below it in the model hierarchy.

Note You can use signal objects in addition to or instead of Data Store Memory blocks to define data stores. See "Working with Data Stores" for more information.

You initialize the data store by specifying a scalar value or an array of values in the **Initial value** parameter. The dimensions of the array determine the dimensionality of the data store. Any data written to the data store must have the dimensions designated by the **Initial value** parameter. Otherwise, an error occurs.

Data Store Memory

Data Type Support

The Data Store Memory block stores real or complex signals of any data type supported by Simulink, including fixed-point data types.

For a discussion on the data types supported by Simulink, see "Data Types Supported by Simulink" in the "Working with Data" chapter of the Using Simulink documentation.

Parameters and Dialog Box

The **Main** pane of the Data Store Memory block dialog appears as follows:
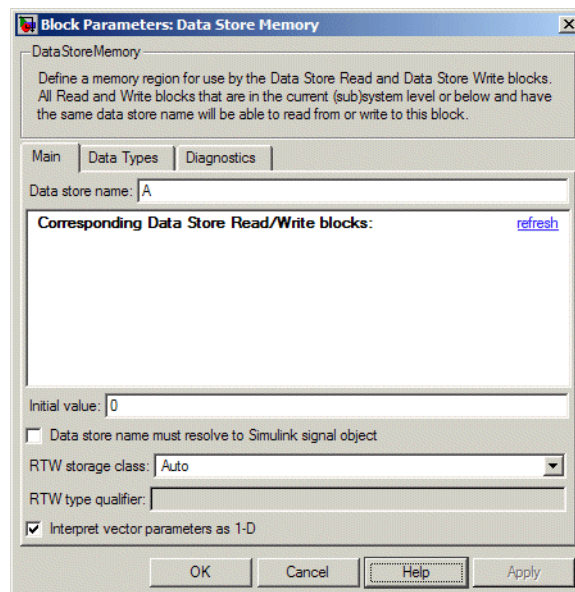
Data store name

Specify a name for the data store you are defining with this block. Data Store Read and Data Store Write blocks with the same name will be able to read from and write to the data store initialized by this block.

Corresponding Data Store Read blocks

> This parameter lists all the Data Store Read and Data Store Write blocks that have the same data store name as the current block, and that are in the current (sub)system or in any subsystem below it in the model hierarchy. Double-click any entry on this list to highlight the block and bring it to the foreground.

Initial value

> Specify the initial value or values of the data store. The dimensions of this value determine the dimensions of data that may be written to the data store.

Data store must resolve to Simulink signal object

> Causes Simulink, when compiling the model, to search the model and base workspace for a `Simulink.Signal` object having the same name. If such an object is not found, Simulink halts the compilation and displays an error. Otherwise Simulink compares the attributes of the signal object with the corresponding attributes of the data store memory block. If the block and the object attributes are inconsistent, Simulink halts model compilation and displays an error.

These following parameters pertain to code generation and have no effect during model simulation:

- **Data store name must resolve to Simulink signal object**

- **RTW storage class**

- **RTW type qualifier**

See "Block States: Storing and Interfacing" in the Real-Time Workshop® documentation for more information.

Interpret vector parameters as 1-D

> If selected and the **Initial value** parameter is specified as a column or row matrix, the data store is initialized to a 1-D array whose elements are equal to the elements of the row or column vector. See "Determining the Output Dimensions of Source

Data Store Memory

Blocks" in the "Working with Signals" chapter of the Using Simulink documentation.

The **Data Types** pane of the Data Store Memory block dialog appears as follows:
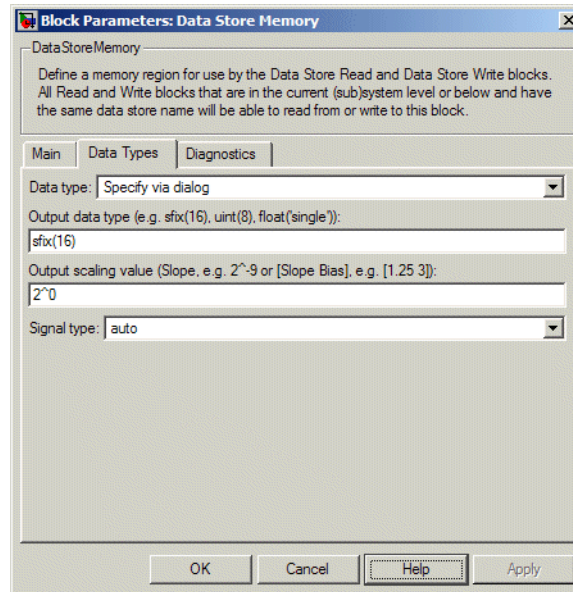
Data type

Select the data type of the values stored in the data store from the drop-down menu. If you select `auto`, Simulink sets the data type of the data store to the data type of the data store read and write blocks that access it. If you select `Specify via dialog`, the dialog box displays the **Output data type** and **Output scaling value** fields, which enable you to specify fixed-point and other data types not listed in the drop-down menu.

Output data type

Specify any data type for the data store, including fixed-point data types. This parameter is only visible if you select `Specify via dialog` for the **Data type** parameter.

Output scaling value

Set the output scaling using either binary point-only or [Slope Bias] scaling. This parameter is only visible if you select `Specify via dialog` for the **Data type** parameter.

Signal type

Specify the numeric type, real or complex, of the values stored in the data store.

The **Diagnostics** pane of the Data Store Memory block dialog appears as follows:
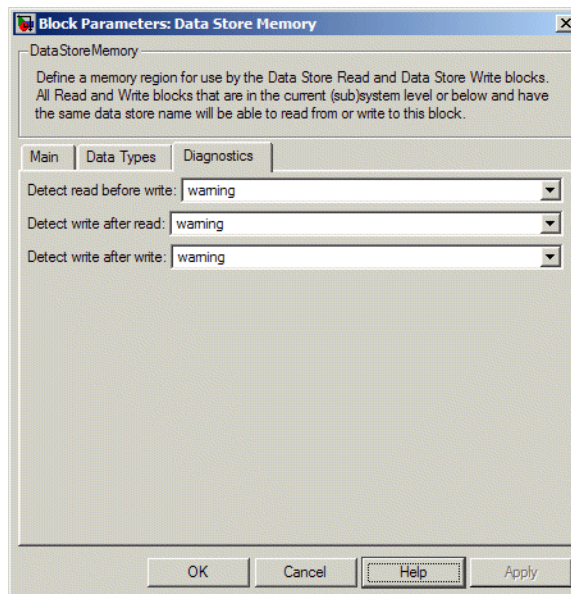
Data Store Memory

Detect read before write
>   The model is attempting to read data from this data store without having previously written data into the store in the current time step.

Detect write after write
>   The model is attempting to store data in this data store twice in succession in the current time step.

Detect write after read
>   The model is attempting to store data in this data store after previously reading data from it in the current time step.

Characteristics

Sample Time	N/A
Dimensionalized	Yes

See Also   Data Store Read, Data Store Write

Purpose   Read data from a data store

Library   Signal Routing

Description   The Data Store Read block copies data from the named data store to its output.
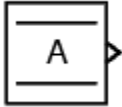
The data store from which the data is read is determined by the location of the Data Store Memory block or signal object that defines the data store. For more information, see "Working with Data Stores" and `Data Store Memory`.

More than one Data Store Read block can read from the same data store.

Note Be careful when setting an execution priority on a Data Store Read block. Make sure that the block reads from the data store after the store is updated by any Data Store Write blocks that write to the store in the same time step.

Data Type Support   The Data Store Read block can output a real or complex signal of any data type supported by Simulink, including fixed-point data types.

For a discussion on the data types supported by Simulink, see "Data Types Supported by Simulink" in the "Working with Data" chapter of the Using Simulink documentation.

Data Store Read

**Parameters
and
Dialog
Box**
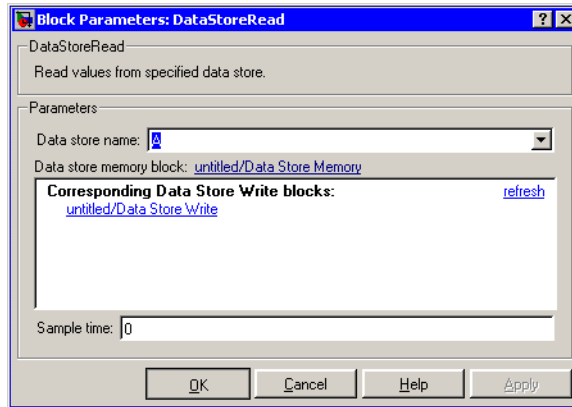
Data store name

Specifies the name of the data store from which this block reads
data. The adjacent pull-down list lists the names of Data Store
Memory blocks that exist at the same level in the model as the
Data Store Read block or at higher levels. To change the name,
select a name from the pull-down list or enter the name directly
in the edit field.

When Simulink compiles the model containing this block,
Simulink searches the model upwards from this block's level for a
Data Store Memory block having the specified data store name.
If Simulink does not find such a block, it searches the model
workspace and the MATLAB workspace for a `Simulink.Signal`
object having the same name. If Simulink finds the signal object,
it creates a hidden Data Store Memory block at the model's root
level having the properties specified by the signal object and
an initial value of `0`. If Simulink finds neither the Data Store
Memory block nor the signal object, it halts the compilation and
displays an error.

Data store memory block

This field lists the Data Store Memory block that initialized the
store from which this block reads.

Data store write blocks

This parameter lists all the Data Store Write blocks with the same data store name as this block that are in the same (sub)system or in any subsystem below it in the model hierarchy. Double-click any entry on this list to highlight the block and bring it to the foreground.

Sample time

The sample time, which controls when the block reads from the data store. A value of -1 indicates that the sample time is inherited. See Specifying Sample Time in the online documentation for more information.

Characteristics

Sample Time	Specified in the **Sample time** parameter
Dimensionalized	Yes

See Also   Data Store Memory, Data Store Write

Data Store Write

Purpose   Write data to a data store

Library   Signal Routing

Description   The Data Store Write block copies the value at its input to the named data store.
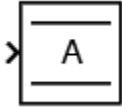
Each write operation performed by a Data Store Write block writes over the data store, replacing the previous contents.

The data store to which this block writes is determined by the location of the Data Store Memory or signal object that defines the data store. For more information, see "Working with Data Stores" and `Data Store Memory`. The size of the data store is set by the signal object or the Data Store Memory block that defines and initializes the data store. Each Data Store Write block that writes to that data store must write the same amount of data.

More than one Data Store Write block can write to the same data store. However, if two Data Store Write blocks attempt to write to the same data store during the same simulation step, results are unpredictable.

Data Type Support   The Data Store Write block accepts a real or complex signal of any data type supported by Simulink, including fixed-point data types.

For a discussion on the data types supported by Simulink, see "Data Types Supported by Simulink" in the "Working with Data" chapter of the Using Simulink documentation.

Parameters and Dialog Box

Data store name

Specifies the name of the data store to which this block writes data. The adjacent pull-down list lists the names of Data Store Memory blocks that exist at the same level in the model as the Data Store Write block or at higher levels. To change the name, select a name from the pull-down list or enter the name directly in the edit field.

When Simulink compiles the model containing this block, Simulink searches the model upwards from this block's level for a Data Store Memory block having the specified data store name. If Simulink does not find such a block, it searches the model workspace and the MATLAB workspace for a `Simulink.Signal` object having the same name. If Simulink finds the signal object, it creates a hidden Data Store Memory block at the model's root level having the properties specified by the signal object and an initial value of `0`. If Simulink finds neither the Data Store Memory block nor the signal object, it halts the compilation and displays an error.

Data store memory block

This field lists the Data Store Memory block that initialized the store to which this block writes.

Data store read blocks

This parameter lists all the Data Store Read blocks with the same data store name as this block that are in the same (sub)system or in any subsystem below it in the model hierarchy. Double-click any entry on this list to highlight the block and bring it to the foreground.

Sample time

Specify the sample time that controls when the block writes to the data store. A value of `-1` indicates that the sample time is inherited. See Specifying Sample Time in the online documentation for more information.

Characteristics

Sample Time	Specified in the **Sample time** parameter
Dimensionalized	Yes

See Also   Data Store Memory, Data Store Read

Data Type Conversion

Purpose   Convert an input signal to a specified data type

Library   Signal Attributes

Description   The Data Type Conversion block converts an input signal of any
Simulink data type to the data type and scaling specified by the block's
Output data type mode, **Output data type**, and/or **Output scaling**
parameters. The input can be any real- or complex-valued signal. If the
input is real, the output is real. If the input is complex, the output
is complex.

Note This block requires that you specify the data type and/or scaling
for the conversion. If you want to inherit this information from an input
signal, you should use the Data Type Conversion Inherited block.

The **Input and output to have equal** parameter controls how the
input is processed. The possible values are `Real World Value (RWV)`
and `Stored Integer (SI)`:

- Select `Real World Value (RWV)` to treat the input as $V = SQ + B$
  where S is the slope and B is the bias. V is used to produce $Q = (V - B)/S,$ which is stored in the output. This is the default value.

- Select `Stored Integer (SI)` to treat the input as a stored integer,
  Q. The value of Q is directly used to produce the output. In this
  mode, the input and output are identical except that the input is a
  raw integer lacking proper scaling information. Selecting `Stored
  Integer` may be useful in these circumstances:

  - If you are generating code for a fixed-point processor, the resulting
    code only uses integers and does not use floating-point operations.

  - If you want to partition your model based on hardware
    characteristics. For example, part of your model may involve
    simulating hardware that produces integers as output.

Working with Fixed-Point Values Greater than 32 Bits

The MATLAB built-in integer data types are limited to 32 bits. If you want to output fixed-point numbers that range between 33 and 53 bits without loss of precision or range, you should break the number into pieces using the Gain block, and then output the pieces using the Data Type Conversion block to store the value inside a `double`.

For example, suppose the original signal is an unsigned 128-bit value with default scaling. You can break this signal into four pieces using four parallel Gain blocks configured with the gain and output settings shown below.

Piece	Gain	Output Data Type
1	2^0	uint(32) - Least significant 32 bits
2	2^-32	uint(32)
3	2^-64	uint(32)
4	2^-96	uint(32) - Most significant 32 bits

For each Gain block, you must also configure the **Round integer calculations toward** parameter to `Floor`, and the **Saturate on integer overflow** check box must be cleared.

Data Type Support

The Data Type Conversion block handles any data type supported by Simulink, including fixed-point data types.

For a discussion on the data types supported by Simulink, see "Data Types Supported by Simulink" in the "Working with Data" chapter of the Using Simulink documentation.

Data Type Conversion

Parameters and Dialog Box

Output data type mode

You can set the output signal to a built-in data type from this drop-down list, or you can choose to inherit the output data type and scaling by backpropagation. Lastly, if you choose Specify via dialog, the **Output data type**, **Output scaling value**, and **Lock output scaling against changes by the autoscaling tool** parameters become visible.

Output data type

Set the output data type. This parameter is only visible if you select Specify via dialog for the **Output data type mode** parameter.

Output scaling value

Set the output scaling using either binary point-only or [Slope Bias] scaling. This parameter is only visible if you select Specify via dialog for the **Output data type mode** parameter.

Lock output scaling against changes by the autoscaling tool
Select to lock scaling of outputs. This parameter is only visible if you select `Specify via dialog` for the **Output data type mode** parameter.

Input and output to have equal
Specify whether the `Real World Value (RWV)` or the `Stored Integer (SI)` of the input and output should be the same.

Round integer calculations toward
Select the rounding mode for fixed-point operations.

Saturate on integer overflow
Select to have overflows saturate.

Sample time (-1 for inherited)
Specify the time interval between samples. To inherit the sample time, set this parameter to `-1`. See Specifying Sample Time in the "How Simulink Works" chapter of the Using Simulink documentation.

Examples   **Example 1 — Real World Values Versus Stored Integers**

This example uses the Data Type Conversion block to help you understand the difference between a real-world value and a stored integer. Consider the two fixed-point models shown below.

Data Type Conversion
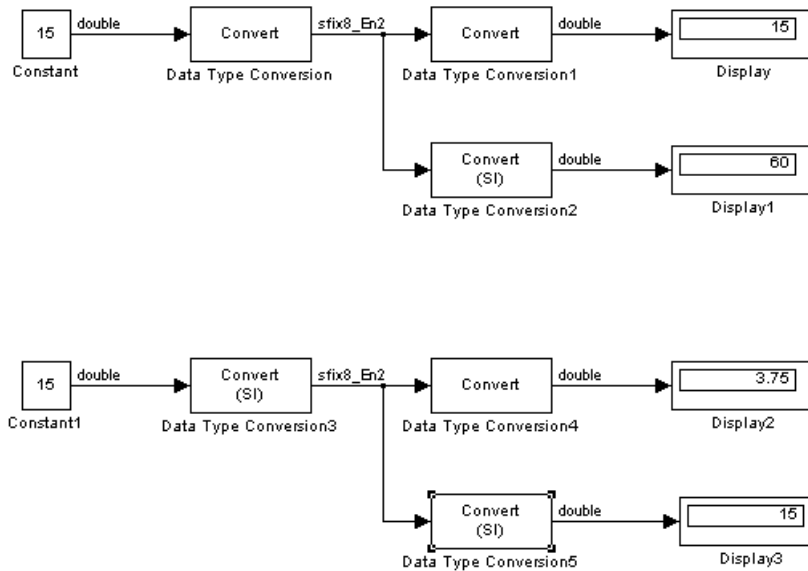
In the top model, the Data Type Conversion block treats the input as a real-world value, and maps that value to an 8-bit signed generalized fixed-point data type with a scaling of 2^{-2}. When the value is then output from the Data Type Conversion1 block as a real-world value, the scaling and data type information is retained and the output value is 001111.00, or 15. When the value is output from the Data Type Conversion2 block as a stored integer, the scaling and data type information is not retained and the stored integer is interpreted as 00111100, or 60.

In the bottom model, the Data Type Conversion3 block treats the input as a stored integer, and the data type and scaling information is not applied. When the value is then output from the Data Type Conversion4 block as a real-world value, the scaling and data type information is applied to the stored integer, and the output value is 000011.11, or 3.75. When the value is output from the Data Type Conversion5 block as a stored integer, you get back the original input value of 15.

Example 2 — Real World Values and Stored Integers in Summations

The model shown below illustrates how a summation operation applies to real-world values and stored integers, and how scaling information is dealt with in generated code.
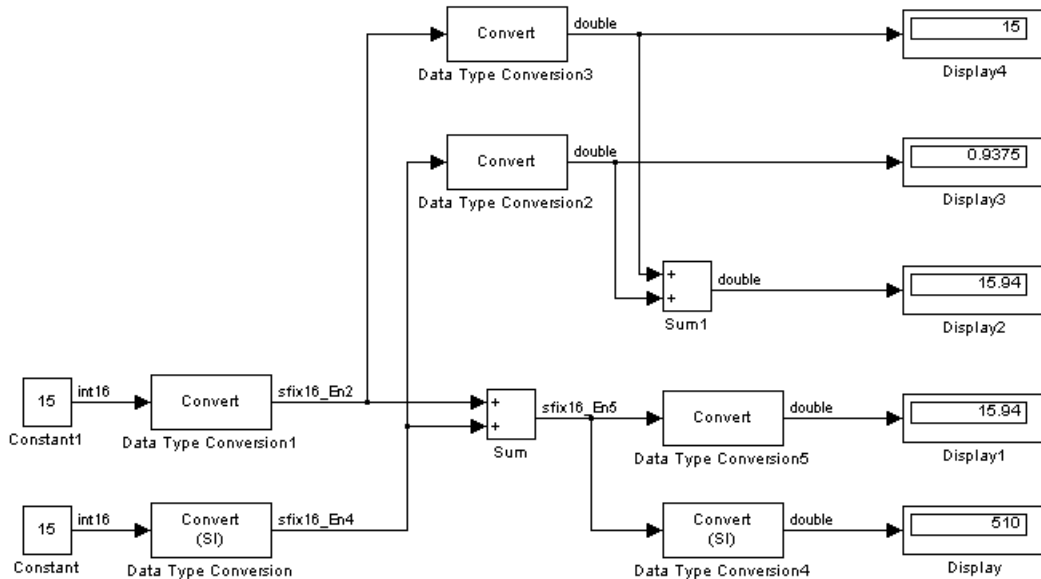
Note that the summation operation produces the correct result when the Data Type Conversion (2 or 5) block outputs a real-world value. This is because the specified scaling information is applied to the stored integer value. However, when the Data Type Conversion4 block outputs a stored integer value, then the summation operation produces an unexpected result due to the absence of scaling information.

If you generate code for the above model, then the code captures the appropriate scaling information. The code for the Sum block is shown below. The inputs to this block are tagged with the specified scaling information so that the necessary shifts are performed for the summation operation.

Data Type Conversion

```
/* Sum Block: <Root>/Sum
 *
 *  y =  u0 + u1
 *
 * Input0  Data Type:  Fixed Point    S16  2^-2
 * Input1  Data Type:  Fixed Point    S16  2^-4
 * Output0 Data Type:  Fixed Point    S16  2^-5
 *
 * Round Mode: Floor
 * Saturation Mode: Wrap
 *
 */
sum = ((in1) << 3);
```

sum += ((in2) << 1);

Characteristics

Direct Feedthrough	Yes
Sample Time	Inherited from driving block
Scalar Expansion	N/A
Dimensionalized	Yes
Zero Crossing	No

See Also   Data Type Conversion Inherited

Purpose   Convert from one data type to another using inherited data type and scaling

Library   Signal Attributes
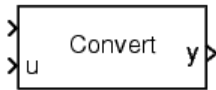
Description   The Data Type Conversion Inherited block forces dissimilar data types to be the same. The first (top) input is used as the reference signal and the second (bottom) input is converted to the reference type by inheriting the data type and scaling information. Either input is scalar expanded such that the output has the same width as the widest input.

Inheriting the data type and scaling provides these advantages:

- It makes reusing existing models easier.
- It allows you to create new fixed-point models with less effort since you can avoid the detail of specifying the associated parameters.

Data Type Support   The Data Type Conversion Inherited block handles any data type supported by Simulink, including fixed-point data types.

For a discussion on the data types supported by Simulink, see "Data Types Supported by Simulink" in the "Working with Data" chapter of the Using Simulink documentation.

Parameters and Dialog Box
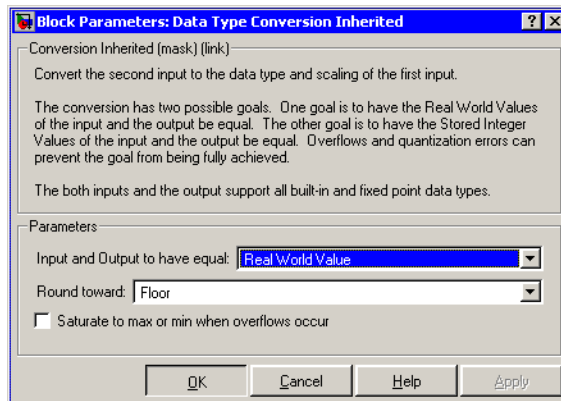
Data Type Conversion Inherited

Input and Output to have equal
> Specify whether the `Real World Value (RWV)` or the `Stored Integer (SI)` of the input and output should be the same. Refer to Description in the Data Type Conversion block reference page for more information about these choices.

Round toward
> Select the rounding mode for fixed-point operations.

Saturate to max or min when overflows occur
> Select to have overflows saturate.

Characteristics

Direct Feedthrough	Yes

See Also   Data Type Conversion

Purpose   Force all inputs to the same data type

Library   Signal Attributes

Description
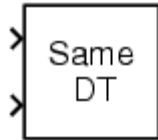
The Data Type Duplicate block forces all inputs to have exactly the same data type. Other attributes of input signals, such as dimension, complexity, and sample time, are completely independent.

You can use the Data Type Duplicate block to check for consistency of data types among blocks. If all signals do not have the same data type, the block returns an error message.

The Data Type Duplicate block is typically used such that one signal to the block controls the data type for all other blocks. The other blocks are set to inherit their data types via backpropagation.

The block is also used in a user created library. These library blocks can be placed in any model, and the data type for all library blocks are configured according to the usage in the model. To create a library block with more complex data type rules than duplication, use the Data Type Propagation block.

Data Type Support

The Data Type Duplicate block accepts signals of any data type supported by Simulink, including fixed-point data types.

Parameters and Dialog Box
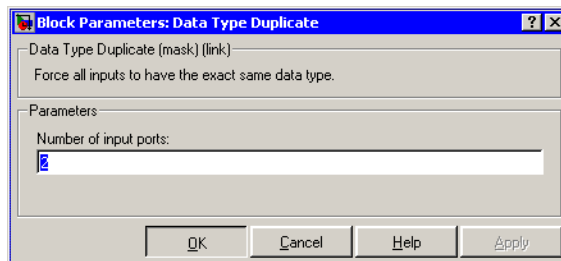
Number of input ports
>Number of input ports.

Data Type Duplicate

Characteristics

Scalar Expansion	Yes
States	0

Purpose   Set the data type and scaling of the propagated signal based on information from the reference signals

Library   Signal Attributes

Description   The Data Type Propagation block allows you to control the data type and scaling of signals in your model. You can use this block in conjunction with fixed-point blocks that have their **Specify data type and scaling** parameter configured to Inherit via back propagation.

The block has three inputs: Ref1 and Ref2 are the reference inputs, while the Prop input back propagates the data type and scaling information gathered from the reference inputs. This information is then passed on to other fixed-point blocks.

The block provides you with many choices for propagating data type and scaling information. For example, you can:

- Use the number of bits from the Ref1 reference signal, or use the number of bits from widest reference signal.

- Use the range from the Ref2 reference signal, or use the range of the reference signal with the greatest range.

- Use a bias of zero, regardless of the biases used by the reference signals.

- Use the precision of the reference signal with the least precision.

You specify how data type information is propagated with the **Propagated data type** parameter list. If the parameter list is configured as Specify via dialog, then you manually specify the data type via the **Propagated data type** edit field. If the parameter list is configured as Inherit via propagation rule, then you must use the parameters described in "Inheriting Data Type Information" of the "Simulink Fixed Point".

You specify how scaling information is propagated with the **Propagated scaling** parameter list. If the parameter list is configured as Specify via dialog, then you manually specify the scaling via the **Propagated**

scaling edit field. If the parameter list is configured as `Inherit via propagation rule`, then you must use the parameters described in "Inheriting Scaling Information" in "Simulink Fixed Point".

After you use the information from the reference signals, you can apply a second level of adjustments to the data type and scaling by using individual multiplicative and additive adjustments. This flexibility has a variety of uses. For example, if you are targeting a DSP, then you can configure the block so that the number of bits associated with a MAC (multiply and accumulate) operation is twice as wide as the input signal, and has a certain number of guard bits added to it.

The Data Type Propagation block also provides a mechanism to force the computed number of bits to a useful value. For example, if you are targeting a 16-bit micro, then the target C compiler is likely to support sizes of only 8 bits, 16 bits, and 32 bits. The block will force these three choices to be used. For example, suppose the block computes a data type size of 24 bits. Since 24 bits is not directly usable by the target chip, the signal is forced up to 32 bits, which is natively supported.

There is also a method for dealing with floating-point reference signals. This makes it easier to create designs that are easily retargeted from fixed-point chips to floating-point chips or visa versa.

The Data Type Propagation block allows you to set up libraries of useful subsystems that will be properly configured based on the connected signals. Without this data type propagation process, a subsystem that you use from a library will almost certainly not work as desired with most integer or fixed-point signals, and manual intervention to configure the data type and scaling would be required. This block can eliminate the manual intervention in many situations.

Precedence Rules

The precedence of the dialog box parameters decreases from top to bottom. Additionally:

- Double-precision reference inputs have precedence over all other data types.

- Single-precision reference inputs have precedence over integer and
fixed-point data types.

- Multiplicative adjustments are carried out before additive
adjustments.

- The number of bits is determined before the precision or positive
range is inherited from the reference inputs.

**Data Type
Support**

The Data Type Propagation block accepts signals of any data type
supported by Simulink, including fixed-point data types.

Data Type Propagation

Parameters and Dialog Box

The **Propagated type** pane of the Data Type Propagation block dialog appears as follows:
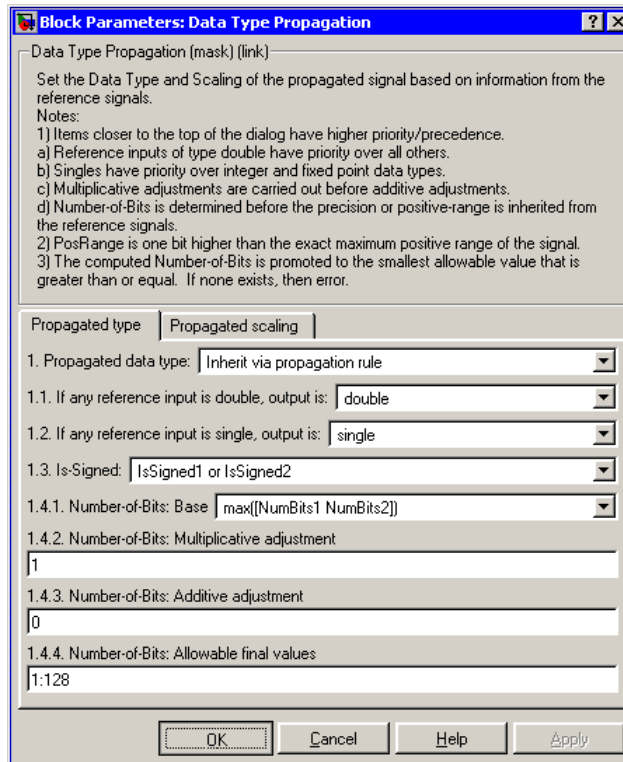
Propagated data type

Use the parameter list to propagate the data type via the dialog box, or inherit the data type from the reference signals. Use the edit field to specify the data type via the dialog box.

If any reference input is double, output is

Specify single or double. This parameter makes it easier to create designs that are easily retargeted from fixed-point chips to floating-point chips or visa versa.

This parameter is only visible if `Inherit via propagation rule` is selected for the **Propagated data type** parameter list.

If any reference input is single, output is
Specify `single` or `double`. This parameter makes it easier to create designs that are easily retargeted from fixed-point chips to floating-point chips or visa versa.

This parameter is only visible if `Inherit via propagation rule` is selected for the **Propagated data type** parameter list.

Is-Signed
Specify the sign of Prop as one of the following values:

Parameter Value	Description
IsSigned1	Prop is a signed data type if Ref1 is a signed data type.
IsSigned2	Prop is a signed data type if Ref2 is a signed data type.
IsSigned1 or IsSigned2	Prop is a signed data type if either Ref1 or Ref2 are signed data types.
TRUE	Ref1 and Ref2 are ignored, and Prop is always a signed data type.
FALSE	Ref1 and Ref2 are ignored, and Prop is always an unsigned data type.

For example, if the Ref1 signal is `ufix(16)`, the Ref2 signal is `sfix(16)`, and the **Is-Signed** parameter is `IsSigned1 or IsSigned2`, then Prop is forced to be a signed data type.

This parameter is only visible if `Inherit via propagation rule` is selected for the **Propagated data type** parameter list.

Data Type Propagation

Number-of-bits: Base

Specify the number of bits used by Prop for the base data type as one of the following values:

Parameter Value	Description
NumBits1	The number of bits for Prop is given by the number of bits for Ref1.
NumBits2	The number of bits for Prop is given by the number of bits for Ref2.
max([NumBits1 NumBits2])	The number of bits for Prop is given by the reference signal with largest number of bits.
min([NumBits1 NumBits2])	The number of bits for Prop is given by the reference signal with smallest number of bits.
NumBits1+NumBits2	The number of bits for Prop is given by the sum of the reference signal bits.

Refer to "Targeting an Embedded Processor" in the Simulink Fixed Point documentation for more information about the base data type.

This parameter is only visible if `Inherit via propagation rule` is selected for the **Propagated data type** parameter list.

Number-of-bits: Multiplicative adjustment

Specify the number of bits used by Prop by including a multiplicative adjustment. For example, suppose you want to guarantee that the number of bits associated with a multiply and accumulate (MAC) operation is twice as wide as the input signal. To do this, you configure this parameter to the value 2.

This parameter is only visible if `Inherit via propagation rule` is selected for the **Propagated data type** parameter list.

Number-of-bits: Additive adjustment

> Specify the number of bits used by Prop by including an additive adjustment. For example, if you are performing multiple additions during a MAC operation, the result may overflow. To prevent overflow, you can associate guard bits with the propagated data type. To associate four guard bits, you specify the value 4.
>
> This parameter is only visible if `Inherit via propagation rule` is selected for the **Propagated data type** parameter list.

Number-of-bits: Allowable final values

> parameter allows you to force the computed number of bits used by Prop to a useful value. For example, if you are targeting a processor that supports only 8, 16, and 32 bits, then you configure this parameter to `[8,16,32]`. The block always propagates the smallest specified value that fits. If you want to allow all fixed-point data types, you would specify the value `1:128`.
>
> This parameter is only visible if `Inherit via propagation rule` is selected for the **Propagated data type** parameter list.

The **Propagated scaling** pane of the Data Type Propagation block dialog appears as follows:

Data Type Propagation
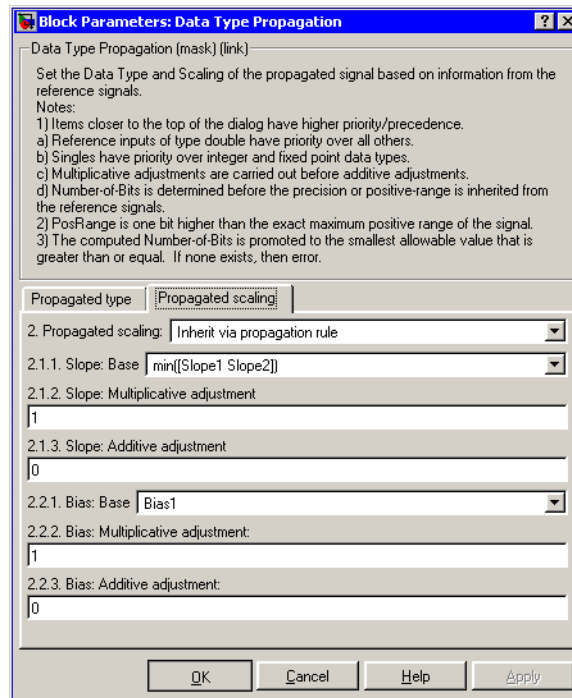
Propagated scaling

    Use the parameter list to propagate the scaling via the dialog box, or inherit the scaling from the reference signals. Use the edit field to specify the scaling via the dialog box.

Values used to determine best precision scaling

    Specify any values to be used to constrain the precision, such as the upper and lower limits on the propagated input. Based on the data type, the scaling will automatically be selected such that these values can be represented with no overflow error and minimum quantization error.

    This parameter is only visible if `Obtain via best precision` is selected for the **Propagated scaling** parameter list.

Slope: Base

Specify the slope used by Prop for the base data type as one of the following values:

Parameter Value	Description
Slope1	The slope of Prop is given by the slope of Ref1.
Slope2	The slope of Prop is given by the slope of Ref2.
max([Slope1 Slope2])	The slope of Prop is given by the maximum slope of the reference signals.
min([Slope1 Slope2])	The slope of Prop is given by the minimum slope of the reference signals.
Slope1*Slope2	The slope of Prop is given by the product of the reference signal slopes.
Slope1/Slope2	The slope of Prop is given by the ratio of the Ref1 slope to the Ref2 slope.
PosRange1	The range of Prop is given by the range of Ref1.
PosRange2	The range of Prop is given by the range of Ref2.
max([PosRange1 PosRange2])	The range of Prop is given by the maximum range of the reference signals.
min([PosRange1 PosRange2])	The range of Prop is given by the minimum range of the reference signals.
PosRange1*PosRange2	The range of Prop is given by the product of the reference signal ranges.
PosRange1/PosRange2	The range of Prop is given by the ratio of the Ref1 range to the Ref2 range.

Data Type Propagation

You control the precision of Prop with `Slope1` and `Slope2`, and you control the range of Prop with `PosRange1` and `PosRange2`. Additionally, `PosRange1` and `PosRange2` are one bit higher than the maximum positive range of the associated reference signal.

This parameter is only visible if `Inherit via propagation rule` is selected for the **Propagated scaling** parameter list.

Slope: Multiplicative adjustment

Specify the slope used by Prop by including a multiplicative adjustment. For example, if you want 3 bits of additional precision (with a corresponding decrease in range), the multiplicative adjustment is `2^-3`.

This parameter is only visible if `Inherit via propagation rule` is selected for the **Propagated scaling** parameter list.

Slope: Additive adjustment

Specify the slope used by Prop by including an additive adjustment. An additive slope adjustment is often not needed. The most likely use is to set the multiplicative adjustment to `0`, and set the additive adjustment to force the final slope to a specified value.

This parameter is only visible if `Inherit via propagation rule` is selected for the **Propagated scaling** parameter list.

Bias: Base

Specify the bias used by Prop for the base data type. The parameter values are described below.

Parameter Value	Description
`Bias1`	The bias of Prop is given by the bias of Ref1.
`Bias2`	The bias of Prop is given by the bias of Ref2.
`max([Bias1 Bias2])`	The bias of Prop is given by the maximum bias of the reference signals.

Parameter Value	Description
min([Bias1 Bias2])	The bias of Prop is given by the minimum bias of the reference signals.
Bias1*Bias2	The bias of Prop is given by the product of the reference signal biases.
Bias1/Bias2	The bias of Prop is given by the ratio of the Ref1 bias to the Ref2 bias.
Bias1+Bias2	The bias of Prop is given by the sum of the reference biases.
Bias1-Bias2	The bias of Prop is given by the difference of the reference biases.

This parameter is only visible if Inherit via propagation rule is selected for the **Propagated scaling** parameter list.

Bias: Multiplicative adjustment
Specify the bias used by Prop by including a multiplicative adjustment.

This parameter is only visible if Inherit via propagation rule is selected for the **Propagated scaling** parameter list.

Bias: Additive adjustment
Specify the bias used by Prop by including an additive adjustment.

If you want to guarantee that the bias associated with Prop is zero, you should configure both the multiplicative adjustment and the additive adjustment to 0.

This parameter is only visible if Inherit via propagation rule is selected for the **Propagated scaling** parameter list.

Data Type Propagation

Characteristics

Direct Feedthrough	Yes
Scalar Expansion	Yes

Data Type Scaling Strip

Purpose   Remove scaling and map to a built in integer

Library   Signal Attributes
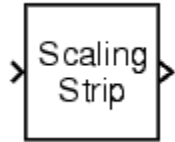
Description   The Scaling Strip block strips the scaling off a fixed point signal. It maps the input data type to the smallest built in data type that has enough data bits to hold the input. The stored integer value of the input is the value of the output. The output always has nominal scaling (slope = 1.0 and bias = 0.0), so the output does not make a distinction between real world value and stored integer value.

Data Type Support   The Data Type Scaling Strip block accepts signals of any data type supported by Simulink, including fixed-point data types.

Parameters and Dialog Box
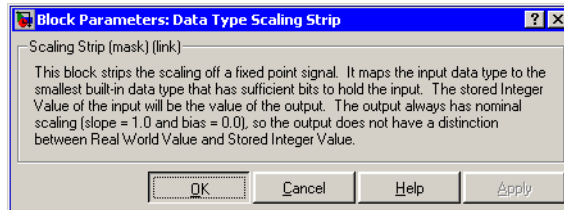
**Characteristics**

Direct Feedthrough	Yes
Scalar Expansion	Yes

Dead Zone

Purpose   Provide a region of zero output

Library   Discontinuities
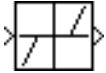
Description   The Dead Zone block generates zero output within a specified region,
                     called its dead zone. The lower and upper limits of the dead zone
                     are specified as the **Start of dead zone** and **End of dead zone**
                     parameters. The block output depends on the input and dead zone:

                     • If the input is within the dead zone (greater than the lower limit and
                       less than the upper limit), the output is zero.

                     • If the input is greater than or equal to the upper limit, the output is
                       the input minus the upper limit.

                     • If the input is less than or equal to the lower limit, the output is
                       the input minus the lower limit.

                     This sample model uses lower and upper limits of -0.5 and +0.5, with a
                     sine wave as input.
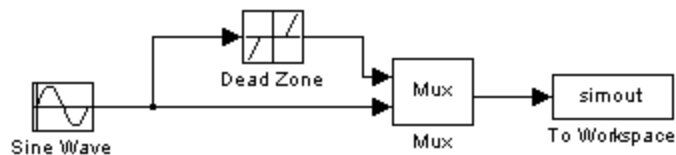
                     This plot shows the effect of the Dead Zone block on the sine wave.
                     While the input (the sine wave) is between -0.5 and 0.5, the output
                     is zero.
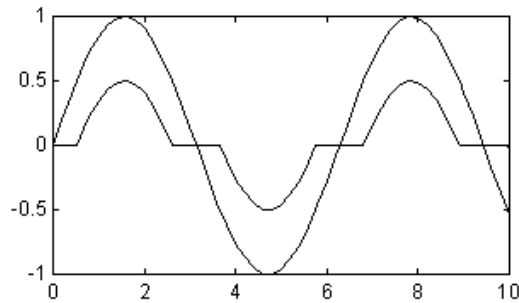
Data Type Support

The Dead Zone block accepts and outputs a real signal of any data type supported by Simulink, except `Boolean`. The Dead Zone block supports fixed-point data types.

For a discussion on the data types supported by Simulink, see "Data Types Supported by Simulink" in the "Working with Data" chapter of the Using Simulink documentation.

Parameters and Dialog Box
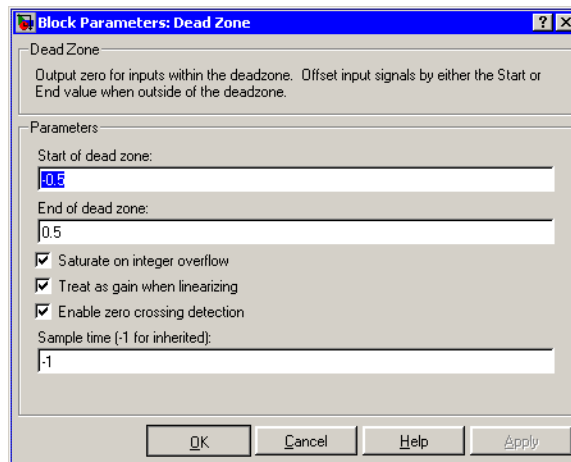
Start of dead zone

Specify the lower limit of the dead zone. The default is `-0.5`.

Dead Zone

End of dead zone
> Specify the upper limit of the dead zone. The default is `0.5`.

Saturate on integer overflow
> Select to have overflows saturate.

Treat as gain when linearizing
> The linearization commands in Simulink treat this block as a gain in state space. Select this option to cause the commands to treat the gain as 1; otherwise, the commands treat the gain as 0.

Enable zero crossing detection
> Select to enable zero crossing detection to detect when the limits are reached. For more information, see Zero Crossing Detection in the "How Simulink Works" chapter of the Using Simulink documentation.

Sample time (-1 for inherited)
> Specify the time interval between samples. To inherit the sample time, set this parameter to `-1`. See Specifying Sample Time in the "How Simulink Works" chapter of the Using Simulink documentation.

Characteristics

Direct Feedthrough	Yes
Sample Time	Specified in the **Sample time** parameter
Scalar Expansion	Yes, of parameters
Dimensionalized	Yes
Zero Crossing	Yes, if enabled

See Also   Dead Zone Dynamic

Purpose   Set inputs within the bounds to zero

Library   Discontinuities

Description   The Dead Zone Dynamic block dynamically bounds the range of the input signal, providing a region of zero output. The bounds change according to the upper and lower limit input signals where
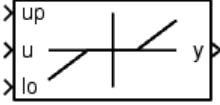
- The input within the bounds is set to zero.

- The input below the lower limit is shifted down by the lower limit.

- The input above the upper limit is shifted down by the upper limit.

The input for the upper limit is the up port, and the input for the lower limit is the lo port.

Data Type Support   The Dead Zone Dynamic block accepts signals of any data type supported by Simulink, including fixed-point data types.

Parameters and Dialog Box
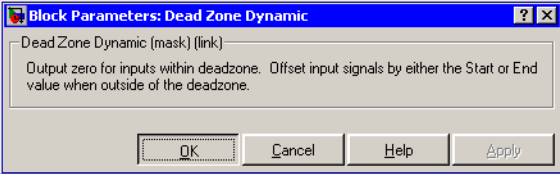
Characteristics

Direct Feedthrough	Yes
Scalar Expansion	Yes

See Also   Dead Zone

Decrement Real World

Purpose   Decrease the real world value of the signal by one

Library   Additional Math & Discrete / Additional Math: Increment - Decrement

Description   The Decrement Real World block decreases the real world value of the signal by one. Overflows always wrap.
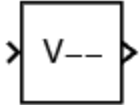
Data Type Support   The Decrement Real World block accepts signals of any data type supported by Simulink, including fixed-point data types.

Parameters and Dialog Box
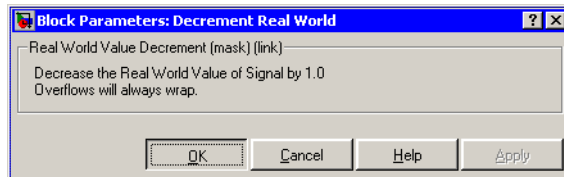
Characteristics

Direct Feedthrough	Yes
Scalar Expansion	No

See Also   Decrement Stored Integer, Decrement Time To Zero, Decrement To Zero, Increment Real World

Purpose   Decrease the stored integer value of a signal by one

Library   Additional Math & Discrete / Additional Math: Increment - Decrement

Description   The Decrement Stored Integer block decreases the stored integer value of a signal by one.
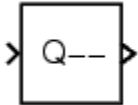
Floating-point signals are also decreased by one, and overflows always wrap.

Data Type Support   The Decrement Stored Integer block accepts signals of any data type supported by Simulink, including fixed-point data types.

Parameters and Dialog Box
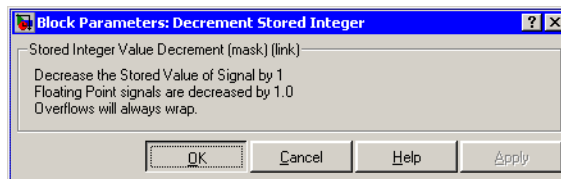
Characteristics

Direct Feedthrough	Yes
Scalar Expansion	No

See Also   Decrement Real World, Decrement Time To Zero, Decrement To Zero, Increment Stored Integer

Decrement Time To Zero

Purpose   Decrease the real-world value of the signal by the sample time, but only to zero.

Library   Additional Math & Discrete / Additional Math: Increment - Decrement

Description   The Decrement Time To Zero block decreases the real-world value of the signal by the sample time, Ts. The output will never go below zero. This block only works with fixed sample rates.

$\rightarrow$ max(V−Ts, 0) $\rightarrow$
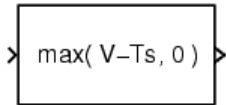
Data Type Support   The Decrement Time To Zero block accepts signals of any data type supported by Simulink, including fixed-point data types.

Parameters and Dialog Box
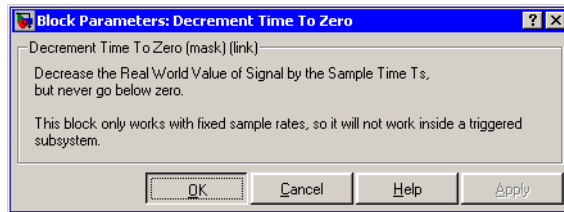
Characteristics

Direct Feedthrough	Yes
Scalar Expansion	No

See Also   Decrement Real World, Decrement Stored Integer, Decrement To Zero

Purpose   Decreases the real-world value of a signal by one, but only to zero.

Library   Additional Math & Discrete / Additional Math: Increment - Decrement

Description   The Decrement To Zero block decreases the real-world value of the signal by one. The output will never go below zero.

> max(V−−, 0)
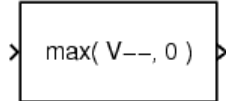
Data Type Support   The Decrement To Zero block accepts signals of any data type supported by Simulink, including fixed-point data types.

Parameters and Dialog Box
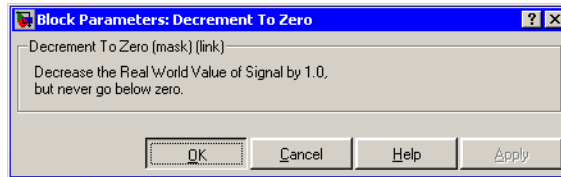
Characteristics

Direct Feedthrough	Yes
Scalar Expansion	No

See Also   Decrement Real World, Decrement Stored Integer, Decrement Time To Zero

Demux

Purpose   Extract and output the elements of a bus or vector signal

Library   Signal Routing

Description   The Demux block extracts the components of an input signal and
outputs the components as separate signals. The block accepts either
vector (1-D array) signals or bus signals (see "Signal Buses" in the
"Working with Signals" chapter of the Using Simulink documentation).
The **Number of outputs** parameter allows you to specify the number
and, optionally, the dimensionality of each output port. If you do not
specify the dimensionality of the outputs, the block determines the
dimensionality of the outputs for you.

The Demux block operates in either vector or bus selection mode,
depending on whether you selected the **Bus selection mode** parameter.
The two modes differ in the types of signals they accept. Vector mode
accepts only a vector-like signal, that is, either a scalar (one-element
array), vector (1-D array), or a column or row vector (one row or one
column 2-D array). Bus selection mode accepts only the output of a
Mux block or another Demux block.

The Demux block's **Number of outputs** parameter determines the
number and dimensionality of the block's outputs, depending on the
mode in which the block operates.

Specifying the Number of Outputs in Vector Mode

In vector mode, the value of the parameter can be a scalar specifying
the number of outputs or a vector whose elements specify the widths of
the block's output ports. The block determines the size of its outputs
from the size of the input signal and the value of the **Number of
outputs** parameter.

The following table summarizes how the block determines the outputs
for an input vector of width n.

Parameter Value	Block outputs...	Comments
`p = n`	p scalar signals	For example, if the input is a three-element vector and you specify three outputs, the block outputs three scalar signals.
`p > n`	Error	
`p < n` `n mod p = 0`	p vector signals each having `n/p` elements	If the input is a six-element vector and you specify three outputs, the block outputs three two-element vectors.
`p < n` `n mod p = m`	m vector signals each having `(n/p)+1` elements and `p-m` signals having `n/p` elements	If the input is a five-element vector and you specify three outputs, the block outputs two two-element vector signals and one scalar signal.
`[p₁ p₂ ... pₘ]` $p_1+p_2+\ldots+p_m=n$ $p_i > 0$	m vector signals having widths p_1, p_2, ... p_m	If the input is a five-element vector and you specify [3, 2] as the output, the block outputs three of the input elements on one port and the other two elements on the other port.
`[p₁ p₂ ... pₘ]` $p_1+p_2+\ldots+p_m=n$ some or all $p_i = -1$	m vector signals	If pi is greater than zero, the corresponding output has width p_i. If p_i is -1, the width of the corresponding output is dynamically sized.
`[p₁ p₂ ... pₘ]` $p_1+p_2+\ldots+p_m!=n$ $p_i => 0$	Error	

Demux

Note that you can specify the number of outputs as fewer than the number of input elements, in which case the block distributes the elements as evenly as possible over the outputs as illustrated in the following example.
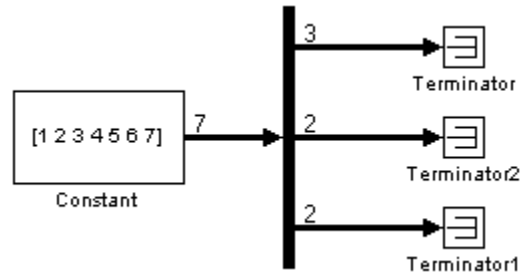
You can use -1 in a vector expression to indicate that the block should dynamically size the corresponding port. For example, the expression [-1, 3 -1] causes the block to output three signals in which the second signal always has three elements while the sizes of the first and third signals depend on the size of the input signal.

If a vector expression comprises positive values and -1 values, the block assigns as many elements as needed to the ports with positive values and distributes the remain elements as evenly as possible over the ports with -1 values. For example, suppose that the block input is seven elements wide and you specify the output as [-1, 3 -1]. In this case, the block outputs two elements on the first port, three elements on the second, and two elements on the third.
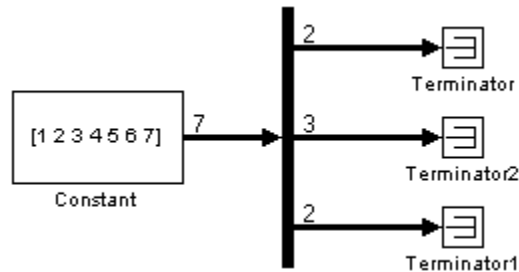
Specifying the Number of Outputs in Bus Selection Mode

In bus selection mode, the value of the **Number of outputs** parameter can be a

- Scalar specifying the number of output ports

  The specified value must equal the number of input signals. For example, if the input bus comprises two signals and the value of this parameter is a scalar, the value must equal 2.
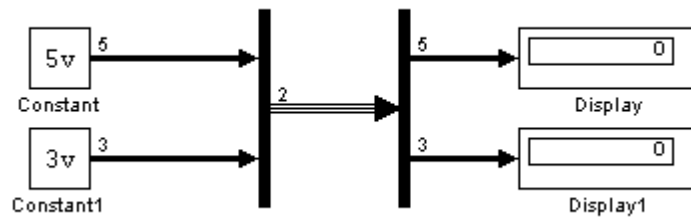
- Vector each of whose elements specifies the number of signals to output on the corresponding port

  For example, if the input bus contains five signals, you can specify the output as [3, 2], in which case the block outputs three of the input signals on one port and the other two signals on a second port.

- Cell array each of whose elements is a cell array of vectors specifying the dimensions of the signals output by the corresponding port

The cell array format constrains the Demux block to accept only signals of specified dimensions. For example, the cell array {{[2 2], 3} {1}} tells the block to accept only a bus signal comprising a 2-by-2 matrix, a three-element vector, and a scalar signal. You can use the value -1 in a cell array expression to let the block determine the dimensionality of a particular output based on the input. For example, the following diagram uses the cell array expression {{-1}, {-1,-1}} to specify the output of the leftmost Demux block.
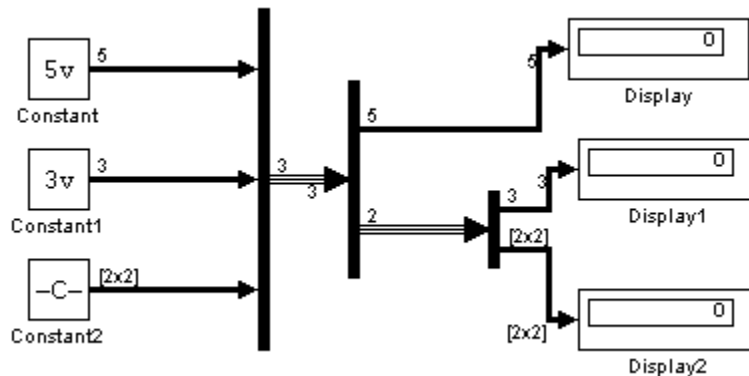
In bus selection mode, if you specify the dimensionality of an output port, i.e., if you specify any value other than -1, the corresponding input element must match the specified dimensionality.

Note Simulink hides the name of a Demux block when you copy it from the Simulink library to a model.

Data Type Support

The Demux block accepts and outputs complex or real signals of any data type supported by Simulink, including fixed-point data types.

For a discussion on the data types supported by Simulink, see "Data Types Supported by Simulink" in the "Working with Data" chapter of the Using Simulink documentation.

Parameters and Dialog Box
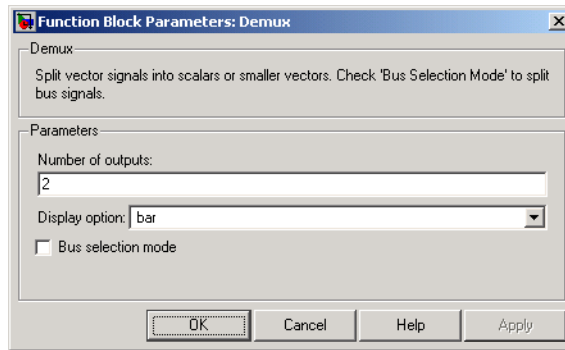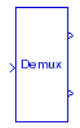
Number of outputs
   The number and dimensions of outputs.

Display option
   Options for displaying the Demux block. The options are

Demux

Option	Description	Example
bar	Display the icon as a solid bar of the block's foreground color.	
none	Display the icon as a box containing the block's type name.	

Bus selection mode

Enable bus selection mode.

Purpose   Output the time derivative of the input

Library   Continuous

Description The Derivative block approximates the derivative of its input by
computing

$$\frac{du}{dt}$$

where *du* is the change in input value and *dt* is the change in time since
the previous simulation time step. The block accepts one input and
generates one output. The initial output for the block is zero.

The accuracy of the results depends on the size of the time steps taken
in the simulation. Smaller steps allow a smoother and more accurate
output curve from this block. Unlike blocks that have continuous states,
the solver does not take smaller steps when the input changes rapidly.

When the input is a discrete signal, the continuous derivative of the
input is an impulse when the value of the input changes, otherwise it is
0. You can obtain the discrete derivative of a discrete signal using

$$y(k) = \frac{1}{\Delta t}(u(k) - u(k-1))$$

and taking the *z*-transform

$$\frac{Y(z)}{u(z)} = \frac{1 - z^{-1}}{\Delta t} = \frac{z - 1}{\Delta t \cdot z}$$

Using `linmod` to linearize a model that contains a Derivative block
can be troublesome. To improve the accuracy of linearizations of this
block, use the optional linearization parameter within the block dialog
box. Additionally, for more information about how to avoid problems
linearizing Derivative blocks, see Linearizing Models in the "Analyzing
Simulation Results" chapter of the Using Simulink documentation.

Derivative

Data Type Support

The Derivative block accepts and outputs a real signal of type `double`.

Parameters and Dialog Box
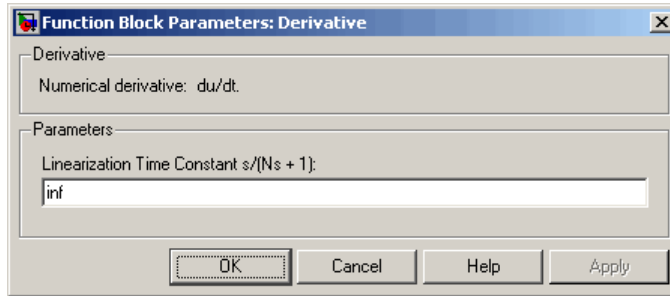
The exact linearization of the Derivative block is difficult due to the fact that the block cannot be represented as a state space system since the dynamic equation for the block is $y = \dot{u}$. However, it is possible to approximate the linearization by adding a pole to the Derivative to create a proper transfer function. The addition of the pole has the effect of filtering the signal before differentiating it, to remove the effect of noise. The approximated linearization of the Derivative block is then

$\frac{s}{Ns+1}$. You can change the **Linearization Time Constant**, N, to more accurately approximate the linearization for your system. Its default value is Inf, corresponding to a linearization of 0, but it is common

practice to change it to $\frac{1}{f_b}$, where f_b is the break frequency for the filter.

Characteristics

Direct Feedthrough	Yes
Sample Time	Continuous
Scalar Expansion	N/A
States	2*[1+(number of input elements)]
Dimensionalized	Yes
Zero Crossing	No

See Also   Discrete Derivative

Detect Change

Purpose   Detect a change in a signal's value

Library   Logic and Bit Operations

Description

> $U \sim= U/z$

The Detect Change block determines if an input does not equal its previous value where
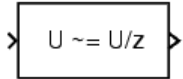
- The output is true (equal to 1), when the input signal does not equal its previous value.

- The output is false (equal to 0), when the input signal equals its previous value.

Data Type Support

The Detect Change block accepts signals of any data type supported by Simulink, including fixed-point data types. The block output is uint8.

Parameters and Dialog Box
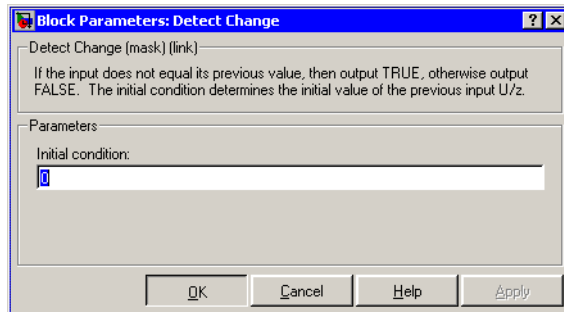
Initial condition
    Set the initial condition for the previous input U/z.

Characteristics

Direct Feedthrough	Yes
Scalar Expansion	Yes

See Also   Detect Decrease, Detect Fall Negative, Detect Fall Nonpositive, Detect Increase, Detect Rise Nonnegative, Detect Rise Positive

Detect Decrease

Purpose   Detect a decrease in a signal's value

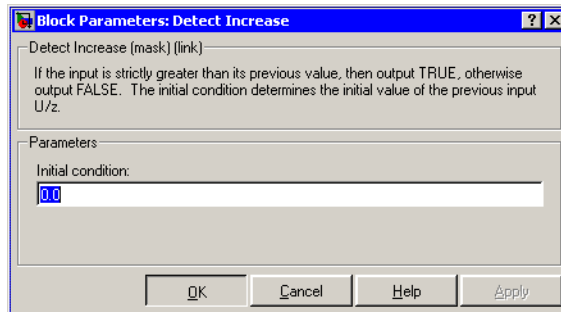**Library**   Logic and Bit Operations

Description   The Detect Decrease block determines if an input is strictly less than its previous value where

> $U < U/z$
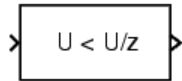
- The output is true (equal to 1), when the input signal is less than its previous value.

- The output is false (equal to 0), when the input signal is greater than or equal to its previous value.

Data Type Support   The Detect Decrease block accepts signals of any data type supported by Simulink, including fixed-point data types. The block output is uint8.

Parameters and Dialog Box
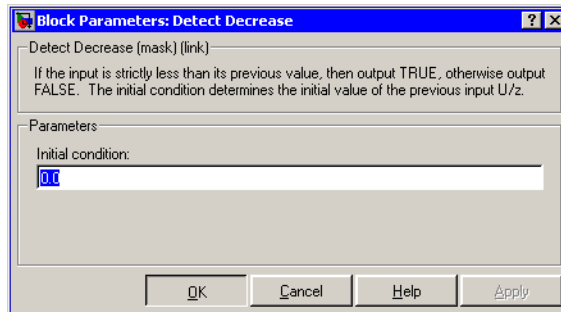
Initial condition
> Set the initial condition for the previous input U/z.

Characteristics

Direct Feedthrough	Yes
Scalar Expansion	Yes

See Also   Detect Change, Detect Fall Negative, Detect Fall Nonpositive, Detect Increase, Detect Rise Nonnegative, Detect Rise Positive

Detect Fall Negative

Purpose
Detect a falling edge when the signal's value decreases to a strictly negative value, and its previous value was nonnegative
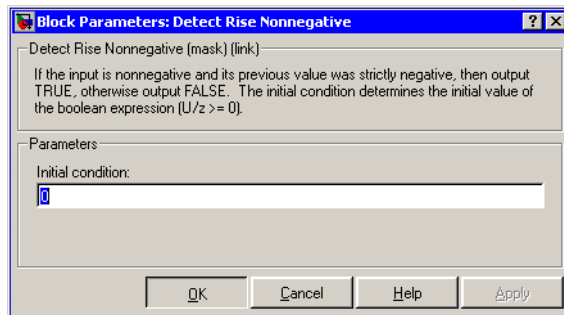
Library
Logic and Bit Operations

Description
The Detect Fall Negative block determines if the input is less than zero, and its previous value was greater than or equal to zero where

```
 U < 0
 & NOT
 U/z < 0
```
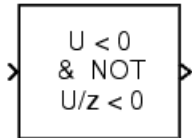
- The output is true (equal to 1), when the input signal is less than zero, and its previous value was greater than or equal to zero.

- The output is false (equal to 0), when the input signal is greater than or equal to zero, or if the input signal is nonnegative, its previous value was positive or zero.

Data Type Support
The Detect Fall Negative block accepts signals of any data type supported by Simulink, including fixed-point data types. The block output is uint8.

Parameters and Dialog Box

Initial condition
Set the initial condition of the Boolean expression U/z < 0.

Characteristics

Direct Feedthrough	Yes
Scalar Expansion	Yes

See Also
Detect Change, Detect Decrease, Detect Fall Nonpositive, Detect Increase, Detect Rise Nonnegative, Detect Rise Positive

Detect Fall Nonpositive

Purpose	Detect a falling edge when the signal's value decreases to a nonpositive value, and its previous value was strictly positive
Library	Logic and Bit Operations

Description   The Detect Fall Nonpositive block determines if the input is less than or equal to zero, and its previous value was positive where

- The output is true (equal to 1), when the input signal is less than or equal to zero, and its previous value was greater than zero.

- The output is false (equal to 0), when the input signal is greater than zero, or if it is nonpositive, its previous value was nonpositive.

Data Type Support   The Detect Fall Nonpositive block accepts signals of any data type supported by Simulink, including fixed-point data types. The block output is uint8.

Parameters and Dialog Box
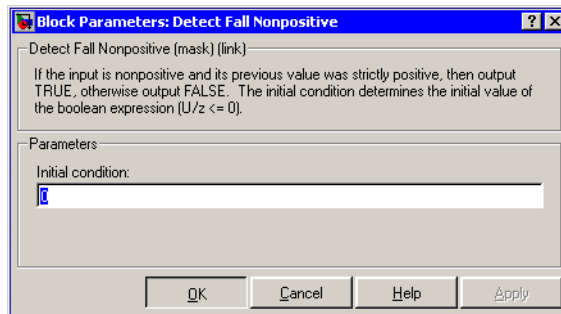
Initial condition
Set the initial condition of the Boolean expression U/z <= 0.

Characteristics

Direct Feedthrough	Yes
Scalar Expansion	Yes

Detect Fall Nonpositive

Purpose   Detect an increase in a signal's value

Library   Logic and Bit Operations

Description   The Detect Increase block determines if an input is strictly greater than
                   its previous value where

```
U > U/z
```
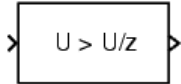
- The output is true (equal to 1), when the input signal is greater than
  its previous value.

- The output is false (equal to 0), when the input signal is less than or
  equal to its previous value.

**Data Type
Support**   The Detect Increase block accepts signals of any data type supported by
                   Simulink, including fixed-point data types. The block output is uint8.

**Parameters
and
Dialog
Box**

Block Parameters: Detect Increase

Detect Increase (mask) (link)

If the input is strictly greater than its previous value, then output TRUE, otherwise
output FALSE. The initial condition determines the initial value of the previous input
U/z.

Parameters

Initial condition:

0.0

| OK | Cancel | Help | Apply |

Initial condition
    Set the initial condition for the previous input U/z.

Characteristics

Direct Feedthrough	Yes
Scalar Expansion	Yes

See Also   Detect Change, Detect Decrease, Detect Fall Negative, Detect Fall
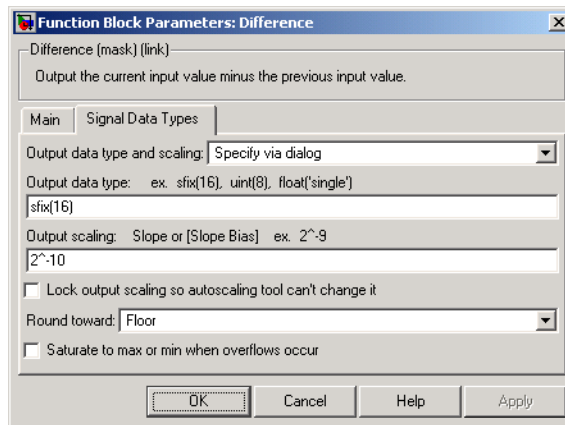   Nonpositive, Detect Rise Nonnegative, Detect Rise Positive

Detect Rise Nonnegative

Purpose   Detect a rising edge when a signal's value increases to a nonnegative value, and its previous value was strictly negative

Library   Logic and Bit Operations

Description   The Detect Rise Nonnegative block determines if the input is greater than or equal to zero, and its previous value was less than zero where
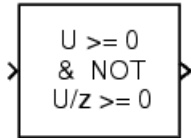
```
U >= 0
& NOT
U/z >= 0
```

- The output is true (equal to 1), when the input signal is greater than or equal to zero, and its previous value was less than zero.

- The output is false (equal to 0), when the input signal is less than zero, or if nonnegative, its previous value was greater than or equal to zero.

Data Type Support   The Detect Rise Nonnegative block accepts signals of any data type supported by Simulink, including fixed-point data types. The block output is uint8.

Parameters and Dialog Box

Initial condition
Set the initial condition of the Boolean expression U/z >= 0.

Characteristics

Direct Feedthrough	Yes
Scalar Expansion	Yes

See Also   Detect Change, Detect Decrease, Detect Fall Negative, Detect Fall Nonpositive, Detect Increase, Detect Rise Positive

Detect Rise Positive

Purpose   Detect a rising edge when a signal's value increases to a strictly positive value, and its previous value was nonpositive

Library   Logic and Bit Operations
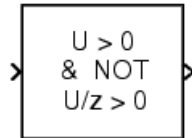
Description   The Detect Rise Positive block determines if the input is strictly positive, and its previous value was nonpositive where

- The output is true (equal to 1), when the input signal is greater than zero, and its previous value was less than zero.

- The output is false (equal to 0), when the input is negative or zero, or if the input is positive, its previous value was also positive.

Data Type Support   The Detect Rise Positive block accepts signals of any data type supported by Simulink, including fixed-point data types. The block output is uint8.

Parameters and Dialog Box

Initial condition
> Set the initial condition of the Boolean expression U/z > 0.

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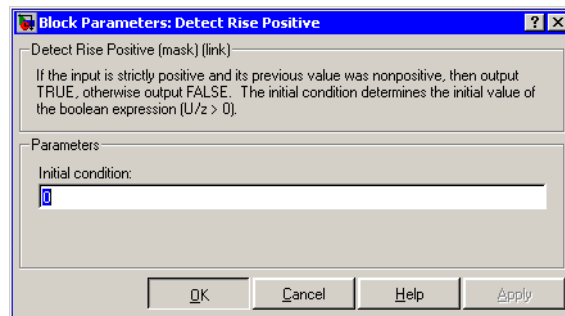
Characteristics

Direct Feedthrough	Yes
Scalar Expansion	Yes

See Also   Detect Change, Detect Decrease, Detect Fall Negative, Detect Fall Nonpositive, Detect Increase, Detect Rise Nonnegative

Difference

Purpose   Calculate the change in a signal over one time step

Library   Discrete

Description   The Difference block outputs the current input value minus the previous input value.

$$\frac{z-1}{z}$$
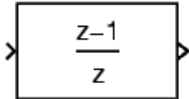
Data Type Support   The Difference block accepts signals of any data type supported by Simulink, including fixed-point data types.

Parameters and Dialog Box   The **Main** pane of the Difference block dialog appears as follows:
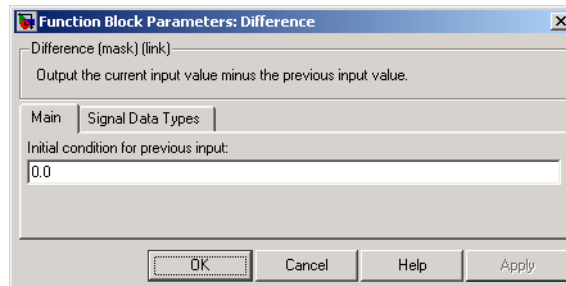
Initial condition for previous output
>   Set the initial condition for the previous output.

The **Signal Data Types** pane of the Difference block dialog appears as follows:

Output data type and scaling
> Specify the output data type and scaling via the dialog box, or
> inherit the data type and scaling from an internal rule or by
> backpropagation.

Output data type
> Set the output data type. This parameter is only visible if you
> select Specify via dialog for the **Output data type and
> scaling** parameter.

Output scaling
> Set the output scaling using either binary point-only or [Slope
> Bias] scaling. This parameter is only visible if you select Specify
> via dialog for the **Output data type and scaling** parameter.

Lock output scaling so autoscaling tool can't change it
> If you select this check box, the output scaling is locked.

Round toward
> Rounding mode for the fixed-point output.

Saturate to max or min when overflows occur
> If selected, fixed-point overflows saturate.

Difference

Characteristics

Direct Feedthrough	Yes
Scalar Expansion	Yes, of inputs and gain

Purpose   Output simulation time at the specified sampling interval

Library   Sources

Description   The Digital Clock block outputs the simulation time only at the specified
sampling interval. At other times, the output is held at the previous
value.

12:34 ▷
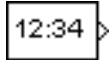
Use this block rather than the Clock block (which outputs continuous
time) when you need the current time within a discrete system.

Data Type Support   The Digital Clock block outputs a real signal of type `double`.

Parameters and Dialog Box
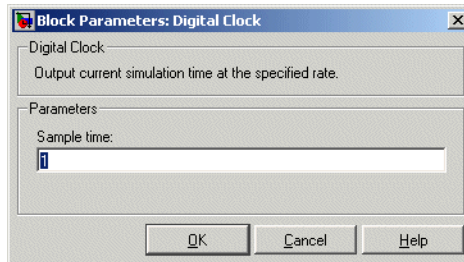
Sample time
The sampling interval. The default value is 1 second. See
Specifying Sample Time in the "How Simulink Works" chapter of
the Using Simulink documentation.

Characteristics

Sample Time	Specified in the **Sample time** parameter
Scalar Expansion	No
Dimensionalized	No
Zero Crossing	No

Direct Lookup Table (n-D)

Purpose   Index into an N-dimensional table to retrieve an element, column, or 2-D matrix

Library   Lookup Tables

Description
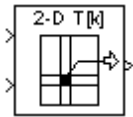
The Direct Lookup Table (n-D) block uses its block inputs as zero-based indices into an n-D table. The number of inputs varies with the shape of the output desired. The output can be an element, a column, or a 2-D matrix. The lookup table uses zero-based indexing, so integer data types can fully address their range. For example, a table dimension using the `uint8` data type can address all 256 elements.

You define a set of output values as the **Table data** parameter. You specify what object the inputs select from the table: an element, a column, or a 2-D matrix. The first input specifies the zero-based index to the first dimension higher than the number of dimensions in the output, the second input specifies the index to the next table dimension, and so on, as shown by this figure:
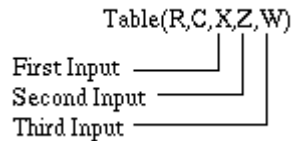
The figure shows a 5-D table with an output shape set to "2-D Matrix"; the output is a 2-D Matrix with R rows and C columns.

This figure shows the set of all the different icons that the Direct Lookup Table block shows (depending on the options you choose in the block's dialog box).
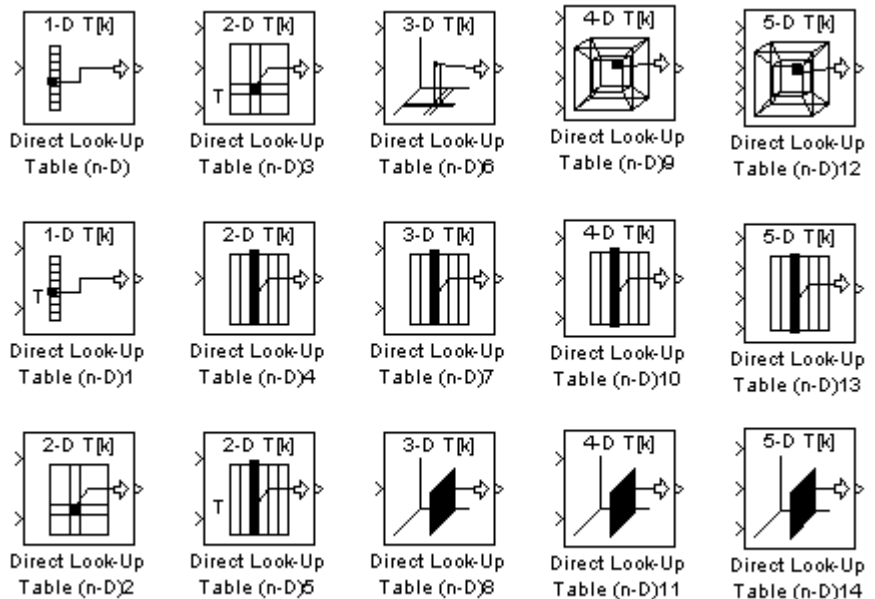
With dimensions higher than 4, the icon matches the 4-D icons, but shows the exact number of dimensions in the top text, e.g., "8-D T[k]." The top row of icons is used when the block output is made from one or more single-element lookups on the table. The blocks labeled "n-D Direct Table Lookup5," 6, 8, and 12 are configured to extract a column from the table, and the two blocks ending in 7 and 9 are extracting a plane from the table. Blocks in the figure ending in 10, 11, and 12 are configured to have the table be an input instead of a parameter.

Example

In this example, the block parameters are defined as

```
Inputs select this object from table:   "Column"
Table data:  int16(a)
```

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Direct Lookup Table (n-D)

where a is a 4-D array of linearly increasing numbers calculated using MATLAB.

```
a = ones(20,4,5,7); L = prod(size(a));
a(1:L) = [1:L]';
```

The figure shows the block outputting a vector of the 20 values in the second column of the fourth element of the third dimension from the third element of the fourth dimension.
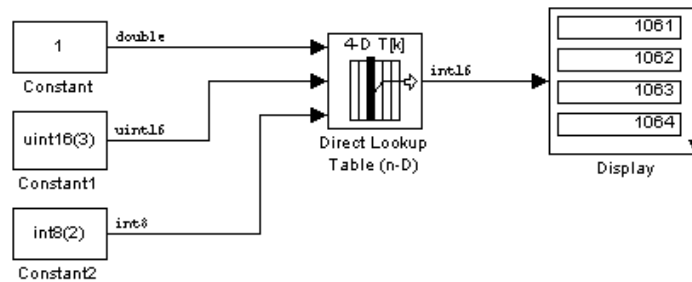
Note that the output has the same data type as the table, i.e., int16. Also note that the block uses zero-based indexing. The output values in this example can be calculated manually in MATLAB (which uses 1-based indexing):

```
a(:,1+1,1+3,1+2)

ans =

        1061
        1062
        1063
        1064
        1065
        1066
        1067
        1068
        1069
```

```
1070
1071
1072
1073
1074
1075
1076
1077
1078
1079
1080
```

Data Type Support

The Direct Lookup Table (n-D) block accepts mixed-type signals of data type supported by Simulink. For a discussion on the data types supported by Simulink, see "Data Types Supported by Simulink" in the "Working with Data" chapter of the Using Simulink documentation.

The output type can differ from the input type and can be any of the types listed for input; the output type is inherited from the data type of the **Table data** parameter.

In the case that the table comes into the block on an input port, the output port type is inherited from the table input port. Inputs for indexing must be real; table data can be complex.

Direct Lookup Table (n-D)

Parameters and Dialog Box
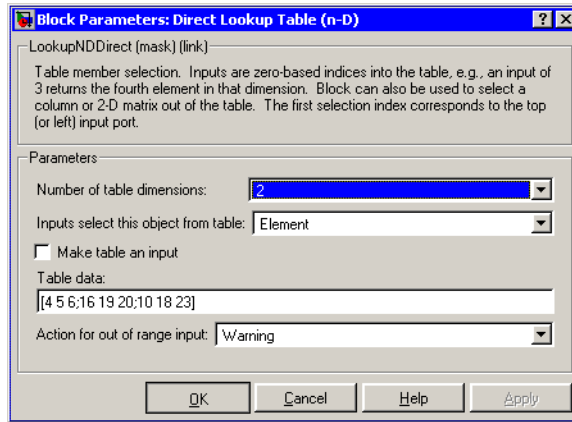
Number of table dimensions

The number of dimensions that the **Table data** parameter must have. This determines the number of independent variables for the table and hence the number of inputs to the block. The options are 1, 2, 3, 4, or More dimensions. If you choose More, the dialog box displays an edit field, **Explicit number of table dimensions**, that allows you to enter a number of dimensions.

Explicit number of table dimensions

This field appears if you select more as the value of the **Number of table dimensions**. Enter the number of table dimensions in this field.

Inputs select this object from table

Specify whether the output data is a single element, a column, or a 2-D matrix. The number of ports changes for each selection:

Element — # of ports = # of dimensions

Column — # of ports = # of dimensions - 1

2-D matrix — # of ports = # of dimensions - 2

This numbering agrees with MATLAB indexing. For example, if you have a 4-D table of data, to access a single element you must specify four indices, as in `array(1,2,3,4)`. To specify a column, you need three indices, as in `array(:,2,3,4)`. Finally, to specify a 2-D matrix, you only need two indices, as in `array(:,:,3,4)`.

Make table an input
Selecting this box forces the Direct Lookup Table (n-D) block to ignore the Table Data parameter. Instead, a new port appears with "T" next to it. Use this port to input table data.

Table data
The table of output values. The matrix size must match the dimensions defined by the **Number of table dimensions** parameter or by the **Explicit number of dimensions** parameter when the number of dimensions exceeds four. During block diagram editing, you can leave the **Table data** field empty, but for running the simulation, you must match the number of dimensions in the **Table data** to the **Number of table dimensions**. For information about how to construct multidimensional arrays in MATLAB, see "Multidimensional Arrays" in the MATLAB online documentation. (This field appears only if **Make table an input** is not selected.)

Action for out of range input
None, Warning, Error.

Characteristics

Direct Feedthrough	Yes
Sample Time	Inherited from driving blocks
Scalar Expansion	For scalar lookups only (not when returning a column or a 2-D matrix from the table)

Direct Lookup Table (n-D)

Dimensionalized	For scalar lookups only (not when returning a column or a 2-D matrix from the table)
Zero Crossing	No

Purpose

Compute a discrete time derivative

Library

Discrete

Description

The Discrete Derivative block computes an optionally scaled discrete time derivative as follows
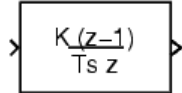
$$y(t_n) = \frac{Ku(t_n)}{T_s} - \frac{Ku(t_{n-1})}{T_s}$$

where $y(t_n)$ and $u(t_n)$ are the block's input and output at the current time step, respectively, $u(t_{n-1})$ is the block's input at the previous time step, K is a scaling factor, and T_s is the simulation's discrete step size, which must be fixed.

Data Type Support

The Discrete Derivative block supports all Simulink data types, including fixed-point data types.

For a discussion on the data types supported by Simulink, see "Data Types Supported by Simulink" in the "Working with Data" chapter of the Using Simulink documentation.

Discrete Derivative

Parameters and Dialog Box

The **Main** pane of the Discrete Derivative block dialog appears as follows:
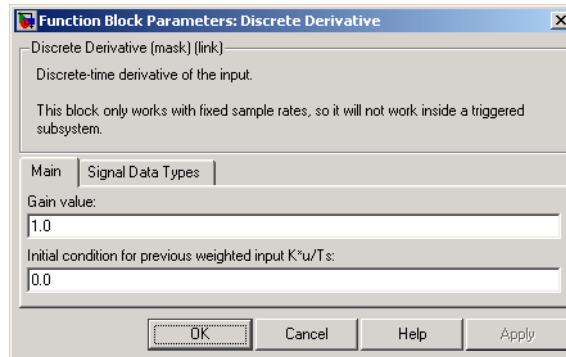
Gain value

> Scaling factor used to weight the block's input at the current time step.

Initial condition for previous weighted input K*u/Ts

> Set the initial condition for the previous scaled input.

The **Signal Data Types** pane of the Discrete Derivative block dialog box appears as follows:

Output data type and scaling
    Specify the output data type and scaling via the dialog box, or
    inherit the data type and scaling from the driving block or by
    backpropagation. If you choose Specify via dialog, the **Output
    data type** and **Output scaling** parameters appear.

Output data type
    Set the output data type. This parameter is only visible if you
    select Specify via dialog for the **Output data type and
    scaling** parameter.

Output scaling
    Set the output scaling using either binary point-only or [Slope
    Bias] scaling. This parameter is only visible if you select Specify
    via dialog for the **Output data type and scaling** parameter.

Lock output scaling so autoscaling tool can't change it
    If you select this check box, the output scaling is locked.

Round toward
    Select the rounding mode for fixed-point operations.

Discrete Derivative

Saturate to max or min when overflows occur
If selected, fixed-point overflows saturate.

Characteristics

Direct Feedthrough	Yes
Scalar Expansion	Yes, of inputs and gain

See Also   Derivative

Purpose   Model IIR and FIR filters

Library   Discrete
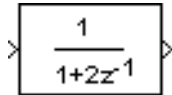
Description   The Discrete Filter block models Infinite Impulse Response (IIR) and Finite Impulse Response (FIR) filters. You specify the filter as a ratio of polynomials in z^{-1}. You can specify that the block have a single output or multiple outputs where the outputs correspond to a set of filters that have the same denominator polynomial but different numerator polynomials.

$$\frac{1}{1+2z^{-1}}$$

Use the **Numerator coefficients** parameter to specify the coefficients of the discrete filter's numerator polynomial or polynomials. Use a vector to specify the coefficients for a single numerator polynomial. Use a matrix to specify the coefficients of multiple numerator polynomials where each row contains the coefficients of one of the polynomials. Use the **Denominator coefficients** parameter to specify the coefficients of the function's denominator polynomial. The value of the **Denominator coefficients** parameter must be a vector of coefficients.

You must specify the coefficients of the numerator and denominator polynomials in ascending powers of z^{-1}. The order of the denominator must be greater than or equal to the order of the numerator.

If you specify a single numerator polynomial, i.e., a vector as the value of the **Numerator coefficients** parameter, the block's output is a scalar signal. If you specify multiple numerator polynomials, i.e., a matrix as the value of the **Numerator coefficients** parameter, the block's output is a vector signal whose width equals the number of matrix rows, i.e., the number or numerator polynomials.

The Discrete Filter block lets you use polynomials in z^{-1} (the delay operator) to represent a discrete system, a method typically used by signal processing engineers. By contrast, the Discrete Transfer Fcn block lets you use polynomials in z to represent a discrete system, the method typically used by control engineers. The two methods are identical when the numerator and denominator polynomials have the same length.

Discrete Filter

The block displays the numerator and denominator according to how they are specified. For a discussion of how Simulink displays the icon, see `Transfer Fcn`.

Data Type Support

The Discrete Filter block accepts and outputs a real signal of type `double`.

Parameters and Dialog Box
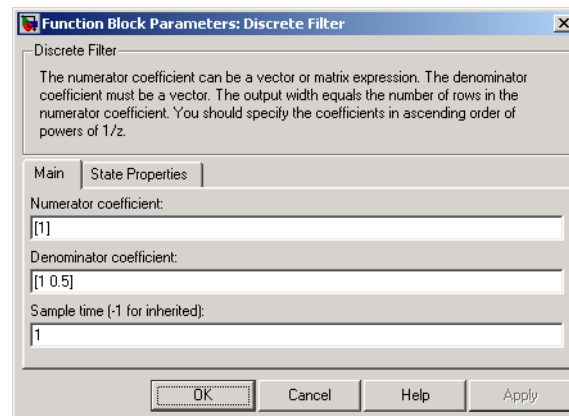
Numerator coefficient

A vector of polynomial coefficients or a matrix of coefficients where each row of coefficients corresponds to a distinct numerator polynomial. You must specify the polynomial coefficients in ascending powers of z^{-1}. If you specify a vector of coefficients, i.e., a single numerator polynomial, the output of the block is a scalar signal. If you specify a matrix of coefficients, i.e., multiple polynomials, the block's output is a vector of signals, each corresponding to the filter consisting off the corresponding numerator polynomial and the denominator polynomial specified by the **Denominator coefficients** parameter. The default is [1].

Denominator coefficient

The vector of denominator coefficients. The default is [1 0.5]. The width of the vector, i.e., the order of the denominator, must

be greater than or equal to the width of the numerator vector or matrix rows, i.e., the order of the numerator.

Sample time
The time interval between samples. See Specifying Sample Time in the "How Simulink Works" chapter of the Using Simulink documentation.

The **State Properties** pane of this block pertains to code generation and has no effect on model simulation. See "Block States: Storing and Interfacing" in the Real-Time Workshop User's Guide for more information.

Characteristics

Direct Feedthrough	Only if the lengths of the **Numerator** and **Denominator** parameters are equal
Sample Time	Specified in the **Sample time** parameter
Scalar Expansion	No
States	Length of **Denominator** parameter -1
Dimensionalized	No
Zero Crossing	No

Discrete State-Space

Purpose   Implement a discrete state-space system

Library   Discrete

Description

The Discrete State-Space block implements the system described

$$x(n+1) = Ax(n) + Bu(n)$$

by $\quad y(n) = Cx(n) + Du(n)$

where u is the input, x is the state, and y is the output. The matrix coefficients must have these characteristics, as illustrated in the following diagram:

- **A** must be an n-by-n matrix, where n is the number of states.
- **B** must be an n-by-m matrix, where m is the number of inputs.
- **C** must be an r-by-n matrix, where r is the number of outputs.
- **D** must be an r-by-m matrix.
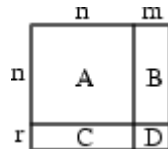
The block accepts one input and generates one output. The input vector width is determined by the number of columns in the B and D matrices. The output vector width is determined by the number of rows in the C and D matrices.

Simulink converts a matrix containing zeros to a sparse matrix for efficient multiplication.

Data Type Support

The Discrete State Space block accepts and outputs a real signal of type `double`.

Parameters and Dialog Box

Function Block Parameters: Discrete State-Space

Discrete State Space

Discrete state-space model:
$$x(n+1) = Ax(n) + Bu(n)$$
$$y(n) = Cx(n) + Du(n)$$

Main | State Properties

A:
1

B:
1

C:
1

D:
1

Initial conditions:
0

Sample time (-1 for inherited):
1

OK | Cancel | Help | Apply
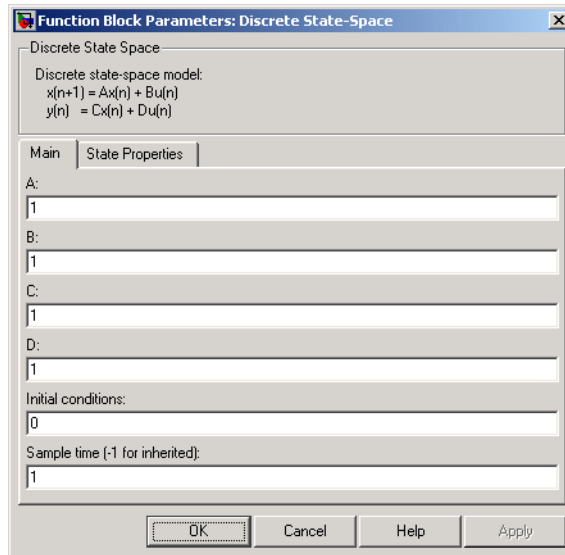
A, B, C, D

The matrix coefficients, as defined in the preceding equations.

Initial conditions

The initial state vector. The default is 0. Simulink does not allow the initial states of this block to be inf or NaN.

Sample time

The time interval between samples. See Specifying Sample Time in the "How Simulink Works" chapter of the Using Simulink documentation.

The **State Properties** pane of this block pertains to code generation and has no effect on model simulation. See "Block States: Storing and Interfacing" in the Real-Time Workshop User's Guide for more information.

Discrete State-Space

Characteristics

Direct Feedthrough	Only if $D \neq 0$
Sample Time	Specified in the **Sample time** parameter
Scalar Expansion	Yes, of the initial conditions
States	Determined by the size of A
Dimensionalized	Yes
Zero Crossing	No

Purpose   Perform discrete-time integration or accumulation of a signal

Library   Discrete

Description   You can use the Discrete-Time Integrator block in place of the Integrator block to create a purely discrete system.

$$\frac{K\ Ts}{z\text{-}1}$$
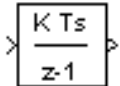
The Discrete-Time Integrator block allows you to

- Define initial conditions on the block dialog box or as input to the block.
- Define an input gain (K) value.
- Output the block state.
- Define upper and lower limits on the integral.
- Reset the state depending on an additional reset input.

These features are described below.

Integration and Accumulation Methods

The block can integrate or accumulate using the Forward Euler, Backward Euler, and Trapezoidal methods. For a given step n, Simulink updates y(n) and x(n+1). In integration mode, T is the block's sample time (delta T in the case of triggered sample time). In accumulation mode, T = 1; the block's sample time determines when the block's output is computed but not the output's value. K is the gain value. Values are clipped according to upper or lower limits.

- Forward Euler method (the default), also known as Forward Rectangular, or left-hand approximation.

  For this method, 1/s is approximated by T/(z-1). The resulting expression for the output of the block at step n is

      y(n) = y(n-1) + K*T*u(n-1)

Discrete-Time Integrator

Let `x(n+1) = x(n) + K*T*u(n)`. The block uses the following steps to compute its output:

```
Step 0:   y(0)   = x(0) = IC (clip if necessary)
    x(1)   = y(0) + K*T*u(0)

Step 1:   y(1)   = x(1)
    x(2)   = x(1) + K*T*u(1)

Step n:   y(n)   = x(n)
    x(n+1) = x(n) + K*T*u(n) (clip if necessary)
```

With this method, input port 1 does not have direct feedthrough.

- Backward Euler method, also known as Backward Rectangular or right-hand approximation.

  For this method, `1/s` is approximated by `T*z/(z-1)`. The resulting expression for the output of the block at step `n` is

  ```
  y(n) = y(n-1) + K*T*u(n)
  ```

  Let `x(n) = y(n-1)`. The block uses the following steps to compute its output

  ```
  Step 0:   y(0)   = x(0) = IC (clipped if necessary)
      x(1)   = y(0)
  ```

  or, depending on **Use initial condition as initial and reset value for** parameter:

  ```
  Step 0:   y(0)   = x(0) = IC (clipped if necessary)
      x(1)   = y(0) = x(0) + K*T*u(0)

  Step 1:   y(1)   = x(1) + K*T*u(1)
      x(2)   = y(1)
  ```

```
Step n:   y(n)  = x(n) + K*T*u(n)
   x(n+1) = y(n)
```

With this method, input port 1 has direct feedthrough.

- Trapezoidal method. For this method, 1/s is approximated by

```
T/2*(z+1)/(z-1)
```

When T is fixed (equal to the sampling period), let

```
x(n) = y(n-1) + K*T/2 * u(n-1)
```

The block uses the following steps to compute its output

```
Step 0:   y(0)  = x(0) = IC (clipped if necessary)
   x(1)   = y(0) + K*T/2 * u(0)
```

or, depending on **Use initial condition as initial and
reset value for**
parameter:

```
Step 0:   y(0)  = x(0) = IC (clipped if necessary)
   x(1)   = y(0) = x(0) + K*T/2*u(0)

Step 1:   y(1)  = x(1) + K*T/2 * u(1)
   x(2)   = y(1) + K*T/2 * u(1)

Step n:   y(n)  = x(n) + K*T/2 * u(n)
   x(n+1) = y(n) + K*T/2 * u(n)
```

Here, x(n+1) is the best estimate of the next output. It isn't quite
the state, in the sense that x(n) != y(n).

If T is variable (i.e. obtained from the triggering times), the block
uses the following algorithm to compute its outputs

```
Step 0:   y(0)  = x(0) = IC (clipped if necessary)
   x(1)   = y(0)
```

```
             or, depending on Use initial condition as initial and
             reset value for
             parameter:

             Step 0:   y(0)   = x(0) = IC (clipped if necessary)
                x(1)   = y(0) = x(0) + K*T/2*u(0)

             Step 1:   y(1)   = x(1) + T/2 * (u(1) + u(0))
                x(2)   = y(1)

             Step n:   y(n)   = x(n) + T/2 * (u(n) + u(n-1))
                x(n+1) = y(n)
```

With this method, input port 1 has direct feedthrough.

The block reflects the selected integration or accumulation method, as this figure shows.
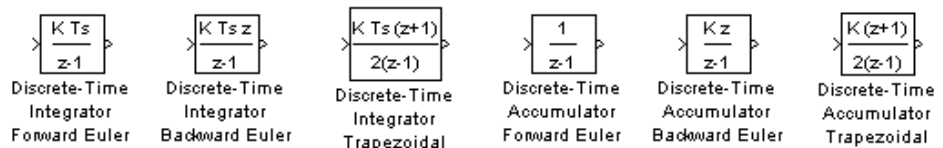
Defining Initial Conditions

You can define the initial conditions as a parameter on the block dialog box or input them from an external signal:

- To define the initial conditions as a block parameter, specify the **Initial condition source** parameter as internal and enter the value in the **Initial condition** parameter field.

- To provide the initial conditions from an external source, specify the **Initial condition source** parameter as external. An additional input port appears under the block input, as shown in this figure.
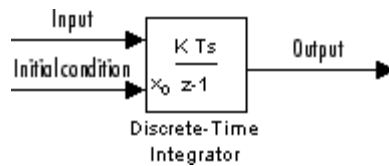
Using the State Port

In two situations, you must use the state port instead of the output port:

- When the output of the block is fed back into the block through the reset port or the initial condition port, causing an algebraic loop. For an example of this situation, see the `bounce` model.

- When you want to pass the state from one conditionally executed subsystem to another, which can cause timing problems. For an example of this situation, see the `clutch` model.

You can correct these problems by passing the state through the state port rather than the output port. Although the values are the same, Simulink generates them at slightly different times, which protects your model from these problems. You output the block state by selecting the **Show state port** check box.

By default, the state port appears on the top of the block, as shown in this figure.
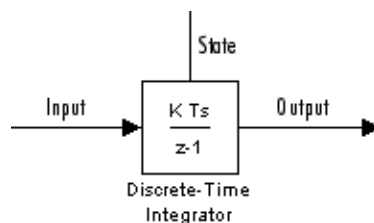
Limiting the Integral

To prevent the output from exceeding specifiable levels, select the **Limit output** check box and enter the limits in the appropriate parameter

Discrete-Time Integrator

fields. Doing so causes the block to function as a limited integrator. When the output reaches the limits, the integral action is turned off to prevent integral wind up. During a simulation, you can change the limits but you cannot change whether the output is limited. The output is determined as follows:

- When the integral is less than or equal to the **Lower saturation limit** and the input is negative, the output is held at the **Lower saturation limit**.

- When the integral is between the **Lower saturation limit** and the **Upper saturation limit**, the output is the integral.

- When the integral is greater than or equal to the **Upper saturation limit** and the input is positive, the output is held at the **Upper saturation limit**.

To generate a signal that indicates when the state is being limited, select the **Show saturation port** check box. A saturation port appears below the block output port, as shown in this figure.
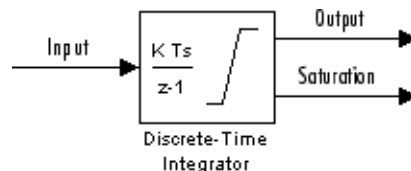
The signal has one of three values:

- 1 indicates that the upper limit is being applied.

- 0 indicates that the integral is not limited.

- -1 indicates that the lower limit is being applied.

Resetting the State

The block can reset its state to the specified initial condition, based on an external signal. To cause the block to reset its state, select one of the

External reset parameter choices. A trigger port appears below the block's input port and indicates the trigger type, as shown in this figure.
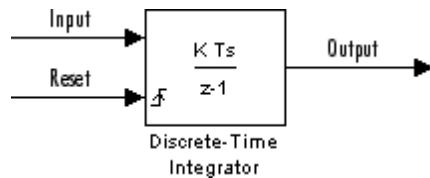
The reset port has direct feedthrough. If the block output is fed back into this port, either directly or through a series of blocks with direct feedthrough, an algebraic loop results. To resolve this loop, feed the output of the block's state port into the reset port instead. To access the block's state, select the **Show state port** check box.

Reset Trigger Types

The **External reset** parameter lets you determine the attribute of the reset signal that triggers the reset. The trigger options include:

- rising

  Resets the state when the reset signal has a rising edge. For example, the following figure shows the effect that a rising reset trigger has on backward Euler integration.
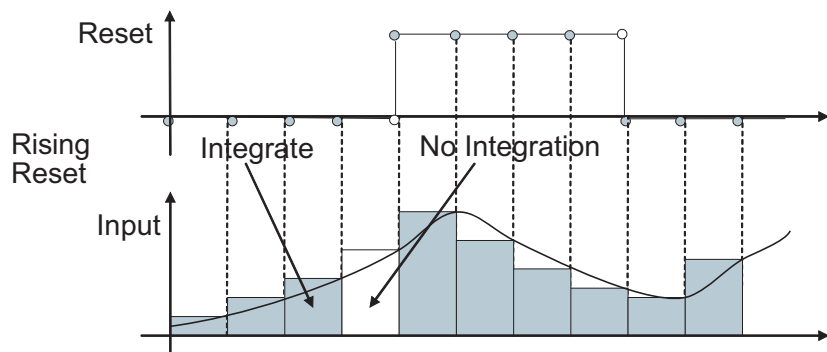
Discrete-Time Integrator

- falling

  Resets the state when the reset signal has a falling edge. For example, the following figure shows the effect that a falling reset trigger has on backward Euler integration.
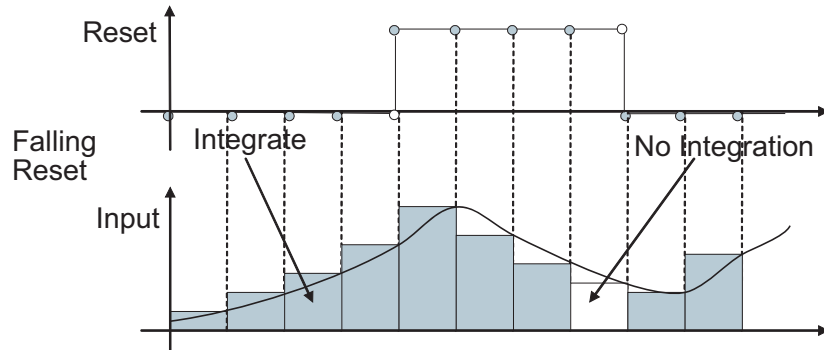
- either

  Resets the state when the reset signal rises or falls. For example, the following figure shows the effect that an either reset trigger has on backward Euler integration.
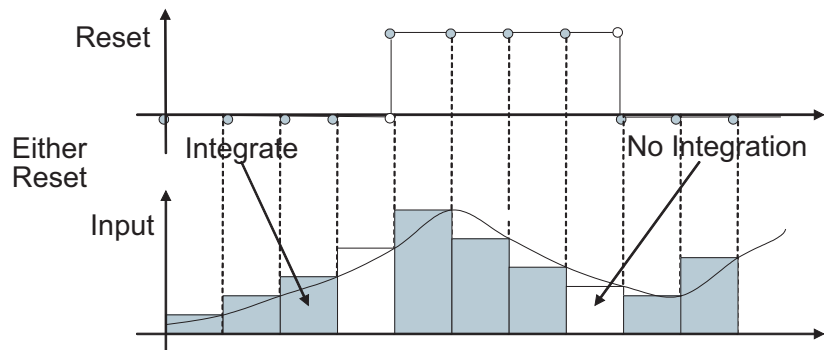
- level

Resets and holds the output to the initial condition while the reset signal is nonzero. For example, the following figure shows the effect that a level reset trigger has on backward Euler integration.
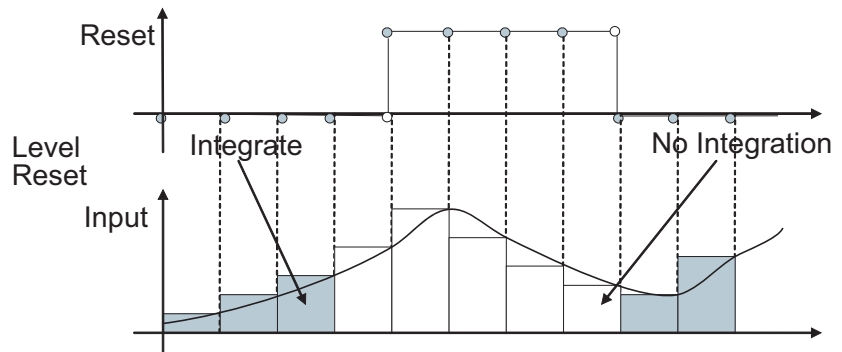
- `sampled level`

  Resets the output to the initial condition when the reset signal is nonzero. For example, the following figure shows the effect that a sampled level reset trigger has on backward Euler integration.
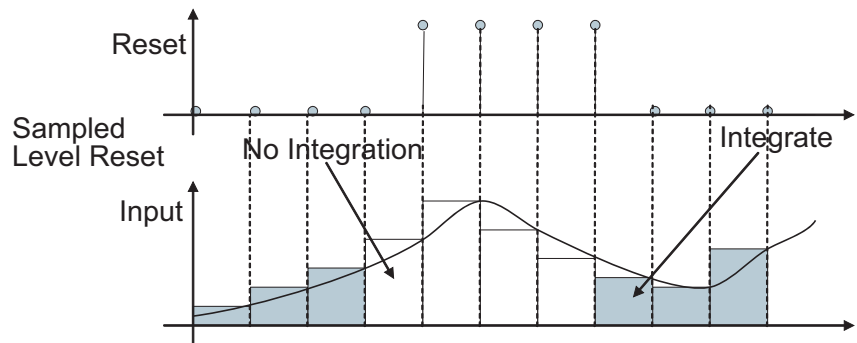
Discrete-Time Integrator

> **Note** The `sampled level` reset option requires fewer computations and hence is more efficient than the `level` reset option. However, the `level` reset option, but may introduces a discontinuity when integration resumes.

Choosing All Options

When all options are selected, the icon looks like this.
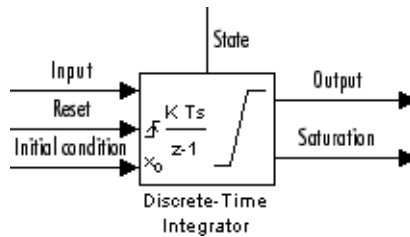
Data Type Support

The Discrete-Time Integrator block accepts real signals of any data type supported by Simulink, including fixed-point data types.

Parameters and Dialog Box

The **Main** pane of the Discrete-Time Integrator block dialog appears as follows:
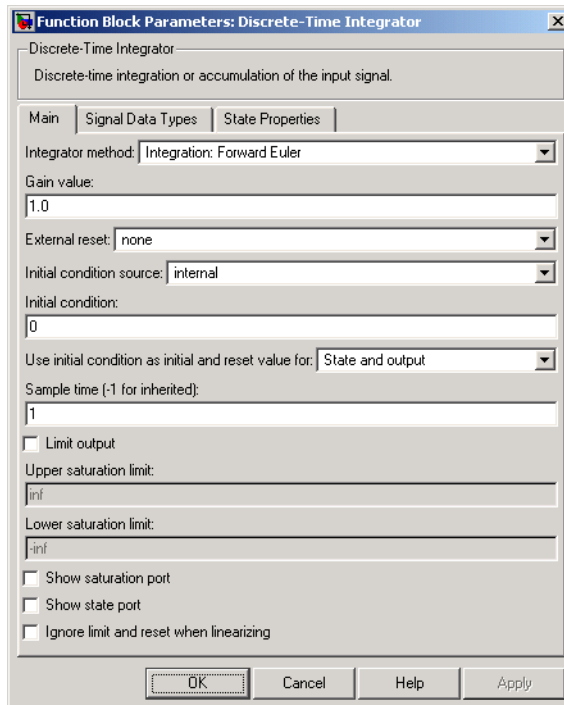
Integrator method

Specify the integration or accumulation method.

Gain value

Specify a value by which to multiply the integrator input. Specifying a value other than 1.0 (the default) is semantically equivalent to connecting a signal to the input of the integrator via a Gain block, i.e., to

Discrete-Time Integrator
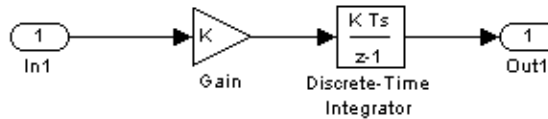
Using this parameter to specify the input gain eliminates a multiplication operation in the generated code. Realizing this benefit, however, requires that this parameter be nontunable. Accordingly, the Real-Time Workshop generates a warning during code generation if the **Model Parameter Configuration** dialog box for this model declares this parameter to be tunable. If you want to tune the input gain, set this parameter to 1.0 and use an external Gain block to specify the input gain.

External reset

Resets the states to their initial conditions when a trigger event occurs in the reset signal. See "Resetting the State" on page 2-216 for more information.

Initial condition source

Gets the states' initial conditions from the **Initial condition** parameter (`internal`) or from an external block (`external`). Simulink does not allow the initial condition of this block to be `inf` or `NaN`.

Initial condition

The states' initial conditions. This parameter is only available if the **Initial condition source** parameter is set to `internal`. Simulink does not allow the initial condition of this block to be `inf` or `NaN`.

Use initial condition as initial and reset value for

When you set this parameter to `State and output`,

```
y(0) = IC

x(0) = IC
```

or at reset

```
y(n) = IC
```

```
x(n) = IC
```

When you set this parameter to `State only (most efficient)`,

```
x(0) = IC
```

or at reset

```
x(n) = IC
```

Sample time
> The time interval between samples. The default is `1`. In accumulation mode, the sample time specifies when the block's output is computed. See Specifying Sample Time in the "How Simulink Works" chapter of the Using Simulink documentation.

Limit output
> If selected, limits the block's output to a value between the **Lower saturation limit** and **Upper saturation limit** parameters.

Upper saturation limit
> The upper limit for the integral. This parameter is only available if you select the **Limit output** parameter.

Lower saturation limit
> The lower limit for the integral. This parameter is only available if you select the **Limit output** parameter.

Show saturation port
> If selected, adds a saturation output port to the block.

Show state port
> If selected, adds an output port to the block for the block's state.

Discrete-Time Integrator

Ignore limit and reset when linearizing
> Select this option to cause Simulink linearization commands to treat this block as unresettable and as having no limits on its output, regardless of the settings of the block's reset and output limitation options. This allows you to linearize a model around an operating point that causes the integrator to reset or saturate.

The **Signal Data Types** pane of the Discrete-Time Integrator block dialog appears as follows:

Output data type mode
> Specify the output data type and scaling via the dialog box, or inherit the data type and scaling from the driving block or by backpropagation.

Output data type

Specify any data type, including fixed-point data types. This parameter is only visible if you select `Specify via dialog` for the **Output data type and scaling** parameter.

Output scaling value

Set the output scaling using either binary point-only or [Slope Bias] scaling. This parameter is only visible if you select `Specify via dialog` for the **Output data type and scaling** parameter.

Lock output scaling against changes by the autoscaling tool

Select to lock scaling of outputs. This parameter is only visible if you select `Specify via dialog` for the **Output data type mode** parameter.

Round integer calculations toward

Select the rounding mode for fixed-point operations.

Saturate on integer overflow

Select to have overflows saturate.

The **State Properties** pane of this block pertains to code generation and has no effect on model simulation. See "Block States: Storing and Interfacing" in the Real-Time Workshop User's Guide for more information.

Characteristics

Direct Feedthrough	Yes, of the reset and external initial condition source ports. The input has direct feedthrough for every integration method except forward Euler and accumulation forward Euler.
Sample Time	Specified in the **Sample time** parameter
Scalar Expansion	Yes, of parameters
States	Inherited from driving block and parameter

Discrete-Time Integrator

Dimensionalized	Yes
Zero Crossing	No

Purpose   Implement a discrete transfer function

Library   Discrete

Description

$$\dfrac{1}{z+0.5}$$

The Discrete Transfer Fcn block implements the *z*-transform transfer function described by the following equations:
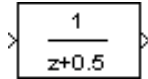
$$H(z) = \frac{num(z)}{den(z)} = \frac{num_0 z^n + num_1 z^{n-1} + \dots + num_m z^{n-m}}{den_0 z^n + den_1 z^{n-1} + \dots + den_n}$$

where *m+1* and *n+1* are the number of numerator and denominator coefficients, respectively. *num* and *den* contain the coefficients of the numerator and denominator in descending powers of *z*. *num* can be a vector or matrix, *den* must be a vector, and both are specified as parameters on the block dialog box. The order of the denominator must be greater than or equal to the order of the numerator.

Block input is scalar; output width is equal to the number of rows in the numerator.

The Discrete Transfer Fcn block represents the method typically used by control engineers, representing discrete systems as polynomials in *z*. The Discrete Filter block represents the method typically used by signal processing engineers, who describe digital filters using polynomials in z^{-1} (the delay operator). The two methods are identical when the numerator is the same length as the denominator.

The Discrete Transfer Fcn block displays the numerator and denominator within its icon depending on how they are specified. See `Transfer Fcn` for more information.

Data Type Support   The Discrete Transfer Function block accepts and outputs real signals of type `double`.

Discrete Transfer Fcn

Parameters and Dialog Box
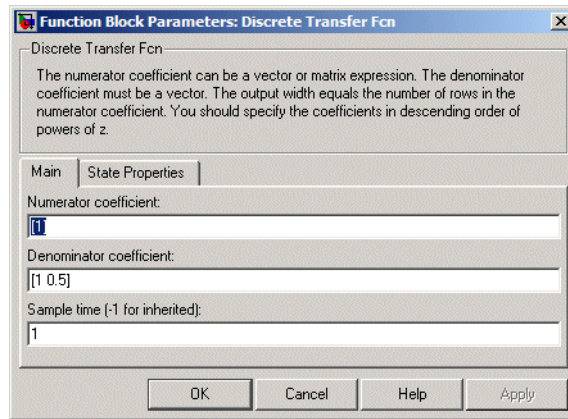
Numerator coefficient

> The row vector of numerator coefficients. A matrix with multiple rows can be specified to generate multiple output. The default is [1].

Denominator coefficient

> The row vector of denominator coefficients. The default is [1 0.5].

Sample time

> The time interval between samples. The default is 1. See Specifying Sample Time in the "How Simulink Works" chapter of the Using Simulink documentation.

The **State Properties** pane of this block pertains to code generation and has no effect on model simulation. See "Block States: Storing and Interfacing" in the Real-Time Workshop User's Guide for more information.

Characteristics

Direct Feedthrough	Only if the lengths of the **Numerator** and **Denominator** parameters are equal
Sample Time	Specified in the **Sample time** parameter
Scalar Expansion	No
States	Length of **Denominator** parameter -1
Dimensionalized	No
Zero Crossing	No

Discrete Zero-Pole

Purpose   Model a system defined by the zeros and poles of a discrete transfer function

Library   Discrete

Description   The Discrete Zero-Pole block models a discrete system defined by the zeros, poles, and gain of a *z*-domain transfer function. This block assumes that the transfer function has the following form
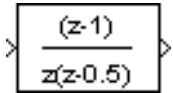
$$H(z) = K\frac{Z(z)}{P(z)} = K\frac{(z - Z_1)(z - Z_2)...(z - Z_m)}{(z - P_1)(z - P_2)...(z - P_n)}$$

where *Z* represents the zeros vector, *P* the poles vector, and *K* the gain. The number of poles must be greater than or equal to the number of zeros ($n \geq m$). If the poles and zeros are complex, they must be complex conjugate pairs.

The block displays the transfer function depending on how the parameters are specified. See Zero-Pole for more information.

Data Type Support   The Discrete Zero-Pole block accepts and outputs real signals of type double.

Parameters and Dialog Box
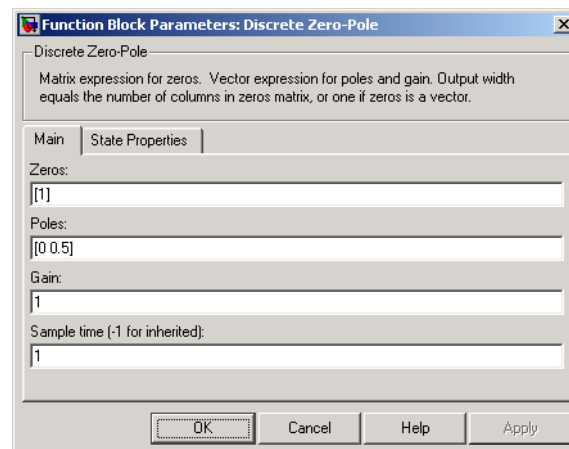
Zeros

    The matrix of zeros. The default is [1].

Poles

    The vector of poles. The default is [0 0.5].

Gain

    The gain. The default is 1.

Sample time

    The time interval between samples. See Specifying Sample Time in the "How Simulink Works" chapter of the Using Simulink documentation.

The **State Properties** pane of this block pertains to code generation and has no effect on model simulation. See "Block States: Storing and Interfacing" in the Real-Time Workshop User's Guide for more information.

Characteristics	Direct Feedthrough	Yes, if the number of zeros and poles are equal
	Sample Time	Specified in the **Sample time** parameter
	Scalar Expansion	No
	States	Length of **Poles** vector
	Dimensionalized	No
	Zero Crossing	No

Display

Purpose   Show the value of the input

Library   Sinks

Description   The Display block shows the value of its input on its icon.
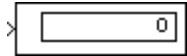
You control the display format using the **Format** parameter:

- short — displays a 5-digit scaled value with fixed decimal point
- long — displays a 15-digit scaled value with fixed decimal point
- short_e — displays a 5-digit value with a floating decimal point
- long_e — displays a 16-digit value with a floating decimal point
- bank — displays a value in fixed dollars and cents format (but with no $ or commas)
- hex (Stored Integer) — displays the stored integer value of a fixed-point input in hexadecimal format
- binary (Stored Integer) — displays the stored integer value of a fixed-point input in binary format
- decimal (Stored Integer) — displays the stored integer value of a fixed-point input in decimal format
- octal (Stored Integer) — displays the stored integer value of a fixed-point input in octal format

The amount of data displayed and the time steps at which the data is displayed are determined by block parameters:

- The **Decimation** parameter enables you to display data at every nth sample, where n is the decimation factor. The default decimation, 1, displays data at every time step.

- The **Sample time** parameter enables you to specify a sampling interval at which to display points. This parameter is useful when you are using a variable-step solver where the interval between time steps might not be the same. The default value of -1 causes the

block to ignore the sampling interval when determining the points to display.

If the block input is an array, you can resize the block to show more than just the first element. You can resize the block vertically or horizontally; the block adds display fields in the appropriate direction. A black triangle indicates that the block is not displaying all input array elements. For example, the following figure shows a model that passes a vector (1-D array) to a Display block. The black triangle on the Display block indicates more data to be displayed.
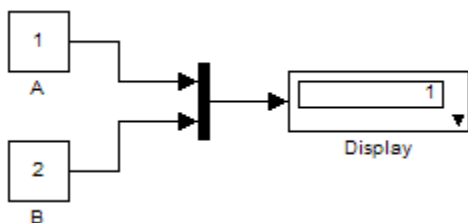
The following figure shows the resized block displaying both input elements.
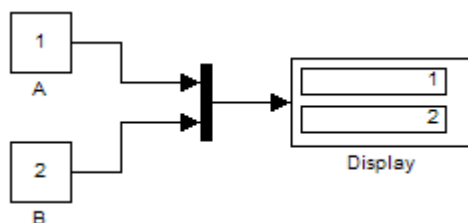
Note that the Display block displays up to ten columns of a matrix.

Display Abbreviations

The following abbreviations appear on the Display block to help you identify the format of the number being displayed.

Display

Symbol	Description
(SI)	This alerts you to the fact that the number being displayed is the stored integer value. This symbol does not appear when the signal is of an integer data type.
hex	The number being displayed is in hexadecimal format.
bin	The number being displayed is in binary format.
oct	The number being displayed is in octal format.

Floating Display

To use the block as a floating display, select the **Floating display** check box. The block's input port disappears and the block displays the value of the signal on a selected line. If you select the **Floating display** option, you must turn off the signal storage reuse feature in Simulink. See "Signal storage reuse" in the "Running Simulations" chapter of the Using Simulink documentation.

Data Type Support

The Display block accepts and outputs real or complex signals of any data type supported by Simulink, including fixed-point data types.

For a discussion on the data types supported by Simulink, see "Data Types Supported by Simulink" in the "Working with Data" chapter of the Using Simulink documentation.

Parameters and Dialog Box
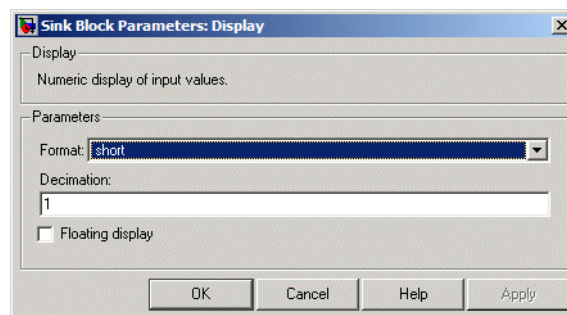
Format

Specify the format of the data displayed, as discussed in
Description. The default is short.

Decimation

Specify how often to display data. The default value, 1, displays
every input point.

Floating display

If selected, the block's input port disappears, which enables the
block to be used as a floating Display block.

Characteristics

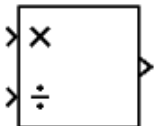| Sample Time	Specified in the **Sample time** parameter
Dimensionalized	Yes

Divide

Purpose   Multiply or divide inputs

Library   Math Operations

Description   The Divide block is an implementation of the Product block. See
                    `Product` for more information.

DocBlock

Purpose	Create text that documents the model and save the text with the model
Library	Model-Wide Utilities

Description The DocBlock allows you to create and edit text that documents a model and save that text with the model. Double-clicking an instance of this block creates a temporary file containing the text associated with this block and opens the file in an appropriate editor. Use the editor to modify the text and save the file. Simulink stores the contents of the saved file in the model file. The DocBlock supports ASCII text, Rich Text Format (RTF), and HTML document types.

Data Type Support Not applicable.

Parameters and Dialog Box Double-clicking an instance of the DocBlock opens a text editor. To access the DocBlock parameter dialog box, select the block in the Model Editor and then select **Mask Parameters** from either the **Edit** menu or the block's context menu.
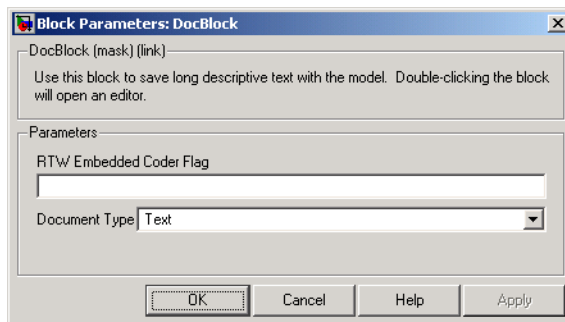
RTW Embedded Coder Flag
> Enter a template symbol name in this field. Real-Time Workshop Embedded Coder uses this symbol to add comments to the code generated from the model. See "Adding Global Comments"

DocBlock

under "Module Packaging Features" in the Real-Time Workshop Embedded Coder documentation for more information.

Document Type

Specify the type of document associated with the DocBlock. By default, the DocBlock uses text (i.e., ASCII text). In this case, double-clicking the DocBlock opens the text editor specified in the MATLAB **Preferences** dialog box. If you specify either RTF or HTML, double-clicking the DocBlock opens the default editor for that document type as defined by your operating system's file associations.

Characteristics Not applicable

Purpose   Generate the dot product of two vectors

Library   Math Operations

Description   The Dot Product block generates the dot product of the vectors at its inputs. The scalar output, y, is equal to the MATLAB operation
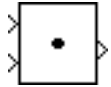
```
y = sum(conj(u1) .* u2 )
```

where `u1` and `u2` represent the vectors at the block's top and bottom inputs, respectively. The inputs can be vectors, column vectors (single-column matrices), or scalars. If both inputs are vectors or column vectors, they must be the same length. If `u1` and `u2` are both column vectors, the block outputs the equivalent of the MATLAB expression `u1'*u2`.

The elements of the input vectors can be real- or complex-valued signals. The signal type (complex or real) of the output depends on the signal types of the inputs.

Input 1	Input 2	Output
real	real	real
real	complex	complex
complex	real	complex
complex	complex	complex

To perform element-by-element multiplication without summing, use the Product block.

Data Type Support   The Dot Product block accepts and outputs signals of any data type supported by Simulink, including fixed-point data types.

For a discussion on the data types supported by Simulink, see "Data Types Supported by Simulink".

Dot Product

Parameters and Dialog Box

Require all inputs to have same data type
Select to require all inputs to have the same data type.

Output data type mode
Set the data type and scaling of the output to be the same as that of the first input, or to be inherited via an internal rule or by backpropagation. Alternatively, choose to specify the data type and scaling of the output through the **Output data type** and **Output scaling value** parameters.

Output data type
Set the output data type. This parameter is only visible if you select Specify via dialog for the **Output data type mode** parameter.

Output scaling
Set the output scaling using either binary point-only or [Slope Bias] scaling. This parameter is only visible if you select Specify via dialog for the **Output data type and scaling** parameter.

Lock output scaling against changes by the autoscaling tool
Select to lock scaling of outputs. This parameter is only visible if you select `Specify via dialog` for the **Output data type mode** parameter.

Round integer calculations toward
Select the rounding mode for fixed-point operations.

Saturate on integer overflow
Select to have overflows saturate.

Characteristics

Direct Feedthrough	Yes
Sample Time	Inherited from driving block
Scalar Expansion	No
States	0
Dimensionalized	Yes
Zero Crossing	No

Embedded MATLAB Function

Purpose   Include MATLAB code in models that generate embeddable C code.

Library   User-Defined Functions

Description

Embedded
MATLAB Function

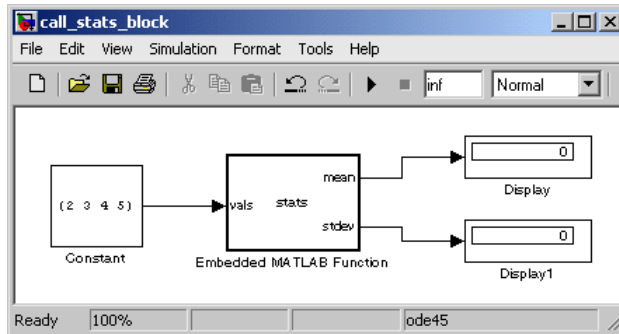An Embedded MATLAB Function block lets you compose a MATLAB function in Simulink like the following example:

The MATLAB function you create executes for simulation and generates code for a Real-Time Workshop target. If you are new to Simulink and MATLAB, see "Using the Embedded MATLAB Function Block" in Simulink documentation for a comprehensive overview including a step-by-step example.

You create the MATLAB function in the **Embedded MATLAB Editor**. To learn about this editor's capabilities see "Using the Embedded MATLAB Editor."

You specify input and output data to the Embedded MATLAB Function block in the function header as arguments and return values. Notice that the argument and return values of the preceding example function correspond to the inputs and outputs of the block in Simulink.

The Embedded MATLAB Function block supports a subset of the language for which it can generate efficient embeddable code. The following table gives a high-level overview of its capabilities with links to more detailed information.

Supported MATLAB Features	Unsupported MATLAB Features
Two-Dimensional Arrays	N-Dimensional Arrays
Matrix operations(+,-,*,....)	Matrix Deletion (X(1) = [])
	Logical Indexing
Complex Numbers	Sparse Matrices
Double/Single Math	`try-catch`
`if/switch/while/for`	Cell Arrays, Structures, Java, User-Defined Classes
Numeric Types	Calling out to functions on the path (except for simulation)
Subfunctions	`global`
`persistent`	Command Duality
Simulink Parameters as Inputs	

Embedded MATLAB Function

See the Chapter 12, "Embedded MATLAB Function Block Reference" for full details.

To generate embeddable code, the Embedded MATLAB Function block relies on an analysis that determines the size and class of each variable. This analysis imposes the following additional restrictions on the way in which the above features may be used.

1 The first definition of a variable must define both its class and size. The class and size of a variable cannot be changed once it has been set.

2 Whether data is complex or real is determined by the first definition. Subsequent definitions may assign real numbers into complex storage but may not assign complex numbers into real storage.

The preceding limitations require you to code in a certain style. Some common idioms to avoid are listed in "Limitations on Indexing Operations" and "Limitations with Complex Numbers" on page 12-39 in Simulink documentation.

In addition to language restrictions, Embedded MATLAB Function blocks support only a subset of the functions available in MATLAB. A list of supported functions is given in the "Embedded MATLAB Run-Time Function Library". These functions include functions in common categories like

- Arithmetic functions like `plus`, `minus`, and `power`
- Matrix operations like `size`, and `length`
- Advanced matrix operations like `lu`, `inv`, `svd`, and `chol`
- Trigonometric functions like `sin`, `cos`, `sinh`, and `cosh`

to name just a few. See "Embedded MATLAB Run-Time Library - by Category" for a complete list of function categories.

Note Although Embedded MATLAB attempts to produce exactly the same results as MATLAB, there will be occasions when they will differ due to rounding errors. These numerical differences, which may be a few eps initially, might be magnified after repeated operations. Reliance on the behavior of nan is not recommended. Different C compilers may yield different results for the same computation.

To support visualization of data, Embedded MATLAB Function blocks support calls to MATLAB functions for simulation only. See "Calling MATLAB Functions" in Simulink documentation to understand some of the limitations of this capability, and how it is integrated into Embedded MATLAB analysis. If these calls do not directly affect any of the Simulink inputs or outputs, they are eliminated from the generated code when generating code with Real-Time Workshop.

You can declare an Embedded MATLAB input to be a Simulink parameter instead of a port in the Model Explorer. The Embedded MATLAB Function block also supports inheritance of types and size for inputs, outputs, and parameters. If needed, you can also set these explicitly using the Model Explorer. See "Typing Function Argument and Return Variables", "Sizing Function Argument and Return Variables", and "Parameter Arguments in Embedded MATLAB Functions" for more detailed descriptions of variables that you use in Embedded MATLAB Functions.

Note that recursive calls are not allowed in Embedded MATLAB.

Data Type Support

The Embedded MATLAB Function block accepts inputs of any type supported by Simulink. For a discussion on the variable types supported by Embedded MATLAB functions in Simulink, refer to "Data Types Supported by Simulink" in the Simulink documentation.

For more information on fixed-point support in Embedded MATLAB, refer to "Using the Fixed-Point Toolbox with Embedded MATLAB" in the Fixed-Point Toolbox documentation.

Embedded MATLAB Function

Simulink frames are not supported. However, you can use the `Rate Transition` block to convert frames into vectors.

Parameters and Dialog Box

The **Block Parameters** dialog box for an Embedded MATLAB Function block is identical to the **Block Parameters** dialog box for a Subsystem block. See the reference page for the `Subsystem`, `Atomic Subsystem`, `CodeReuse Subsystem` blocks for an identification of each field.

Characteristics

Direct Feedthrough	Yes
Sample Time	Specified in the **Sample time** parameter
Scalar Expansion	Yes
Dimensionalized	Yes
Zero Crossing	No

Purpose   Add an enabling port to a subsystem

Library   Ports & Subsystems

Description   Adding an Enable block to a subsystem makes it an enabled subsystem. An enabled subsystem executes while the input received at the Enable port is greater than zero.

At the start of simulation, Simulink initializes the states of blocks inside an enabled subsystem to their initial conditions. When an enabled subsystem restarts (executes after having been disabled), the **States when enabling** parameter determines what happens to the states of blocks contained in the enabled subsystem:

- reset resets the states to their initial conditions (zero if not defined).

- held holds the states at their previous values.

You can output the enabling signal by selecting the **Show output port** check box. Selecting this option allows the system to process the enabling signal.

A subsystem can contain no more than one Enable block.

Data Type Support   The data type of the input of the Enable port, i.e., the enable port that appears on the subsystem in which the Enable block resides, can be any data type supported by Simulink, including fixed-point data types.

For a discussion on the data types supported by Simulink, see "Data Types Supported by Simulink" in the "Working with Data" chapter of the Using Simulink documentation.

Enable

Parameters and Dialog Box
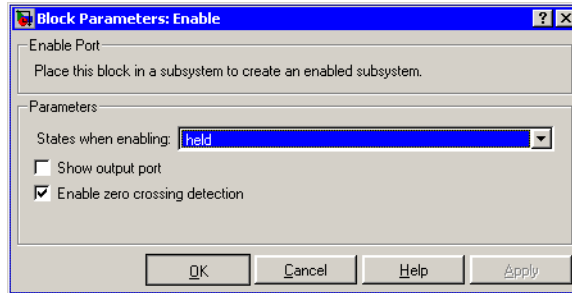
States when enabling
> Specifies how to handle internal states when the subsystem becomes reenabled.

Show output port
> If selected, Simulink draws the Enable block output port and outputs the enabling signal.

Enable zero crossing detection
> Select to enable zero crossing detection. For more information, see "Zero Crossing Detection" in the "How Simulink Works" chapter of the Using Simulink documentation.

Characteristics

Sample Time	Determined by the signal at the enable port
Dimensionalized	Yes
Zero Crossing	Yes, if enabled.

Purpose   Represent a subsystem whose execution is enabled and triggered by external input

Library   Ports & Subsystems

Description   This block is a Subsystem block that is preconfigured to serve as the starting point for creating an enabled and triggered subsystem. For more information, see "Triggered and Enabled Subsystems" in the online Simulink help.
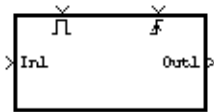
Enabled Subsystem

Purpose   Represent a subsystem whose execution is enabled by external input

Library   Ports & Subsystems

Description   This block is a Subsystem block that is preconfigured to serve as the starting point for creating an enabled subsystem. For more information, see "Enabled Subsystems" in the "Creating a Model" chapter of the Using Simulink documentation.

Purpose   Create branches of a block diagram that apply only to simulation or
                   only to code generation.

Library   Signal Routing

Description   This block outputs the signal at its Sim port only if the model that
                   contains it is being simulated. It outputs the signal at its RTW port
                   only if code is being generated from the model. This allows you to create
                   branches of a model's block diagram that apply only to simulation or
                   only to code generation. Real-Time Workshop does not generate code
                   for blocks connected to the Sim port. If you enable block reduction
                   optimization (see Block reduction optimization in the online Simulink
                   documentation), Simulink eliminates blocks in the branch connected to
                   the block's RTW port when compiling the model for simulation.

                   Note Real-Time Workshop eliminates the blocks connected to the Sim
                   branch only if the Sim branch has the same signal dimensions as the
                   RTW branch. Regardless of whether it eliminates the Sim branch,
                   Real-Time Workshop uses the sample times on the Sim branch as well
                   as the RTW branch to determine the fundamental sample time of the
                   generated code and may, in some cases, generate sample-time handling
                   code that applies only to sample times specified on the Sim branch.

Data Type   The Environment Controller block accepts signals of any numeric or
Support   data type. It outputs the type at its input.

**Parameters
and
Dialog
Box**
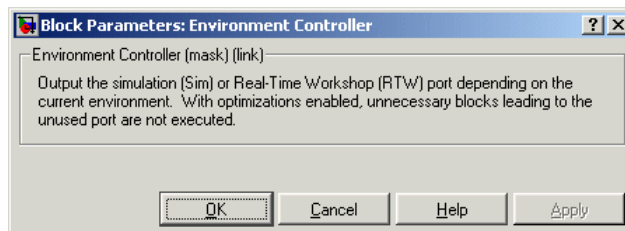
Extract Bits

Purpose　　　Output a selection of contiguous bits from the input signal

Library　　　Logic and Bit Operations

Description　　The Extract Bits block allows you to output a contiguous selection of bits from the stored integer value of the input signal. The **Bits to extract** parameter defines the method by which you select the output bits.

Extract Bits
Upper Half

Extract Bits

- Select Upper half to output the half of the input bits that contain the most significant bit. If there is an odd number of bits in the input signal, the number of output bits is given by the equation

$$\text{number of output bits} = \text{ceil}(\text{number of input bits}/2)$$

- Select Lower half to output the half of the input bits that contain the least significant bit. If there is an odd number of bits in the input signal, the number of output bits is given by the equation

$$\text{number of output bits} = \text{ceil}(\text{number of input bits}/2)$$

- Select Range starting with most significant bit to output a certain number of the most significant bits of the input signal. Specify the number of most significant bits to output in the **Number of bits** parameter.

- Select Range ending with least significant bit to output a certain number of the least significant bits of the input signal. Specify the number of least significant bits to output in the **Number of bits** parameter.

- Select Range of bits to indicate a series of contiguous bits of the input to output in the **Bit indices** parameter. You indicate the range in [start end] format, and the indices of the input bits are labeled contiguously starting at 0 for the least significant bit.

Data Type Support　　The Extract Bits block accepts inputs of any data type supported by Simulink, including fixed-point data types. Floating-point inputs are

passed through the block unchanged. Boolean inputs are treated as uint8 signals.

For a discussion on the data types supported by Simulink, see "Data Types Supported by Simulink" in the Simulink documentation.

Parameters and Dialog Box
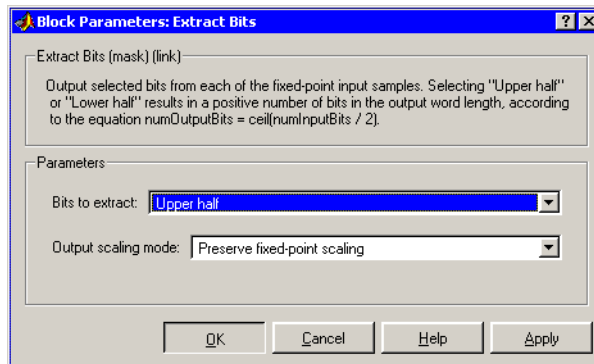
Bits to extract
   Select the mode by which to extract bits from the input signal, as discussed in Description.

Number of bits
   (Not shown on dialog above.) Select the number of bits to output from the input signal.

   This parameter is only visible if you select Range starting with most significant bit or Range ending with least significant bit for the **Bits to extract** parameter.

Bit indices
   (Not shown on dialog above.) Specify a contiguous range of bits of the input signal to output. Specify the range in [start end] format. The indices are assigned to the input bits starting with 0 at the least significant bit.

   This parameter is only visible if you select Range of bits for the **Bits to extract** parameter.

Extract Bits

Output scaling mode

Select the scaling mode to use on the output bits selection:

- When you select `Preserve fixed-point scaling`, the fixed-point scaling of the input is used to determine the output scaling during the data type conversion.

- When you select `Treat bit field as an integer`, the fixed-point scaling of the input is ignored, and only the stored integer is used to compute the output data type.

Example   Consider an input signal that is represented in binary by 110111001:

- If you select `Upper half` for the **Bits to extract** parameter, the output is 11011 in binary.

- If you select `Lower half` for the **Bits to extract** parameter, the output is 11001 in binary.

- If you select `Range starting with most significant bit` for the **Bits to extract** parameter, and specify 3 for the **Number of bits** parameter, the output is 110 in binary.

- If you select `Range ending with least significant bit` for the **Bits to extract** parameter, and specify 8 for the **Number of bits** parameter, the output is 10111001 in binary.

- If you select `Range of bits` for the **Bits to extract** parameter, and specify [4 7] for the **Bit indices** parameter, the output is 1011 in binary.

Characteristics

Direct Feedthrough	Yes
Sample Time	Inherited
Scalar Expansion	N/A
States	None

Dimensionalized	Inherited
Zero Crossing	No

Fcn

Purpose   Apply a specified expression to the input

Library   User-Defined Functions

Description   The Fcn block applies the specified C language style expression to its input. The expression can be made up of one or more of these components:
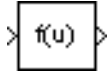
- u — The input to the block. If u is a vector, u(i) represents the ith element of the vector; u(1) or u alone represents the first element.

- Numeric constants

- Arithmetic operators (+ - * /^)

- Relational operators (== != > < >= <=) — The expression returns 1 if the relation is true; otherwise, it returns 0.

- Logical operators (&& || !) — The expression returns 1 if the relation is true; otherwise, it returns 0.

- Parentheses

- Mathematical functions — abs, acos, asin, atan, atan2, ceil, cos, cosh, exp, fabs, floor, hypot, ln, log, log10, pow, power, rem, sgn, sin, sinh, sqrt, tan, and tanh.

- Workspace variables —Variable names that are not recognized in the preceding list of items are passed to MATLAB for evaluation. Matrix or vector elements must be specifically referenced (e.g., A(1,1) instead of A for the first element in the matrix).

Note The Fcn block does not support tunable parameters, i.e., it ignores changes in the values of workspace variables during simulation. The Fcn block also does not support Custom Storage Classes (see the Real-Time Workshop documentation for more information).

The Fcn block observes the following rules of operator precedence:

1 ( )

2 ^

3 + - (unary)

4 !

5 * /

6 + -

7 > < <= >=

8 == !=

9 &&

10 | |

The expression differs from a MATLAB expression in that the expression cannot perform matrix computations. Also, this block does not support the colon operator (:).

Block input can be a scalar or vector. The output is always a scalar. For vector output, consider using the Math Function block. If a block input is a vector and the function operates on input elements individually (for example, the sin function), the block operates on only the first vector element.

Note Simulink does not allow you to change the value of the block's **Expression** parameter while running a model in accelerated mode (see "Simulink Accelerator"). Furthermore, Simulink does not update the value of the Fcn expression to reflect changes in the workspace while running in accelerated mode.

Fcn

Data Type Support

The Fcn block accepts and outputs signals of type double.

Parameters and Dialog Box
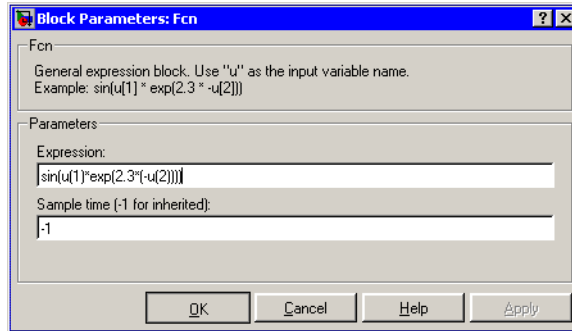
Expression

The C language style expression applied to the input. Expression components are listed above. The expression must be mathematically well formed (i.e., matched parentheses, proper number of function arguments, etc.).

Sample time (-1 for inherited)

Specify the time interval between samples. To inherit the sample time, set this parameter to -1. See "Specifying Sample Time" in the online documentation for more information.

Characteristics

Direct Feedthrough	Yes
Sample Time	Inherited from driving block
Scalar Expansion	No
Dimensionalized	No
Zero Crossing	No

Purpose   Implement a first-order sample-and-hold

Library   Discrete
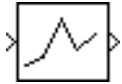
Description   The First-Order Hold block implements a first-order sample-and-hold that operates at the specified sampling interval. This block has little value in practical applications and is included primarily for academic purposes.

This figure compares the output from a Sine Wave block and a First-Order Hold block.
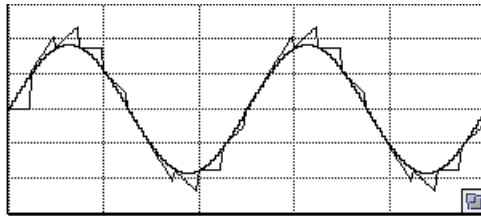
Data Type Support   The First-Order Hold block accepts and outputs signals of type double.
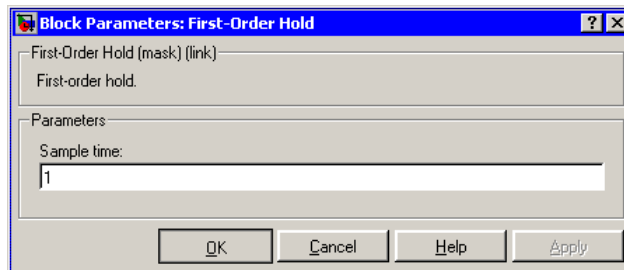
Parameters and Dialog Box

Sample time
>   The time interval between samples. See "Specifying Sample Time" in the online documentation for more information.

First-Order Hold

Characteristics

Direct Feedthrough	No
Sample Time	Specified in the **Sample time** parameter
Scalar Expansion	No
States	1 continuous and 1 discrete per input element
Dimensionalized	Yes
Zero Crossing	No

Fixed-Point State-Space

Purpose   Implement discrete-time state space

Library   Additional Math & Discrete / Additional Discrete

Description   The Fixed-Point State-Space block implements the system described by

$$y(n) = Cx(n) + Du(n)$$

$$x(n+1) = Ax(n) + Bu(n)$$

where u is the input, x is the state, and y is the output. Both equations have the same data type.

The matrices A, B, C and D have the following characteristics:

- A must be an n-by-n matrix, where n is the number of states.
- B must be an n-by-m matrix, where m is the number of inputs.
- C must be an r-by-n matrix, where r is the number of outputs.
- D must be an r-by-m matrix.

In addition:

- The state x must be a n-by-1 vector
- The input u must be a m-by-1 vector
- The output y must be a r-by-1 vector

The block accepts one input and generates one output. The input vector width is determined by the number of columns in the B and D matrices. The output vector width is determined by the number of rows in the C and D matrices.

Data Type Support   The Fixed-Point State-Space block accepts signals of any data type supported by Simulink, including fixed-point data types.

Fixed-Point State-Space

The **Main** pane of the Fixed-Point State-Space block dialog appears as follows:
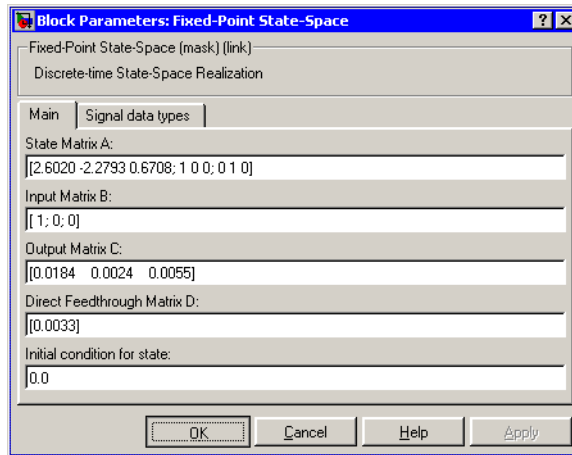
State Matrix A
> Specify the matrix of states.

Input Matrix B
> Specify the column vector of inputs.

Output Matrix C
> Specify the column vector of outputs.

Direct Feedthrough Matrix D
> Specify the matrix for direct feedthrough.

Initial condition for state
> Specify the initial condition for the state.

The **Signal data types** pane of the Fixed-Point State-Space block dialog appears as follows:
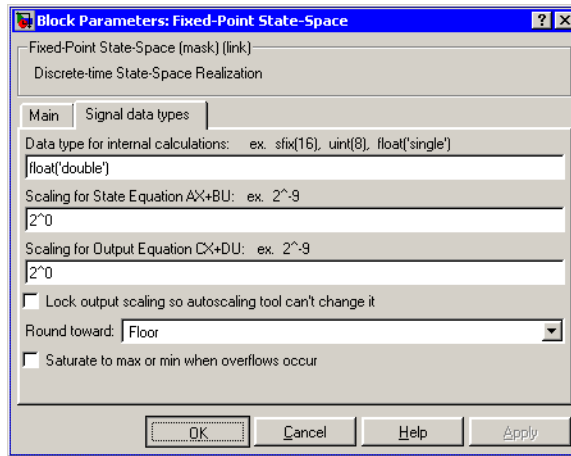
Data type for internal calculations
> Specify the data type for internal calculations.

Scaling for State Equation AX+BU
> Specify the scaling for state equations.

Scaling for Output Equation CX+DU
> Specify the scaling for output equations.

Lock output scaling so autoscaling tool can't change it
> If you select this check box, the output scaling is locked.

Round toward
> Select the rounding mode for fixed-point operations.

Saturate to max or min when overflows occur
> If selected, fixed-point overflows saturate.

Characteristics

Direct Feedthrough	Yes
Scalar Expansion	Yes, of initial conditions

For Iterator

Purpose   Repeatedly execute the contents of a subsystem at the current time step until an iteration variable exceeds a specified iteration limit.

Library   Ports & Subsystems/For Iterator Subsystem

Description   The For Iterator block, when placed in a subsystem, repeatedly executes the contents of the subsystem at the current time step until an iteration variable exceeds a specified iteration limit. You can use this block to implement the block diagram equivalent of a `for` loop in the C programming language.

```
For
Iterator
```
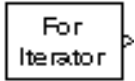
The block's parameter dialog allows you to specify the maximum value of the iteration variable or an external source for the maximum value and an optional external source for the next value of the iteration variable. If you do not specify an external source for the next value of the iteration variable, the next value is determined by incrementing the current value:

$$i_{n+1} = i_n + 1$$

The model in the following figure uses a For Iterator block to increment an initial value of zero by 10 over 20 iterations at every time step.
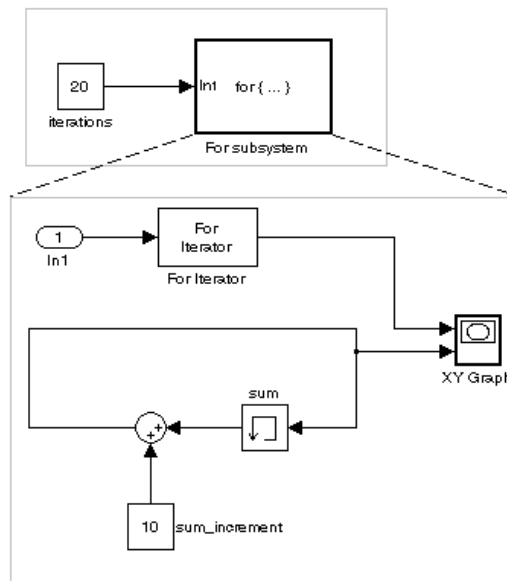
The following figure shows the result.
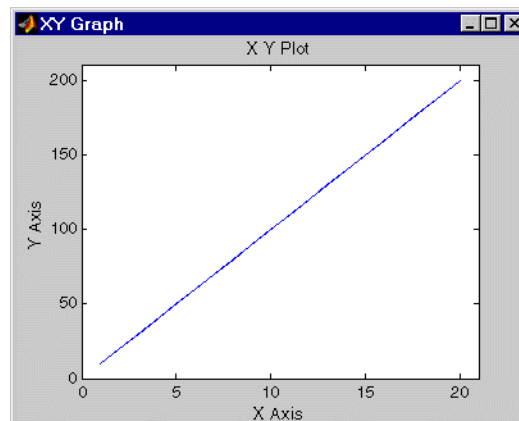
The For Iterator subsystem in this example is equivalent to the following C code.

For Iterator

```
sum = 0;
iterations = 20;
sum_increment = 10;
for (i = 0; i < iterations; i++) {
 sum = sum + sum_increment;
}
```

Note Placing a For Iterator block in a subsystem makes it an atomic subsystem if it is not already an atomic subsystem.

Data Type Support

The following rules apply to the data type of the number of iterations (N) input port:

- The input port accepts data of mixed types.

- If the input port value is noninteger, it is first truncated to an integer.

- Internally, the input value is cast to an integer of the type specified for the iteration variable output port.

- If no output port is specified, the input port value is cast to type int32.

- If the input port value exceeds the maximum value of the output port's type, it is truncated to that maximum value.

Data output for the iterator value can be selected as double, int32, int16, or int8 in the Block Properties dialog.

The following rules apply to the iteration variable input port.

- It can appear only if the iteration variable output port is enabled.

- The data type of the iteration variable input port is the same as the data type of the iteration variable output port.

**Parameters
and
Dialog
Box**
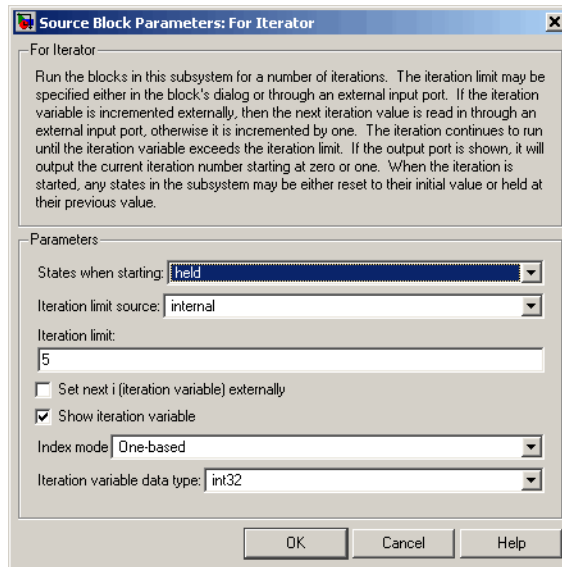
States when starting

Set this field to reset if you want the states of the For subsystem
to be reinitialized before the first iteration at each time step.
Otherwise, set this field to held (the default) to make sure that
these subsystem states retain their values from the last iteration
at the previous time step.

Iteration limit source

If you set this field to internal, the value of the **Number of
iterations** field determines the number of iterations. If you set
this field to external, the signal at the For Iterator block's N port
determines the number of iterations. The iteration limit source
must reside outside the For Iterator subsystem.

Iteration limit

Set the number of iterations for the For Iterator block to this
value. This field appears only if you selected internal for the
Source of number of iterations field.

For Iterator

Set next i (iteration variable) externally

This option can be selected only if you select the **Show iteration variable** option. If you select this option, the For Iterator block displays an additional input for connecting an external iteration variable source. The value of the input at the current iteration is used as the value of the iteration variable at the next iteration.

Show iteration variable

If you select this check box, the For Iterator block outputs its iteration value.

Index mode

If you set this field to Zero-based, the iteration number starts at zero. If you set this field to One-based, the iteration number starts at one.

Iteration variable data type

Set the type for the iteration value output from the iteration number port to double, int32, int16, or int8.

Characteristics

Direct Feedthrough	No
Sample Time	Inherited from driving blocks
Scalar Expansion	No
Dimensionalized	No
Zero Crossing	No

Purpose   Represent a subsystem that executes repeatedly during a simulation time step

Library   Ports & Subsystems

Description

The For Iterator Subsystem block is a Subsystem block that is preconfigured to serve as a starting point for creating a subsystem that executes repeatedly during a simulation time step. For more information, see the `For Iterator` block in the online Simulink block reference and "Modeling Control Flow Logic" in the Using Simulink documentation.
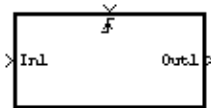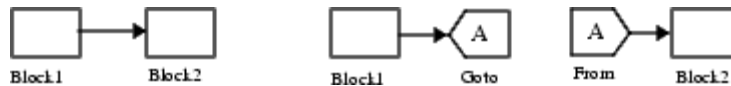
From

Purpose   Accept input from a Goto block

Library   Signal Routing

Description   The From block accepts a signal from a corresponding Goto block, then
passes it as output. The data type of the output is the same as that of
the input from the Goto block. From and Goto blocks allow you to pass
a signal from one block to another without actually connecting them.
To associate a Goto block with a From block, enter the Goto block's
tag in the **Goto Tag** parameter.

A From block can receive its signal from only one Goto block, although a
Goto block can pass its signal to more than one From block.

This figure shows that using a Goto block and a From block is equivalent
to connecting the blocks to which those blocks are connected. In the
model at the left, Block1 passes a signal to Block2. That model is
equivalent to the model at the right, which connects Block1 to the Goto
block, passes that signal to the From block, then on to Block2.

The visibility of a Goto block tag determines the From blocks that
can receive its signal. For more information, see Goto and Goto Tag
Visibility. The block indicates the visibility of the Goto block tag:

- A local tag name is enclosed in brackets ([]).

- A scoped tag name is enclosed in braces ({}).

- A global tag name appears without additional characters.

**Data Type
Support**   The From block outputs real or complex signals of any data type
supported by Simulink, including fixed-point data types.

For a discussion on the data types supported by Simulink, see "Data
Types Supported by Simulink" in the Simulink documentation.

Parameters and Dialog Box

Source Block Parameters: From

From

Receive signals from the Goto block with the specified tag. If the tag is defined as 'scoped' in the Goto block, then a Goto Tag Visibility block must be used to define the visibility of the tag. After 'Update Diagram', the block icon displays the selected tag name (local tags are enclosed in brackets, [], and scoped tag names are enclosed in braces, {}).

Parameters

Goto Tag: A   Update Tags

Goto Source: *none*

Icon Display: Tag

OK   Cancel   Help
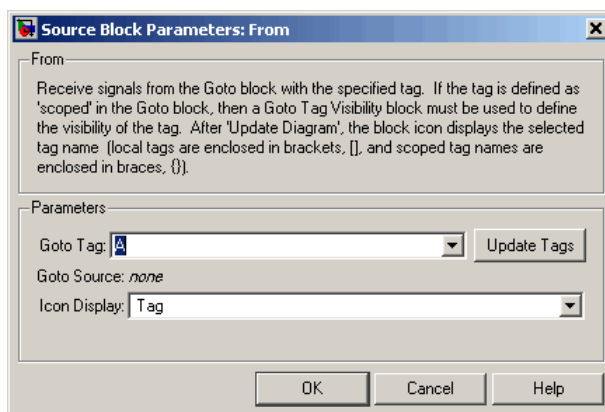
Goto Tag

The tag of the Goto block that forwards its signal to this From block. To change the tag, select a new tag from this control's drop-down list. The drop-down list displays the Goto tags that the From block can currently see. An item labeled <More Tags...> appears at the end of the list the first time you display the list in a Simulink session. Selecting this item causes the block to update the tags list to include the tags of Goto blocks residing in library subsystems referenced by the model containing this From block. Simulink displays a progress bar while building the list of library tags. Simulink saves the updated tags list for the duration of the Simulink session or until the next time you select the adjacent **Update Tags** button. You need to update the tags list again in the current session only if the libraries referenced by the model have changed since the last time you updated the list.

Update Tags

Updates the list of tags visible to this From block, including tags residing in libraries referenced by the model containing this From block.

Goto Source

Path of the Goto block connected to this From block. Clicking the path displays and highlights the Goto block.

From

Icon Display

Specifies the text to display on the From block's icon. The options are the block's tag, the name of the signal that the block represents, or both the tag and the signal name.

Characteristics

Sample Time	Inherited from block driving the Goto block
Dimensionalized	Yes

Purpose　　　Read data from a MAT file.

Library　　　Sources

Description　　The From File block outputs data read from a MAT file. Its icon displays the pathname of the file supplying the data.

untitled.mat ▷

Note The From block can read data only from MAT files. It does not support any other file format.

The MAT file must contain a matrix of two or more rows. The first row must contain monotonically increasing time points. Other rows contain data points that correspond to the time point in that column. The matrix is expected to have this form.

$$\begin{bmatrix} t_1 & t_2 & \dots t_{final} \\ u1_1 & u1_2 & \dots u1_{final} \\ \dots \\ un_1 & un_2 & \dots un_{final} \end{bmatrix}$$

The width of the output depends on the number of rows in the MAT file. The block uses the time data to determine its output, but does not output the time values. This means that in a matrix containing m rows, the block outputs a vector of length m-1, consisting of data from all but the first row of the appropriate column.

If an output value is needed at a time that falls between two values in the MAT file, the value is linearly interpolated between the appropriate values. If the required time is less than the first time value or greater than the last time value in the MAT file, Simulink extrapolates, using the first two or last two points to compute a value.

From File

If the matrix includes two or more columns at the same time value, the output is the data point for the first column encountered. For example, for a matrix that has this data:

```
time values:    0 1 2 2
data points:    2 3 4 5
```

At time 2, the output is 4, the data point for the first column encountered at that time value.

Simulink reads the MAT file into memory at the start of the simulation. As a result, you cannot read data from the same MAT file named in a To File block in the same model.

Using Data Saved by a To File or a To Workspace Block

The From File block can read data written by a To File block without any modifications.

To read data written by a To Workspace block and saved to a MAT file:

- The data must include the simulation times. The easiest way to include time data in the simulation output is to specify a variable for time on the **Data Import/Export** pane of the **Configuration Parameters** dialog box. See The Data Import/Export Pane for more information.

- Before saving the data from the To Workspace block, transpose it to the form expected by the From File block.

Data Type Support   The From File block outputs real signals of type `double`.
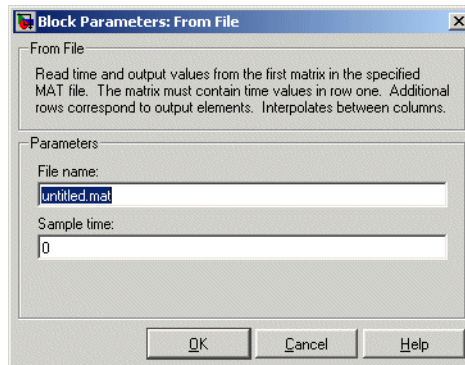
**Parameters
and
Dialog
Box**

Opening this dialog box causes a running simulation to pause.
See "Changing Source Block Parameters" in the online Simulink
documentation for details.

File name
> The fully qualified pathname or file name of the MAT file that
> contains the data used as input. On UNIX, the pathname can
> start with a tilde (~) character signifying your home directory. The
> default file name is untitled.mat. If you specify an unqualified
> file name, Simulink assumes that the MAT file resides in the
> MATLAB working directory. (To determine the working directory,
> enter pwd at the MATLAB command line.) If Simulink cannot
> find the specified file name in the working directory, it displays
> an error message.

Sample time
> The sample period and offset of the data read from the file. See
> "Specifying Sample Time" in the online documentation for more
> information.

Characteristics

Sample Time	Specified in the **Sample time** parameter
Scalar Expansion	No

Dimensionalized	1-D array only
Zero Crossing	No

Purpose   Read data from the workspace

Library   Sources
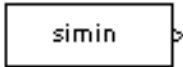
Description   The From Workspace block reads data from the MATLAB workspace. The block's **Data** parameter specifies the workspace data via a MATLAB expression that evaluates to a matrix (2-D array), a structure containing an array of signal values and time steps, or a time-series object (see `Simulink.Timeseries`). The format of the matrix or structure is the same as that used to load root-level input port data from the workspace (see "Importing Data from the MATLAB Workspace". The From Workspace icon displays the expression in the **Data** parameter.

```
simin
```

Note You must use the structure-with-time format or a time-series object to load matrix (2-D) data from the workspace.

The From Workspace block's **Interpolate data** parameter determines the block's output in the time interval for which workspace data is supplied. If you select the **Interpolate data** option, the block uses linear Lagrangian interpolation to compute data values for time steps that occur between time steps for which the workspace supplies data. In particular, the block linearly interpolates a missing data point from the two known data points between which it falls. For example, suppose the block reads the following time series from the workspace.

```
time:      1   2   3    4
signal:   253 254  ?   256
```

In this case, the block would output:

```
time:      1   2   3    4
signal:   253 254 255   256
```

If you do not select the **Interpolate data** option, the block uses the most recent data value supplied from the workspace.

From Workspace

The block's **Form output after final data value by** parameter determines the block's output after the last time step for which data is available from the workspace. The following table summarizes the output block based on the options that the parameter provides.

Form Output Option	Interpolate Option	Block Output After Final Data
Extrapolate	On	Extrapolated from final data value
Extrapolate	Off	Error
SettingToZero	On	Zero
SettingToZero	Off	Zero
HoldingFinalValue	On	Final value from workspace
HoldingFinalValue	Off	Final value from workspace
CyclicRepetition	On	Error
CyclicRepetition	Off	Repeated from workspace. This option is valid only for workspace data in structure-without-time format.

If the input array contains more than one entry for the same time step, Simulink detects a zero crossing at this time step. For example, suppose the input array has this data:

```
time:    0 1 2 2 3
signal:  2 3 4 5 6
```

At time 2, there is a zero crossing from input signal discontinuity.

If the interpolation option is on, the block uses the last two known data points to extrapolates data points that occur after the last known point. Consider the following example.
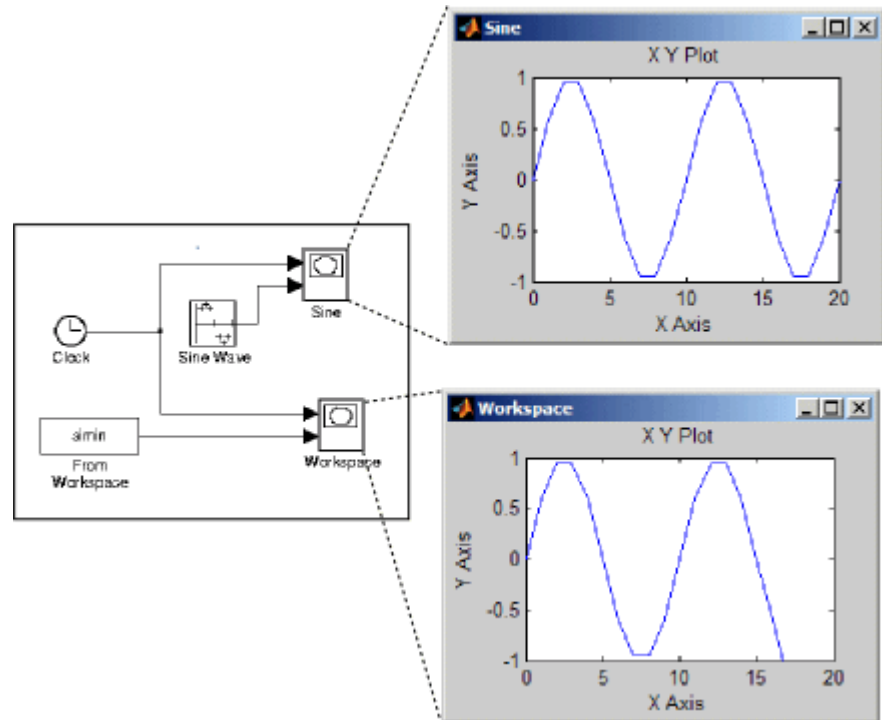
In this example, the From Workspace block reads data from the workspace consisting of the output of the Simulink Sine block sampled at one-second intervals. The workspace contains the first 16 samples of the output. The top and bottom X-Y plots display the output of the Sine Wave and From Workspace blocks, respectively, from 0 to 20 seconds. The straight line in the output of the From Workspace block reflects the block's linear extrapolation of missing data points at the end of the simulation.

From Workspace

> **Note** A From Workspace block can directly read the output of a To Workspace block (see `To Workspace`) if the output is in structure-with-time format (see "Importing Data from the MATLAB Workspace" for a description of these formats).

Data Type Support

The From Workspace block accepts from the workspace and outputs real or complex signals of any type supported by Simulink. Real signals of type `double` can be in either structure or matrix format. Complex signals and real signals of any type other than `double` must be in structure format.

How Data Types Affect Interpolation

The data type of the data supplied by the workspace can affect interpolation and extrapolation of missing values in the following cases.

Integer data

If the input data type is an integer type and an interpolated data point exceeds the data type's range, the block sets the missing data point to be the maximum value that the data type can represent. Similarly, if the interpolated or extrapolated value is less than the minimum value that the data type can represent, the block sets the missing data point to the minimum value that the data type can represent. For example, suppose that the data type is `uint8` and the value interpolated for a missing data point is 256.

```
time:      1   2   3   4
signal:   253 254 255  ?
```

In this case, the block sets the value of the missing point to 255, the largest value that can be represented by the `uint8` data type:

```
time:      1   2   3    4
signal:   253 254 255  255
```

Boolean data

If the input data is boolean, the block uses the value of the nearest
workspace data point as the value of missing data point when
determining missing data points that fall between the first and last
known points. For example, suppose the workspace supplies values at
time steps 1 and 4 but not at 2 and 3:

```
time:    1 2 3 4
signal:  1 ? ? 0
```

In this case, the block would use the value of data point 1 as the value
of data point 2 and the value of data point 4 as the value of data point 3:

```
time:    1 2 3 4
signal:  1 1 0 0
```

The block uses the value of the last known data point as the value of
time steps that occur after the last known data point.

From Workspace

Parameters and Dialog Box

```
Source Block Parameters: From Workspace                          [X]
┌─ From Workspace ─────────────────────────────────────────────┐
│ Read data values specified in array or structure format from  │
│ MATLAB's workspace.                                           │
│ Array (or matrix) format:                                     │
│   1-D signal:                                                 │
│     var=[TimeValues DataValues]                               │
│   For 2-D signal use structure format                         │
│ Structure format:                                             │
│     var.time=[TimeValues]                                     │
│     var.signals.values=[DataValues]                           │
│     var.signals.dimensions=[DimValues]                        │
│ Select interpolation to interpolate or extrapolate at time    │
│ steps for which data does not                                 │
│ exist.                                                        │
└───────────────────────────────────────────────────────────────┘
┌─ Parameters ─────────────────────────────────────────────────┐
│ Data:                                                         │
│ [simin                                                      ] │
│ Sample time:                                                  │
│ [0                                                          ] │
│ ☑ Interpolate data                                            │
│ ☑ Enable zero crossing detection                             │
│ Form output after final data value by: [Extrapolation      ▼] │
└───────────────────────────────────────────────────────────────┘
            [  OK  ]    [ Cancel ]    [  Help  ]
```

Data

An expression that evaluates to an array or a structure containing an array of simulation times and corresponding signal values. For example, suppose that the workspace contains a column vector of times named T and a vector of corresponding signal values named U. Entering the expression [T,U] for this parameter yields the required input array. If the required signal-versus-time array or structure already exists in the workspace, enter the name of the structure or matrix in this field.

Sample time

Sample rate of data from the workspace. See "Specifying Sample Time" in the online documentation for more information.

Interpolate data

This option causes the block to linearly interpolate at time steps for which no corresponding workspace data exists. Otherwise, the current output equals the output at the most recent time for which data exists.

Enable zero crossing detection
> Select to enable zero crossing detection. For more information, see "Zero Crossing Detection" in the "How Simulink Works" chapter of the Using Simulink documentation.

Form output after final data value by
> Select method for generating output after the last time point for which data is available from the workspace.

Characteristics

Sample Time	Specified in the **Sample time** parameter
Scalar Expansion	No
Dimensionalized	Yes
Zero Crossing	Yes

Function-Call Generator

Purpose   Execute a function-call subsystem a specified number of times at a specified rate

Library   Ports & Subsystems

Description   The Function-Call Generator block executes a function-call subsystem (for example, a Stateflow® state chart configured as a function-call system) at the rate specified by the block's **Sample time** parameter. To execute multiple function-call subsystems in a prescribed order, first connect a Function-Call Generator block to a Demux block that has as many output ports as there are function-call subsystems to be controlled. Then connect the output ports of the Demux block to the systems to be controlled. The system connected to the first demux port executes first, the system connected to the second demux port executes second, and so on.
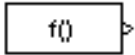
Data Type Support   The Function-Call Generator block outputs a signal of type `fcn_call`.

Parameters and Dialog Box
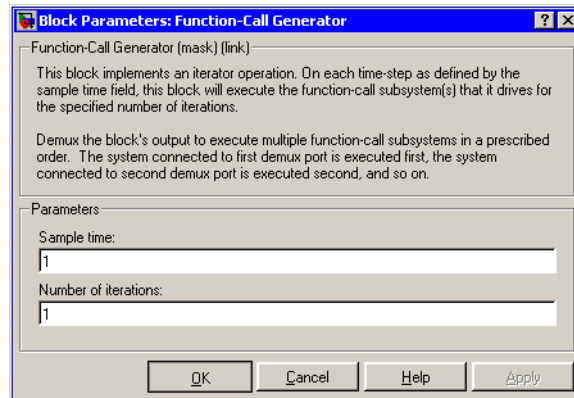
Sample time
> The time interval between samples. See "Specifying Sample Time"in the online documentation for more information.

Number of iterations

> Number of times to execute the block per time step. The value of this parameter may be a vector where each element of the vector specifies a number of times to execute a function-call subsystem. The total number of times that a function-call subsystem executes per time step equals the sum of the values of the elements of the generator signal entering its control port. For example, suppose you specify the number of iterations to be [2 2] and connect the output of this block to the control port of a function-call subsystem. In this case, the function-call subsystem executes four times at each time step.

Characteristics

Direct Feedthrough	No
Sample Time	Specified in the **Sample time** parameter
Scalar Expansion	No
Dimensionalized	Yes
Zero Crossing	No

Function-Call Subsystem

Purpose   Represent a subsystem that can be invoked as a function by another
             block

Library   Ports & Subsystems

Description   The Function-Call Subsystem block is a Subsystem block that is
             preconfigured to serve as a starting point for creating a function-call
             subsystem. For more information, see "Function-Call Subsystems" in
             the "Creating a Model" chapter of the Using Simulink documentation.

Purpose   Multiply the input by a constant

Library   Math Operations

Description   The Gain block multiplies the input by a constant value (gain). The input and the gain can each be a scalar, vector, or matrix.

You specify the value of the gain in the **Gain** parameter. The **Multiplication** parameter lets you specify element-wise or matrix multiplication. For matrix multiplication, this parameter also lets you indicate the order of the multiplicands.

The gain is converted from doubles to the data specified in the block mask offline using round-to-nearest and saturation. The input and gain are then multiplied, and the result is converted to the output data type using the specified rounding and overflow modes.

Data Type Support   The Gain block accepts a real or complex scalar, vector, or matrix of any data type supported by Simulink except `Boolean`. The Gain block supports fixed-point data types. If the input of the Gain block is real and the gain is complex, the output is complex.

For a discussion on the data types supported by Simulink, see "Data Types Supported by Simulink" in the Simulink documentation.

Gain

**Parameters
and
Dialog
Box**

The **Main** pane of the Gain block dialog appears as follows:
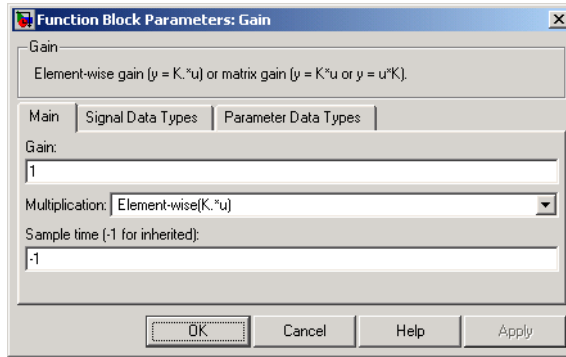
Gain

Specify the value by which to multiply the input. The gain may be a scalar, vector, or matrix. The gain may not be `Boolean`.

Multiplication

Specify the multiplication mode:

- `Element-wise(K*u)`—Each element of the input is multiplied by each element of the gain. The block performs expansions, if necessary, so that the input and gain have the same dimensions.

- `Matrix(K*u)`—The input and gain are matrix multiplied with the input as the second operand.

- `Matrix(u*K)`—The input and gain are matrix multiplied with the input as the first operand.

- `Matrix(K*u)(u vector)`—The input and gain are matrix multiplied with the input as the second operand. The input and the output are required to be vectors and their lengths are determined by the dimensions of the gain.

Sample time (-1 for inherited)

> Specify the time interval between samples. To inherit the sample time, set this parameter to -1. See "Specifying Sample Time" in the online documentation for more information.

The **Signal Data Types** pane of the Gain block dialog appears as follows:
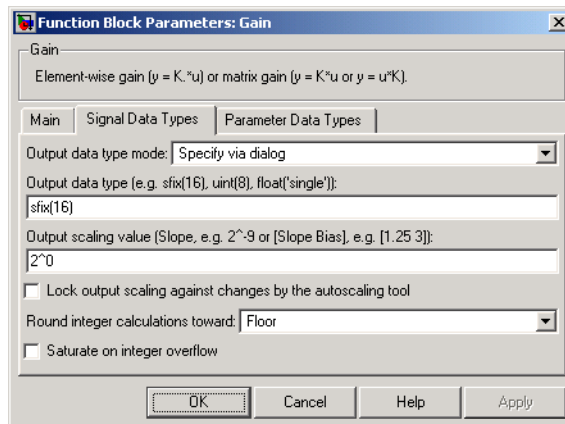
Output data type mode

> Set the data type and scaling of the output to be the same as that of the input, or to be inherited via an internal rule or by back propagation. Alternatively, choose to specify the data type and scaling of the output through the **Output data type** and **Output scaling value** parameters in the dialog.
>
> If you select Inherit via internal rule for this parameter, Simulink chooses a combination of output scaling and data type that requires the smallest amount of memory consistent with accommodating the output range and maintaining the output precision of the block and with the word size of the targeted hardware implementation specified for the model. If the **Device type** parameter on the **Hardware Implementation** configuration parameters pane is set to ASIC/FPGA, Simulink

Gain

chooses the output data type without regard to hardware
constraints. Otherwise, Simulink chooses the smallest available
hardware data type capable of meeting the range and precision
constraints. For example, if the block multiplies an input of type
`int8` by a gain of `int16` and `ASIC/FPGA` is specified as the targeted
hardware type, the output data type is `sfix24`. If `Unspecified
(assume 32-bit Generic)`, i.e., a generic 32-bit microprocessor,
is specified as the target hardware, the output data type is `int32`.
If none of the word lengths provided by the target microprocessor
can accommodate the output range, Simulink displays an error
message in the Simulation Diagnostics Viewer.

Output data type
Set the output data type. This parameter is only visible if you
select `Specify via dialog` for the **Output data type mode**
parameter.

Output scaling value
Set the output scaling using either binary point-only or [Slope
Bias] scaling. This parameter is only visible if you select `Specify
via dialog` for the **Output data type mode** parameter.

Lock output scaling against changes by the autoscaling tool
Select to lock scaling of outputs. This parameter is only visible
if you select `Specify via dialog` for the **Output data type
mode** parameter.

Round integer calculations toward
Select the rounding mode for fixed-point operations.

Saturate on integer overflow
Select to have overflows saturate.

The **Parameter Data Types** pane of the Gain block dialog appears
as follows:
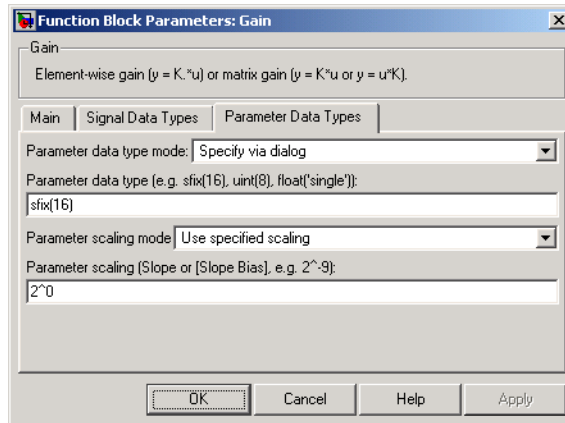
Parameter data type mode

Set the data type and scaling of the gain to be the same as that of the input, or to be inherited via an internal rule. Alternatively, choose to specify the data type and scaling of the gain through the **Parameter data type**, **Parameter scaling mode**, and **Parameter scaling** parameters in the dialog.

Parameter data type

Specifies the data type of the **Gain** parameter. This parameter is visible only if you select Specify via dialog for the **Parameter data type mode** parameter.

Parameter scaling mode

Set the mode to determine the scaling of the gain.

- Use specified scaling—This mode allows you to set the scaling of the gain in the **Parameter scaling** parameter.

- Best Precision: Element-wise—This mode sets binary points for the elements of the gain such that the precision of each element is maximized.

- Best Precision: Row-wise—This mode sets a common binary point within each row of the gain such that the largest element of each row has the best possible precision.

Gain

- Best Precision: Column-wise—This mode sets a common binary point within each column of the gain such that the largest element of each column has the best possible precision.

- Best Precision: Matrix-wise—This mode sets a common binary point for all the elements of the gain such that the largest element has the best possible precision.

Parameter scaling

Set the gain scaling using either binary point-only or [Slope Bias] scaling. This parameter is only visible if you select Specify via dialog for the **Parameter data type mode** parameter, and if you select Use specified scaling for the **Parameter scaling mode** parameter.

Characteristics

Direct Feedthrough	Yes
Sample Time	Specified in the **Sample time** parameter
Scalar Expansion	Yes, of input and **Gain** parameter for Element-wise multiplication
Dimensionalized	Yes
Zero Crossing	No

Purpose   Pass block input to From blocks

Library   Signal Routing

Description The Goto block passes its input to its corresponding From blocks. The
input can be a real- or complex-valued signal or vector of any data
type. From and Goto blocks allow you to pass a signal from one block
to another without actually connecting them.

A Goto block can pass its input signal to more than one From block,
although a From block can receive a signal from only one Goto block.
The input to that Goto block is passed to the From blocks associated
with it as though the blocks were physically connected. Goto blocks and
From blocks are matched by the use of Goto tags, defined in the **Tag**
parameter.

The **Tag Visibility** parameter determines whether the location of From
blocks that access the signal is limited:

- local, the default, means that From and Goto blocks using the same
  tag must be in the same subsystem. A local tag name is enclosed
  in brackets ([]).

- scoped means that From and Goto blocks using the same tag must be
  in the same subsystem or at any level in the model hierarchy below
  the Goto Tag Visibility block that does not entail crossing a nonvirtual
  subsystem boundary, i.e., the boundary of an atomic, conditionally
  executed, or function-call subsystem or a model reference. A scoped
  tag name is enclosed in braces ({}).

- global means that From and Goto blocks using the same tag can
  be anywhere in the model except in locations that span nonvirtual
  subsystem boundaries.

The rule that From-Goto block connections cannot cross nonvirtual
subsystem boundaries has the following exception. A Goto block
connected to a state port in one conditionally executed subsystem is
visible to a From block inside another conditionally executed subsystem.
For more information about conditionally executed subsystems, see

Goto

"Creating Conditionally Executed Subsystems" in the "Creating a Model" chapter of the Using Simulink documentation.

Note A scoped Goto block in a masked system is visible only in that subsystem and in the nonvirtual subsystems it contains. Simulink generates an error if you run or update a diagram that has a Goto Tag Visibility block at a higher level in the block diagram than the corresponding scoped Goto block in the masked subsystem.

Use local tags when the Goto and From blocks using the same tag name reside in the same subsystem. You must use global or scoped tags when the Goto and From blocks using the same tag name reside in different subsystems. When you define a tag as global, all uses of that tag access the same signal. A tag defined as scoped can be used in more than one place in the model. This example shows a model that uses two scoped tags with the same name (A).
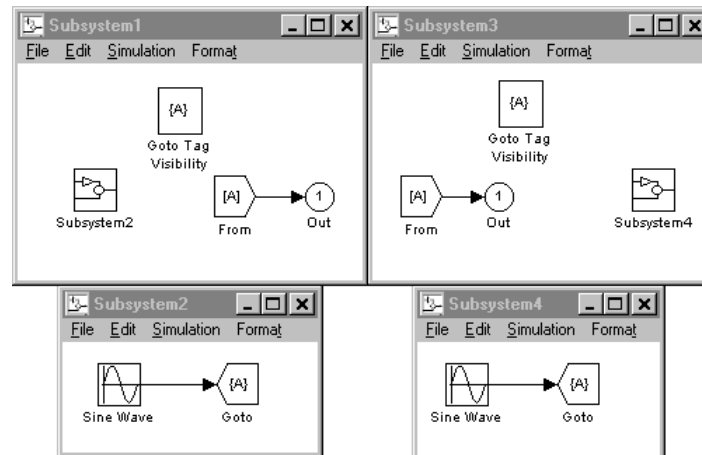
Data Type Support

The Goto block accepts real or complex signals of any data type supported by Simulink, including fixed-point data types.

For a discussion on the data types supported by Simulink, see "Data Types Supported by Simulink" in the Simulink documentation.

Parameters and Dialog Box
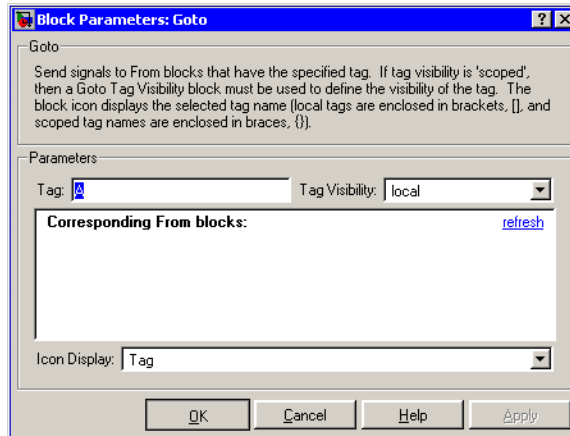
Tag

The Goto block identifier. This parameter identifies the Goto block whose scope is defined in this block.

Tag Visibility

The scope of the Goto block tag: local, scoped, or global. The default is local.

Corresponding From blocks

List of the From blocks connected to this Goto block. Double-clicking any entry in this list displays and highlights the corresponding From block.

Icon Display

Specifies the text to display on the block's icon. The options are the block's tag, the name of the signal that the block represents, or both the tag and the signal name.

Goto

Characteristics

Sample Time	Inherited from driving block
Dimensionalized	Yes

Purpose	Define scope of Goto block tag
Library	Signal Routing

Description

{A}

The Goto Tag Visibility block defines the accessibility of Goto block tags that have scoped visibility. The tag specified as the **Goto tag** parameter is accessible by From blocks in the same subsystem that contains the Goto Tag Visibility block and in subsystems below it in the model hierarchy.

A Goto Tag Visibility block is required for Goto blocks whose **Tag Visibility** parameter value is scoped. No Goto Tag Visibility block is needed if the tag visibility is either local or global. The block shows the tag name enclosed in braces ({}).

Data Type Support

Not applicable.

Parameters and Dialog Box

Block Parameters: Goto Tag Visibility

GotoTagVisibility

Used in conjunction with Goto and From blocks to define the visibility of scoped tags. For example, if this block resides in a subsystem (or root system) called MYSYS, then the tag is visible to From blocks that reside in MYSYS or in subsystems of MYSYS.

Parameters

Goto tag:

A

OK   Cancel   Help   Apply
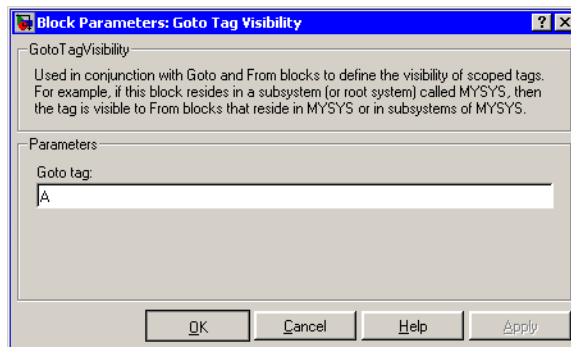
Goto tag
The Goto block tag whose visibility is defined by the location of this block.

Goto Tag Visibility

Characteristics

Sample Time	N/A
Dimensionalized	N/A

Purpose   Ground an unconnected input port

Library   Sources

Description   The Ground block can be used to connect blocks whose input ports are
                   not connected to other blocks. If you run a simulation with blocks
                   having unconnected input ports, Simulink issues warning messages.
                   Using Ground blocks to ground those blocks avoids warning messages.
                   The Ground block outputs a signal with zero value. The data type of the
                   signal is the same as that of the port to which it is connected.

**Data Type
Support**   The Ground block outputs a signal of the same numeric type and data
                   type as the port to which it is connected. For example, consider the
                   following model.
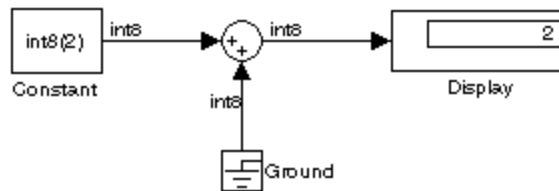
                   In this example, the output of the Constant block determines the data
                   type (int8) of the port to which the Ground block is connected. That port
                   in turn determines the type of the signal output by the Ground block.

                   The Ground block supports all data types supported by Simulink,
                   including fixed-point data types.

**Parameters
and
Dialog
Box**
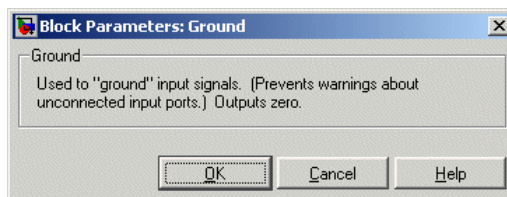
Ground

Characteristics

Sample Time	Inherited from driven block
Dimensionalized	Yes

Purpose   Detect crossing point

Library   Discontinuities
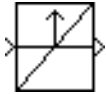
Description   The Hit Crossing block detects when the input reaches the **Hit crossing offset** parameter value in the direction specified by the **Hit crossing direction** property.

The block accepts one input of type `double`. If you select the **Show output port** check box, the block output indicates when the crossing occurs. If the input signal is exactly the value of the offset value after the hit crossing is detected, the block continues to output a value of 1. If the input signals at two adjacent points bracket the offset value (but neither value is exactly equal to the offset), the block outputs a value of 1 at the second time step. If the **Show output port** check box is *not* selected, the block ensures that the simulation finds the crossing point but does not generate output. If the input signal is constant and equal to the offset value, the block outputs 1 only if the **Hit crossing direction** property is set to `either`.

When the block's **Hit crossing direction** property is set to `either`, the block serves as an "Almost Equal" block, useful in working around limitations in finite mathematics and computer precision. Used for these reasons, this block might be more convenient than adding logic to your model to detect this condition.

The `hardstop` and `clutch` demos illustrate the use of the Hit Crossing block. In the `hardstop` demo, the Hit Crossing block is in the Friction Model subsystem. In the `clutch` demo, the Hit Crossing block is in the Lockup Detection subsystem.

Data Type Support   The Hit Crossing block outputs a signal of type `Boolean` if Boolean logic signals are enabled (see "Enabling Strict Boolean Type Checking"). Otherwise, the block outputs a signal of type `double`.

Hit Crossing

Parameters and Dialog Box
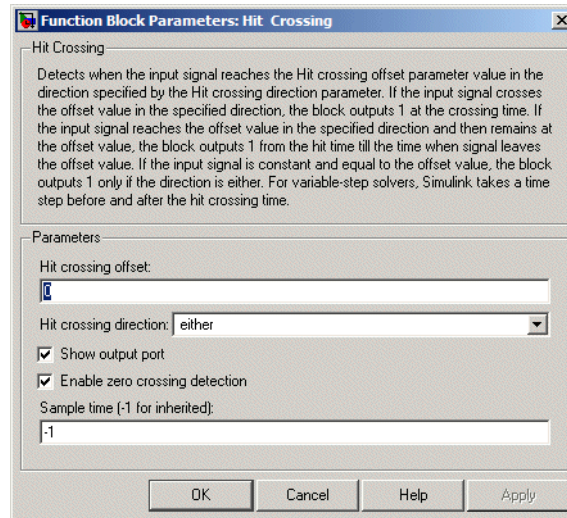
Hit crossing offset

The value whose crossing is to be detected.

Hit crossing direction

The direction from which the input signal approaches the hit crossing offset for a crossing to be detected.

Show output port

If selected, draw an output port.

Enable zero crossing detection

Select to enable zero crossing detection. For more information, see "Zero Crossing Detection" in the "How Simulink Works" chapter of the Using Simulink documentation.

Sample time (-1 for inherited)

Specify the time interval between samples. To inherit the sample time, set this parameter to -1. See "Specifying Sample Time" in the online documentation for more information.

Characteristics

Direct Feedthrough	Yes
Sample Time	Inherited from driving block
Scalar Expansion	Yes
Dimensionalized	Yes
Zero Crossing	Yes, if enabled.

IC

Purpose   Set the initial value of a signal

Library   Signal Attributes
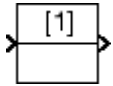
Description The IC block sets the initial condition of the signal at its input port, i.e.,
the value of the signal at the simulation start time (t=0, by default). The
block does this by outputting the specified initial condition when you
start the simulation, regardless of the actual value of the input signal.
Thereafter, the block outputs the actual value of the input signal.

>[1]>

The IC block is useful for providing an initial guess for the algebraic
state variables in the loop. For more information, see "Algebraic
Loops" in the "How Simulink Works" chapter of the Using Simulink
documentation.

Data Type Support The IC block accepts and outputs signals of any Simulink built-in and
fixed-point data type. The **Initial value** parameter accepts any built-in
data type supported by Simulink.

Parameters and Dialog Box
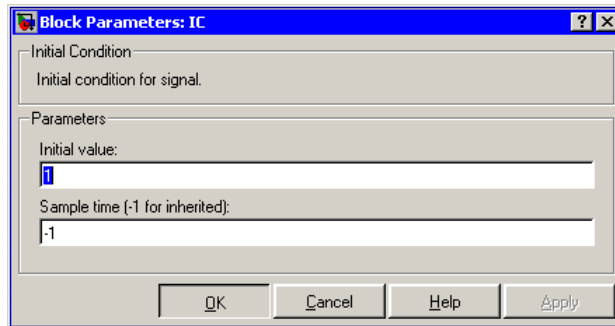
Initial value
    Specify the initial value for the input signal.

Sample time (-1 for inherited)
    Specify the time interval between samples. To inherit the sample
    time, set this parameter to -1. See "Specifying Sample Time" in
    the online documentation for more information.

Examples   The following diagram illustrates how the IC block initializes a signal labeled "test signal."
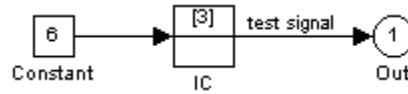
At t = 0, the signal value is 3. Afterwards, the signal value is 6.

Characteristics

Direct Feedthrough	Yes
Sample Time	Specified in the **Sample time** parameter
Scalar Expansion	Yes, of parameter only
Dimensionalized	Yes
Zero Crossing	No

If

Purpose   Model `if-else` control flow

Library   Ports & Subsystems

Description   The If block, along with If Action subsystems containing Action Port blocks, implements standard C-like `if-else` logic.
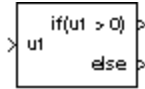
The following shows a completed `if-else` control flow statement.
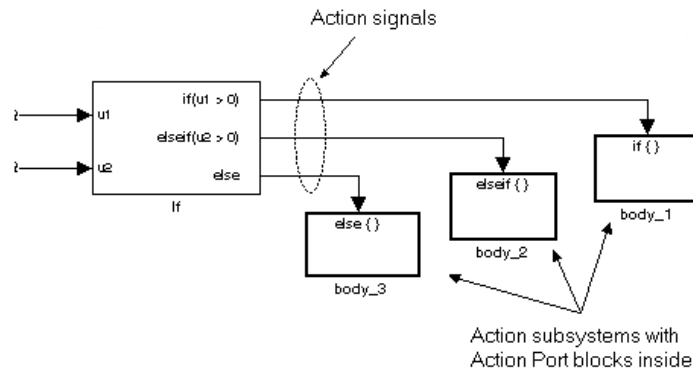
In this example, the inputs to the If block determine the values of conditions represented as output ports. Each output port is attached to an If Action subsystem. The conditions are evaluated top down starting with the `if` condition. If a condition is true, its If Action subsystem is executed and the If block does not evaluate any remaining conditions.

The preceding `if-else` control flow statement can be represented by the following pseudocode.

```
if (u1 > 0) {
 body_1;
}
else if (u2 > 0){
 body_2;
}
else {
 body_3;
```

```
}
```

You construct a Simulink `if-else` control flow statement like the preceding example as follows:

1 Place an If block in the current system.

2 Open the **Block Parameters** dialog of the If block and enter as follows:

- Enter the **Number of inputs** field with the required number of inputs necessary to define conditions for the `if-else` control flow statement.

  Elements of vector inputs can be accessed for conditions using (row, column) arguments. For example, you can specify the fifth element of the vector u2 in the condition u2(5) > 0 in an **If expression** or **Elseif expressions** field.

- Enter the expression for the if condition of the `if-else` control flow statement in the **If expression** field.

  This creates an if output port for the If block with a label of the form `if(condition)`. This is the only required If Action signal output for an If block.

- Enter expressions for any elseif conditions of the `if-else` control flow statement in the **Elseif expressions** field.

  Use a comma to separate one condition from another. Entering these conditions creates an output port for the If block for each condition, with a label of the form `elseif(condition)`. elseif ports are optional and not required for operation of the If block.

- Check the **Show else condition** check box to create an else output port.

  The else port is optional and not required for the operation of the If block.

If

3 Create If Action subsystems to connect to each of the if, else, and elseif ports.

These consist of a subsystem with an Action Port block. When you place an Action Port block inside each subsystem, an input port named Action is added to the subsystem.

4 Connect each if, else, and elseif port of the If block to the Action port of an If Action subsystem.

When you make the connection, the icon for the If Action block is renamed to the type of the condition that it attaches to.

Note During simulation of an `if-else` control flow statement, the Action signal lines from the If block to the If Action subsystems turn from solid to dashed.

5 In each If Action subsystem, enter the Simulink blocks appropriate to the body to be executed for the condition it handles.

Note All blocks in an If Action Subsystem must run at the same rate as the driving If block. You can achieve this by setting each block's sample time parameter to be either inherited (`-1`) or the same value as the If block's sample time.

In the preceding example, the If Action subsystems are named `body_1`, `body_2`, and `body_3`.

Data Type Support   Inputs `u1,u2,...,un` can be scalar or vector of any built-in Simulink data type. For a discussion on the data types supported by Simulink, see "Data Types Supported by Simulink" in the Simulink documentation.

Outputs from the if, else, and elseif ports are Action signals to If Action subsystems that are created with Action Port blocks and subsystems. See `Action Port`.

Parameters and Dialog Box
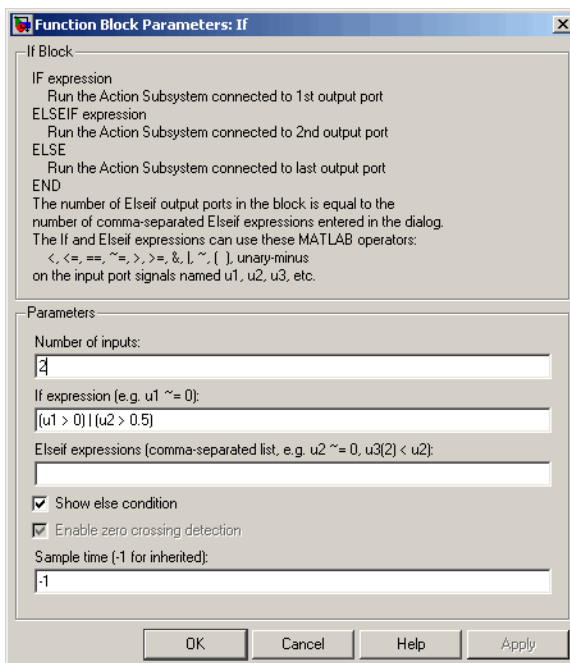
Number of inputs

The number of inputs to the If block. These appear as data input ports labeled with a `'u'` character followed by a number, `1,2,...,n`, where n equals the number of inputs that you specify.

If expression

The condition for the `if` output port. This condition appears on the If block adjacent to the `if` output port. The `if` expression can use any of the following operators: `<. <=, ==, ~=, >, >=, &, |, ~, (), unary-minus`. The If Action subsystem attached to the `if` port executes if its condition is true.

Elseif expressions

> A string list of `elseif` conditions delimited by commas. These conditions appear below the `if` port and above the `else` port if you select the **Show else condition** check box. `elseif` expressions can use any of the following operators: `<`, `<=`, `==`, `~=`, `>`, `>=`, `&`, `|`, `~`, `()`, `unary-minus`. The If Action subsystem attached to an `elseif` port executes if its condition is true and all of the `if` and `elseif` conditions are false.

Show else condition

> If you select this check box, an `else` port is created. The If Action subsystem attached to the `else` port executes if the `if` port and all the `elseif` ports are false.

Enable zero crossing detection

> Select to enable zero crossing detection. For more information, see "Zero Crossing Detection" in the "How Simulink Works" chapter of the Using Simulink documentation.

Sample time

> Specify the sample time of the input signal. See "Specifying Sample Time" in the online documentation for more information.

Examples   The If block does not directly support fixed-point data types. However, you can use the Compare To Constant block to work around this limitation.

For example, consider the following floating-point model.
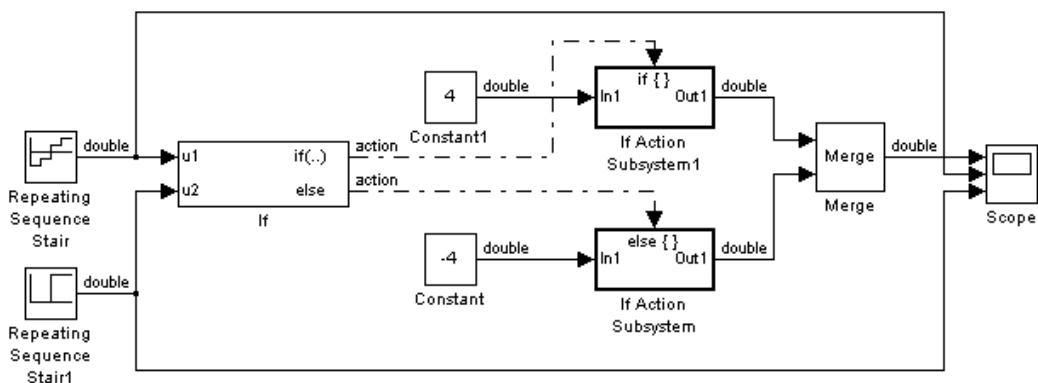
In this model, the If Action subsystems use their default configurations. The block and simulation parameters for the model are set to their default values except as follows:

Block or Dialog	Parameter	Setting
Configuration Parameters Dialog — **Solver** pane	**Start time**	`0.0`
	Stop time	`1.0`
	Type	`Fixed-step`
	Solver	`discrete (no continuous states)`
	Fixed-step size	`.1`
Repeating Sequence Stair	**Vector of output values**	`[-2 -1 1 2].'`
Repeating Sequence Stair1	**Vector of output values**	`[0 0 0 0 1 1 1 1].'`
If	**Number of inputs**	`2`

Block or Dialog	Parameter	Setting
	If expression	`(u1 > 0) | (u2 > 0.5)`
	Show else condition	selected
Constant	**Constant value**	`-4`
Constant1	**Constant value**	`4`
Scope	**Number of axes**	`3`
	Time range	`1`

For this model, if input u1 is greater than 0 or input u2 is greater than 0.5, the output is 4. Otherwise, the output is -4. The Scope block shows the output, u1, and u2 as depicted here:
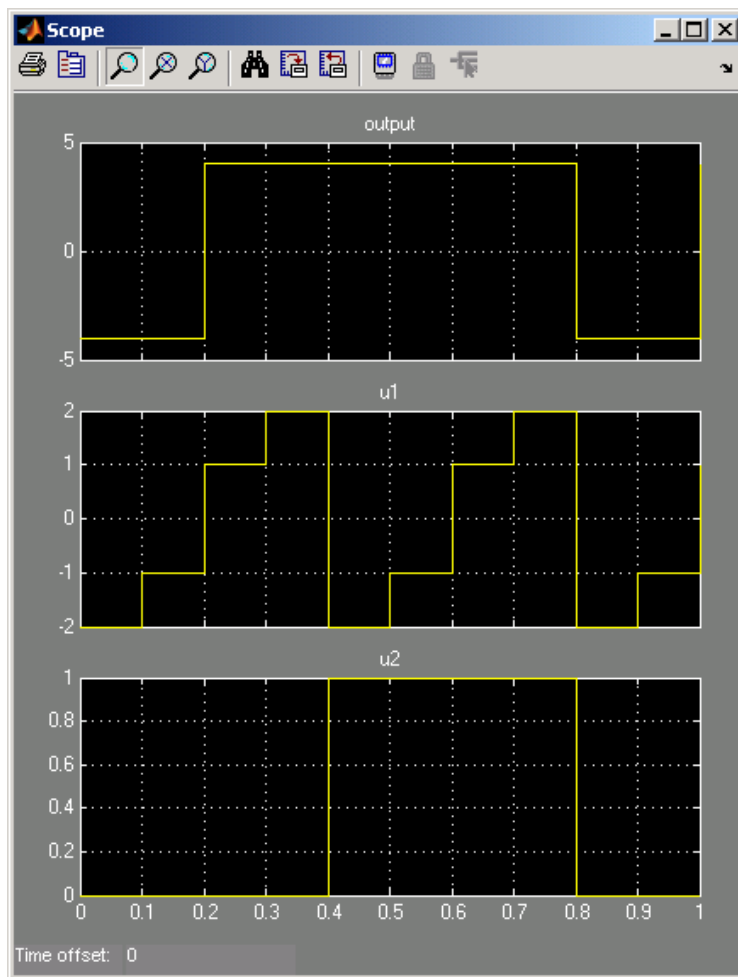
The same model can be implemented using fixed-point data types:
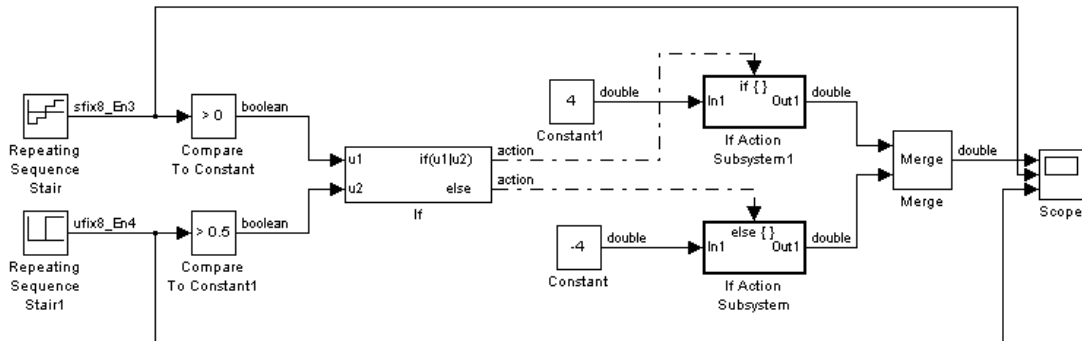
The Repeating Sequence stair blocks are now outputting fixed-point data types.

The Compare To Constant blocks implement two parts of the **If expression** that is used in the If block in the floating-point version of the model, (u1 > 0) and (u2 > 0.5). The OR operation, (u1|u2), can still be implemented inside the If block. For a fixed-point model, the expression must be partially implemented outside of the If block as it is here.

The block and simulation parameters for the fixed-point model are the same as for the floating-point model with the following exceptions and additions:

Block	Parameter	Setting
Compare To Constant	**Operator**	>
	Constant value	0
	Output data type mode	Boolean
	Enable zero crossing detection	unselected
Compare To Constant1	**Operator**	>

Block	Parameter	Setting
	Constant value	0.5
	Output data type mode	Boolean
	Enable zero crossing detection	unselected
If	**Number of inputs**	2
	If expression	u1|u2

Characteristics

Direct Feedthrough	Yes
Sample Time	Inherited from driving block
Scalar Expansion	No
Dimensionalized	Yes
Zero Crossing	Yes, if enabled

If Action Subsystem

Purpose　　　　Represent a subsystem whose execution is triggered by an If block

Library　　　　Ports & Subsystems

Description　　The If Action Subsystem block is a Subsystem block that is
preconfigured to serve as a starting point for creating a subsystem
whose execution is triggered by an If block.
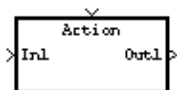
Note All blocks in an If Action Subsystem must run at the same rate
as the driving If block. You can achieve this by setting each block's
sample time parameter to be either inherited (-1) or the same value as
the If block's sample time.

For more information, see the If block and "Modeling with Control
Flow Blocks" in the "Creating a Model" chapter of the Using Simulink
documentation.

Purpose   Increase the real world value of the signal by one

Library   Additional Math & Discrete / Additional Math: Increment - Decrement

Description   The Increment Real World block increases the real world value of the signal by one. Overflows always wrap.

Data Type Support   The Increment Real World block accepts signals of any data type supported by Simulink, including fixed-point data types.

Parameters and Dialog Box

Characteristics

Direct Feedthrough	Yes
Scalar Expansion	No

See Also   Decrement Real World, Increment Stored Integer

Increment Stored Integer

Purpose   Increase the stored integer value of a signal by one

Library   Additional Math & Discrete / Additional Math: Increment - Decrement

Description   The Increment Stored Integer block increases the stored integer value
                   of a signal by one.
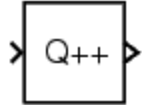
Floating-point signals are also increased by one, and overflows always
wrap.

Data Type   The Increment Stored Integer block accepts signals of any data type
Support   supported by Simulink, including fixed-point data types.

**Parameters
and
Dialog
Box**

Characteristics

Direct Feedthrough	Yes
Scalar Expansion	No

See Also   Decrement Stored Integer, Increment Real World

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Purpose   Switch output between different inputs based on the value of the first input

Library   Signal Routing

Description   The Index Vector block is an implementation of the Multiport Switch block. See `Multiport Switch` for more information.

Inport

Purpose   Create an input port for a subsystem or an external input

Library   Ports & Subsystems, Sources

Description Inport blocks are the links from outside a system into the system.

Simulink assigns Inport block port numbers according to these rules:

- It automatically numbers the Inport blocks within a top-level system or subsystem sequentially, starting with 1.

- If you add an Inport block, it is assigned the next available number.

- If you delete an Inport block, other port numbers are automatically renumbered to ensure that the Inport blocks are in sequence and that no numbers are omitted.

- If you copy an Inport block into a system, its port number is *not* renumbered unless its current number conflicts with an Inport block already in the system. If the copied Inport block port number is not in sequence, you must renumber the block or you will get an error message when you run the simulation or update the block diagram.

You can specify the dimensions of the input to the Inport block using the **Port dimensions** parameter, or let Simulink determine it automatically by providing a value of -1.

The **Sample time** parameter is the rate at which the signal is coming into the system. A value of -1 causes the block to inherit its sample time from the block driving it. You might need to set this parameter for Inport blocks in a top-level system or in models where Inport blocks are driven by blocks whose sample times cannot be determined. See "Specifying Sample Time" in the online documentation for more information.

Inport Blocks in a Subsystem

Inport blocks in a subsystem represent inputs to the subsystem. A signal arriving at an input port on a Subsystem block flows out of the associated Inport block in that subsystem. The Inport block associated

with an input port on a Subsystem block is the block whose **Port number** parameter matches the relative position of the input port on the Subsystem block. For example, the Inport block whose **Port number** parameter is 1 gets its signal from the block connected to the topmost port on the Subsystem block.

If you renumber the **Port number** of an Inport block, the block becomes connected to a different input port, although the block continues to receive its signal from the same block outside the subsystem.

The Inport block name appears in the Subsystem icon as a port label. To suppress display of the label, select the Inport block and choose **Hide Name** from the **Format** menu.

Inport Blocks in a Top-Level System

Inport blocks in a top-level system have two uses:

- To supply external inputs from the workspace, use either the **Configuration Parameters** dialog (see "Importing Data from the MATLAB Workspace") or the ut argument of the sim command (see sim) to specify the inputs.

- To provide a means for perturbation of the model by the linmod and trim analysis functions, use Inport blocks to define the points where inputs are injected into the system.

Creating Duplicate Inports

You can create any number of duplicates of an Inport block. The duplicates are graphical representations of the original intended to simplify block diagrams by eliminating unnecessary lines. The duplicate has the same port number, properties, and output as the original. Changing a duplicate's properties changes the original's properties and vice versa.

To create a duplicate of an Inport block,

1 Select the block.

Inport

2 Select **Copy** from the Simulink **Edit** menu or from the block's context menu.

3 Position the mouse cursor in the model's block diagram where you want to create the duplicate.

4 Select **Paste Duplicate Inport** from the Simulink **Edit** menu or the block diagram's context menu.

Data Type Support

The Inport block accepts complex or real signals of any data type supported by Simulink, including fixed-point data types. For a discussion on the data types supported by Simulink, see "Data Types Supported by Simulink".

The numeric and data types of the block's output are the same as those of its input. You can specify the signal type, data type, and sampling mode of an external input to a root-level Inport block using the **Signal type**, **Data type**, and **Sampling mode** parameters.

The elements of a signal array connected to a root-level Inport block must be of the same numeric and data types. Signal elements connected to a subsystem input port can be of differing numeric and data types except in the following circumstance: If the subsystem contains an Enable or Trigger block or is an Atomic Subsystem and the input port, or an element of the input port, is connected directly to an output port, the input elements must be of the same type. For example, consider the follow enabled subsystem.
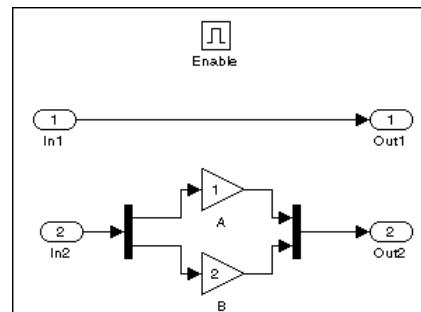
In this example, the elements of a signal vector connected to In1 must be of the same type. The elements connected to In2, however, can be of differing types.

Parameters and Dialog Box

The **Main** pane of the Inport block dialog appears as follows:
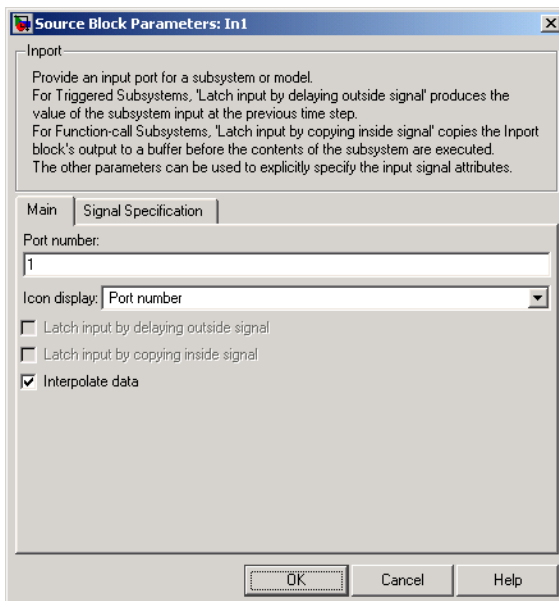
Port number

    Specify the port number of the Inport block.

Icon display

    Specifies the information to be displayed on the icon of this input port. The options are:

Inport

`Port number`	Displays port number of this port.
`Signal name`	Displays the name of the signal connected to this port (or signals if the input is a bus).
`Port name and signal name`	Displays both the port number and the names of the signals connected to this port.

Latch input by delaying outside signal

This option applies only to triggered subsystems and is enabled only if the Inport block resides in a triggered subsystem. If selected, the block outputs the value of the input signal at the previous time step. This enables the subsystem to implement hardware triggering, defined as:

```
if (trigger_signal_edge_detected) {
  out(t) = f(in(t-h));   // h == last step size
}
```

If disabled, the block outputs the value of the input signal at the current time step. This enables the subsystem to implement software triggering, defined as:

```
if (trigger_signal_edge_detected) {
  out(t) = f(in(t));
}
```

Type `sl_subsys_semantics` at the MATLAB prompt for examples using latched inputs with triggered subsystems. The Inport block indicates that this option is selected by displaying <Lo>.
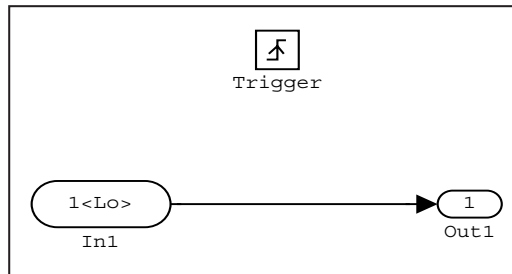
Latch input by copying inside signal

> This option applies only to function-call subsystems and hence is enabled only if the Inport block resides in a function-call subsystem. Selecting this option causes Simulink to copy the signal output by the block into a buffer before executing the contents of the subsystem and to use this copy as the block's output during execution of the subsystem. This ensures that the subsystem's inputs, including those generated by the subsystem's context, will not change during execution of the subsystem. The Inport block displays <Li> to indicate that this option is selected.
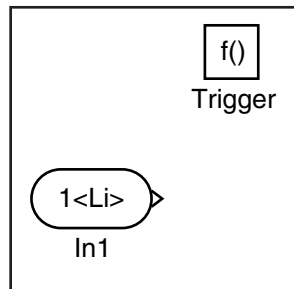
Interpolate data

> Select this parameter to cause the block to interpolate or extrapolate output at time steps for which no corresponding workspace data exists when loading data from the workspace. See "Importing Data from the MATLAB Workspace" for more information.

Inport

The **Signal Specification** pane of the Inport block dialog appears as follows:
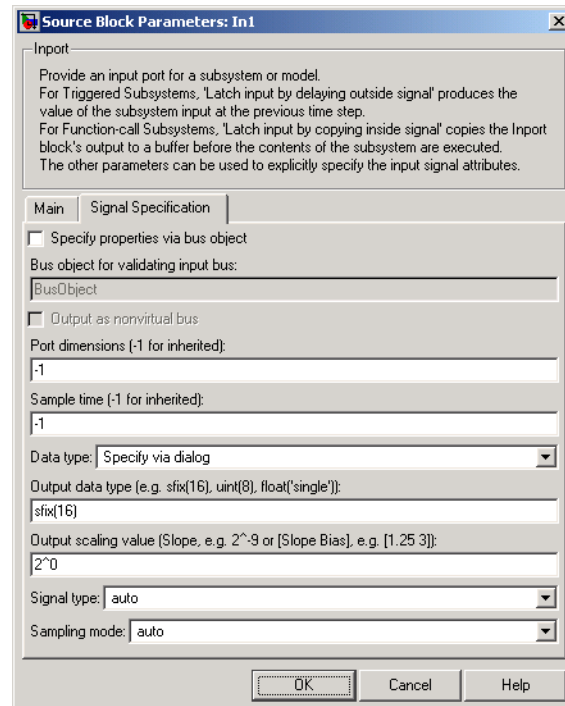
Specify properties via bus object

Select this option to use a bus object to define the structure of the bus created by this block (see "Working with Data Objects" and Simulink.Bus class to learn how to create bus objects).

Bus object for validating input bus

This option is enabled only if you select the **Specify properties via bus object option**. It specifies the name of the bus object that defines the structure that a bus must have to be connected to this input port. At the beginning of a simulation or when you update the model's diagram, Simulink checks whether the bus

connected to this input port has the specified structure. If not, Simulink displays an error message.

Output as nonvirtual bus

This option is enabled only if you select the **Specify properties via bus object option**. If this option is selected, this block outputs a nonvirtual bus; otherwise, it outputs a virtual bus (see "Virtual Versus Nonvirtual Buses"). Select this option if you want code generated from this model to use a C structure to define the structure of the bus signal output by this block.

Port dimensions

Specify the dimensions of the input signal to the Inport block. Valid values are:

-1	Dimensions are inherited from input signal
n	Vector signal of width n accepted
[m n]	Matrix signal having m rows and n columns accepted

Sample time

Specify the sample time of the input signal. See "Specifying Sample Time".

Data type

Specify the data type of the external input. To accept any data type, set this parameter to auto.

Output data type

Specify any data type, including fixed-point data types. This parameter is only visible if you select Specify via dialog for the **Data type** parameter.

Output scaling value

Set the output scaling using binary point-only or [Slope Bias] scaling. This parameter is only visible if you select Specify via dialog for the **Data type** parameter.

Inport

Signal type

Specify the numeric type (`real` or `complex`) of the external input. To accept either type, set this parameter to `auto`.

Sampling mode

Specify the sampling mode (`Sample based` or `Frame based`) that the input signal must match. To accept any sampling mode, set this parameter to `auto`. This parameter is intended to support signal processing applications based on Simulink. See the documentation for the `buffer` function provided by the Signal Processing Toolbox or "Frame-Based Signals" in the documentation for the Signal Processing Blockset for information about frame-based signals.

Characteristics

Sample Time	Specified in the **Sample time** parameter
Dimensionalized	Yes

Purpose   Delay a signal N sample periods

Library   Discrete

Description   The Integer Delay block delays its input by N sample periods.
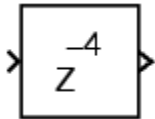
The block accepts one input and generates one output, both of which can be scalar or vector. If the input is a vector, all elements of the vector are delayed by the same sample period.

Data Type Support   The Integer Delay block accepts signals of any data type supported by Simulink, including fixed-point data types.

Parameters and Dialog Box

Initial condition
The initial output of the simulation. The **Initial condition** parameter is converted from a double to the input data type offline using round-to-nearest and saturation.

Sample time (-1 for inherited)
Specify the time interval between samples. To inherit the sample time, set this parameter to -1. See "Specifying Sample Time" in the online documentation for more information.

Integer Delay

Number of delays
The number of periods to delay the input signal.

Characteristics

Direct Feedthrough	No
Sample Time	Specified in the **Sample time** parameter
Scalar Expansion	Yes, of input or initial conditions

Integrator

Purpose   Integrate a signal

Library   Continuous
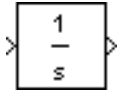
Description   The Integrator block outputs the integral of its input at the current time step. The following equation represents the output of the block y as a function of its input u and an initial condition y_0, where y and u are vector functions of the current simulation time t.

$$y(t) = \int_{t_0}^{t} u(t)dt + y_0$$

Simulink can use a number of different numerical integration methods to compute the Integrator block's output, each with advantages in particular applications. The **Solver** pane of the **Configuration parameters** dialog box (see The Solver Pane) allows you to select the technique best suited to your application.

Simulink treats the Integrator block as a dynamic system with one state, its output. The Integrator block's input is the state's time derivative.

$$x = y(t)$$

$$x_0 = y_0$$

$$\dot{x} = u(t)$$

The currently selected solver computes the output of the Integrator block at the current time step, using the current input value and the value of the state at the previous time step. To support this computational model, the Integrator block saves its output at the current time step for use by the solver to compute its output at the next time step. The block also provides the solver with an initial condition for use in computing the block's initial state at the beginning of a simulation run. The default value of the initial condition is 0. The block's parameter dialog box allows you to specify another value for the initial condition or create an initial value input port on the block.

Integrator

The parameter dialog box also allows you to

- Define upper and lower limits on the integral
- Create an input that resets the block's output (state) to its initial value, depending on how the input changes
- Create an optional state output that allows you to use the value of the block's output to trigger a block reset

Use the Discrete-Time Integrator block to create a purely discrete system.

Defining Initial Conditions

You can define the initial conditions as a parameter on the block dialog box or input them from an external signal:

- To define the initial conditions as a block parameter, specify the **Initial condition source** parameter as `internal` and enter the value in the **Initial condition** parameter field.
- To provide the initial conditions from an external source, specify the **Initial condition source** parameter as `external`. An additional input port appears under the block input, as shown in this figure.
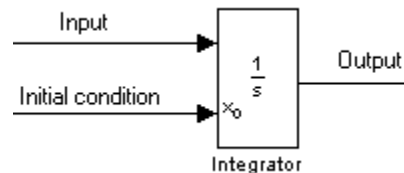
Note If the integrator limits its output (see **"Limiting the Integral" on page 2-333)**, the initial condition must fall inside the integrator's saturation limits. If the initial condition is outside the block's saturation limits, the block displays an error message.

Limiting the Integral

To prevent the output from exceeding specifiable levels, select the **Limit output** check box and enter the limits in the appropriate parameter fields. Doing so causes the block to function as a limited integrator. When the output reaches the limits, the integral action is turned off to prevent integral wind up. During a simulation, you can change the limits but you cannot change whether the output is limited. The output is determined as follows:

- When the integral is less than or equal to the **Lower saturation limit**, the output is held at the **Lower saturation limit**.

- When the integral is between the **Lower saturation limit** and the **Upper saturation limit**, the output is the integral.

- When the integral is greater than or equal to the **Upper saturation limit**, the output is held at the **Upper saturation limit**.

To generate a signal that indicates when the state is being limited, select the **Show saturation port** check box. A saturation port appears below the block output port, as shown on this figure.
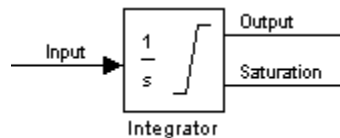
The signal has one of three values:

- 1 indicates that the upper limit is being applied.

- 0 indicates that the integral is not limited.

- -1 indicates that the lower limit is being applied.

When you select this option, the block has three zero crossings: one to detect when it enters the upper saturation limit, one to detect when

it enters the lower saturation limit, and one to detect when it leaves saturation.

Resetting the State

The block can reset its state to the specified initial condition based on an external signal. To cause the block to reset its state, select one of the **External reset** choices. A trigger port appears below the block's input port and indicates the trigger type, as shown in this figure.
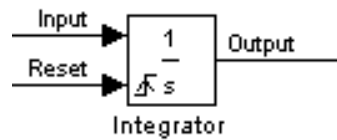
- Select `rising` to trigger the state reset when the reset signal has a rising edge.

- Select `falling` to trigger the state reset when the reset signal has a falling edge.

- Select `either` to trigger the reset when either a rising or falling signal occurs.

- Select `level` to trigger the reset and hold the output to the initial condition while the reset signal is nonzero.

The reset port has direct feedthrough. If the block output is fed back into this port, either directly or through a series of blocks with direct feedthrough, an algebraic loop results (see "Algebraic Loops"). The Integrator block's state port allows you to feed back the block's output without creating an algebraic loop.

About the State Port

Selecting the **Show state port** option on the Integrator block's parameter dialog box causes an additional output port, the state port, to appear atop the Integrator block.
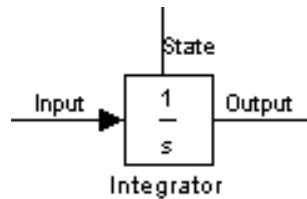
The output of the state port is the same as the output of the block's standard output port except for the following case. If the block is reset in the current time step, the output of the state port is the value that would have appeared at the block's standard output if the block had not been reset. The state port's output appears earlier in the time step than the output of the Integrator block's output port. This allows you to avoid creating algebraic loops in the following modeling scenarios:

- Self-resetting integrators (see "Creating Self-Resetting Integrators" on page 2-335)

- Handing off a state from one enabled subsystem to another (see "Handing Off States Between Enabled Subsystems" on page 2-337)

Note The state port is intended to be used specifically in these two scenarios. When updating a model, Simulink checks to ensure that the state port is being used in one of these two scenarios. If not, Simulink signals an error. Also, Simulink does not allow you to log the output of this port in a referenced model. If logging is enabled for the port, Simulink generates a "signal not found" warning during simulation of the referenced model.

Creating Self-Resetting Integrators

The Integrator block's state port allows you to avoid creating algebraic loops when creating an integrator that resets itself based on the value of its output. Consider, for example, the following model.

Integrator
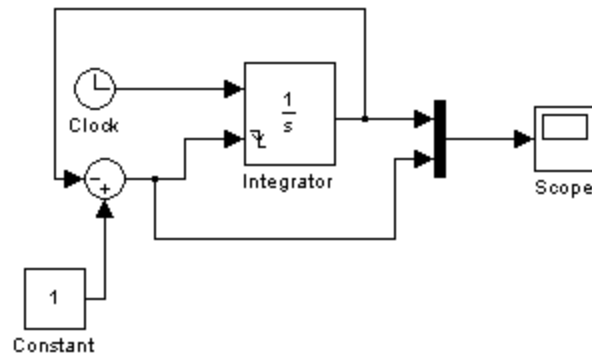
This model tries to create a self-resetting integrator by feeding the integrator's output, subtracted from 1, back into the integrator's reset port. In so doing, however, the model creates an algebraic loop. To compute the integrator block's output, Simulink needs to know the value of the block's reset signal, and vice versa. Because the two values are mutually dependent, Simulink cannot determine either. It therefore signals an error if you try to simulate or update this model.

The following model uses the integrator's state port to avoid the algebraic loop.
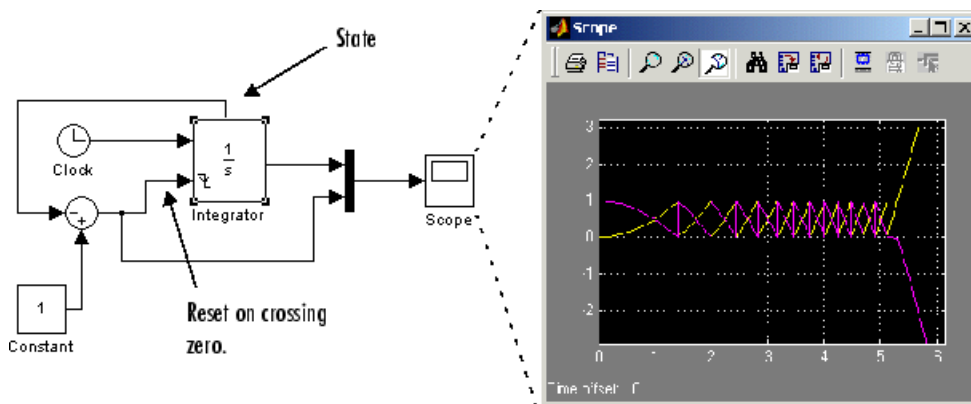
In this version, the value of the reset signal depends on the value of the state port. The value of the state port is available earlier in the current time step than the value of the integrator block's output port. Thus, Simulink can determine whether the block needs to be reset before computing the block's output, thereby avoiding the algebraic loop.

Handing Off States Between Enabled Subsystems

The state port allows you to avoid an algebraic loop when passing a state between two enabled subsystems. Consider, for example, the following model.
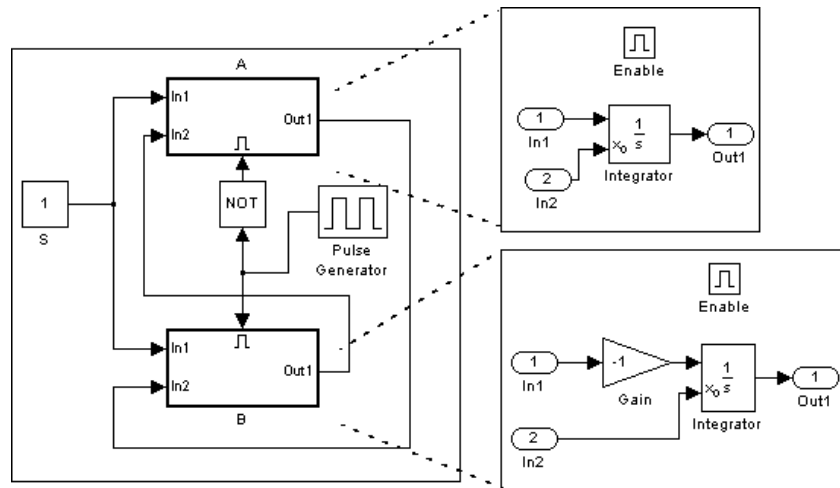
In this model, a constant input signal drives two enabled subsystems that integrate the signal. A pulse generator generates an enabling signal that causes execution to alternate between the two subsystems. The enable port of each subsystem is set to reset. This causes the subsystem to reset its integrator when it becomes active. Resetting the integrator causes the integrator to read the value of its initial condition port. The initial condition port of the integrator in each subsystem is connected to the output port of the integrator in the other subsystem.

Integrator

This connection is intended to enable continuous integration of the input signal as execution alternates between the two subsystems. However, the connection creates an algebraic loop. To compute the output of A, Simulink needs to know the output of B, and vice versa. Because the outputs are mutually dependent, Simulink cannot compute them. It therefore generates an error if you attempt to update or simulate this model.

The following version of the same model uses the integrator state port to avoid creating an algebraic loop when handing off the state.
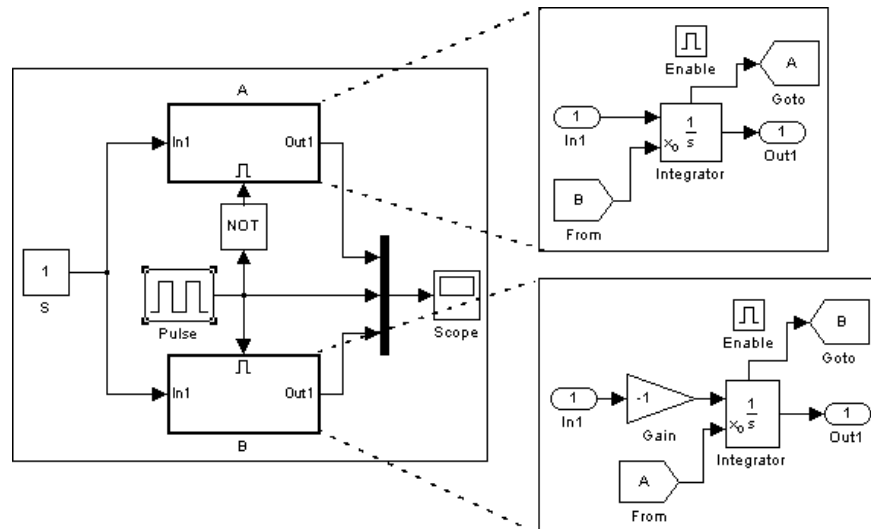
In this model, the initial condition of the integrator in A depends on the value of the state port of the integrator in B, and vice versa. The values of the state ports are updated earlier in the simulation time step than the values of the integrator output ports. Thus, Simulink can compute the initial condition of either integrator without knowing the final output value of the other integrator. For another example of using the state port to hand off states between conditionally executed subsystems, see the clutch model.

Note Simulink does not permit three or more enabled subsystems to hand off a model state. If Simulink detects that a model is handing off a state among more than two enabled subsystems, it generates an error.

Specifying the Absolute Tolerance for the Block's Outputs

By default Simulink uses the absolute tolerance value specified in the **Configuration Parameters** dialog box (see "Specifying Variable-Step Solver Error Tolerances") to compute the output of the Integrator block. If this value does not provide sufficient error control, specify a more appropriate value in the **Absolute tolerance** field of the Integrator block's dialog box. The value that you specify is used to compute all of the block's outputs.

Choosing All Options

When all options are selected, the icon looks like this.
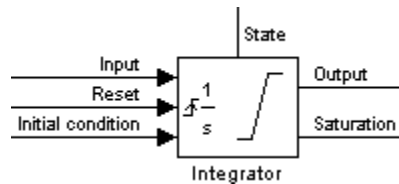
Data Type Support

The Integrator block accepts and outputs signals of type `double` on its data ports. Its external reset port accepts signals of type `double` or `Boolean`.

Integrator

**Parameters
and
Dialog
Box**
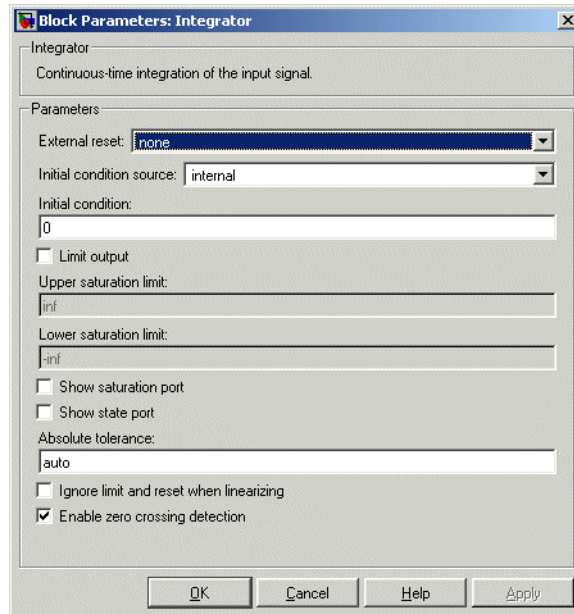
External reset

Resets the states to their initial conditions when a trigger event (`rising`, `falling`, `either`, or `level`) occurs in the reset signal.

Initial condition source

Gets the states' initial conditions from the **Initial condition** parameter (if set to `internal`) or from an external block (if set to `external`).

Initial condition

The states' initial conditions. Set the **Initial condition source** parameter value to `internal`. Simulink does not allow the initial condition of this block to be `inf` or `NaN`.

Limit output

If selected, limits the states to a value between the **Lower saturation limit** and **Upper saturation limit** parameters.

Upper saturation limit

The upper limit for the integral. The default is `inf`.

Lower saturation limit

The lower limit for the integral. The default is `-inf`.

Show saturation port

If selected, adds a saturation output port to the block.

Show state port

If selected, adds an output port to the block for the block's state.

Absolute tolerance

Absolute tolerance used to compute the block's outputs. You can enter `auto` or a numeric value. If you enter `auto`, Simulink determines the absolute tolerance (see "Specifying Variable-Step Solver Error Tolerances"). If you enter a numeric value, Simulink uses the specified value to compute the block's outputs. Note that a numeric value overrides the setting for the absolute tolerance in the **Configuration Parameters** dialog box.

Ignore limit and reset when linearizing

Select this option to cause Simulink linearization commands to treat this block as unresettable and as having no limits on its output, regardless of the settings of the block's reset and output limitation options. This allows you to linearize a model around an operating point that causes the integrator to reset or saturate.

Enable zero crossing detection

If this option, **Limit output**, and zero-crossing detection for the model as a whole are selected, the Integrator block uses zero-crossings to detect and take a time step at any of the following events: reset, entering or leaving an upper saturation state, entering or leaving a lower saturation state. For more information, see "Zero Crossing Detection" in the "How Simulink Works" chapter of the Using Simulink documentation.

Integrator

Characteristics

Direct Feedthrough	Yes, of the reset and external initial condition source ports
Sample Time	Continuous
Scalar Expansion	Yes, of parameters
States	Inherited from driving block or parameter
Dimensionalized	Yes
Zero Crossing	Yes, if enabled and you select the **Limit output** option, one for detecting reset, one each to detect upper and lower saturation limits, one when leaving saturation

Purpose   Perform high-performance constant or linear interpolation, mapping N input values to a sampled representation of a function in N variables via output from PreLookup Index Search block

Library   Lookup Tables
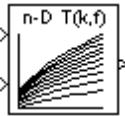
Description   The Interpolation (n-D) Using PreLookup block is intended for use with the PreLookup Index Search block. The PreLookup Index Search block calculates the index and interval fraction that specifies how its input value relates to the breakpoint data set. You feed the resulting (index, fraction) pair into an Interpolation (n-D) Using PreLookup block to interpolate an *n*-dimensional table. This combination of blocks performs the equivalent operation that a single instance of the Lookup Table (n-D) block performs. But by using these blocks instead, you can potentially increase the simulation performance of models that use many interpolation blocks.

This block supports two interpolation methods: flat (constant) interval lookup and linear interpolation. These operations can be applied to 1-D, 2-D, 3-D, 4-D and higher dimensioned tables.

You define a set of output values as the **Table data** parameter. These table values must correspond to the breakpoint data sets specified in the PreLookup Index Search blocks. For example, the following model illustrates the use of an Interpolation (n-D) Using PreLookup block with two PreLookup Index Search blocks:

Interpolation (n-D) Using PreLookup
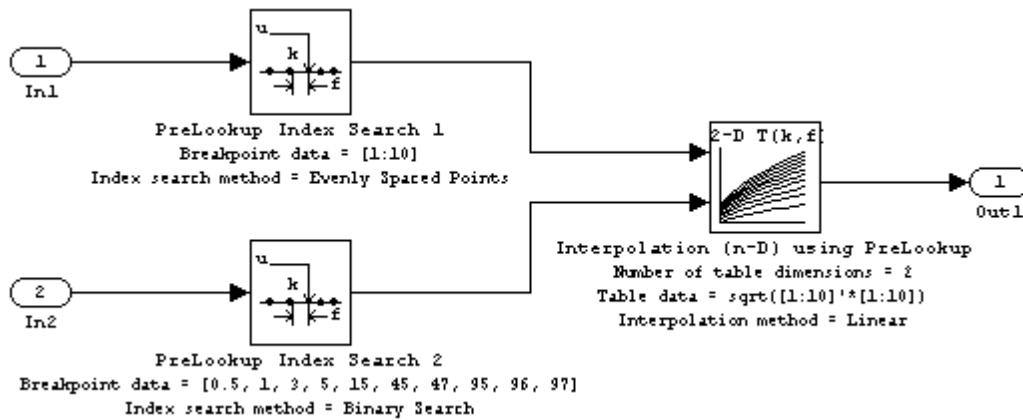
The breakpoint data set in the first PreLookup Index Search block contains 10 breakpoints, while that of the second PreLookup Index Search block contains 10 breakpoints. Consequently, the Interpolation (n-D) Using PreLookup block's table data is of size 10-by-10.

The block generates its output by interpolating the table values based on the (index, fraction) pairs fed into the block by each PreLookup Index Search block:

- If the inputs match breakpoint parameter values, the output is the table value at the intersection of the row, column, and higher dimensions' breakpoints.

- If the inputs do not match row and column parameter values, the block generates output by interpolating between the appropriate table values. If either or both block inputs are less than the first or greater than the last row or column parameter values, the block extrapolates from the first two or last two points in each corresponding dimension.

The block can perform interpolation on a portion of the table. For more information, see "Lookups: Prelookup and Sub-Table Interpolation Blocks" in the **Simulink > Modeling Features** section on the MATLAB Help browser's **Demos** pane.

**Data Type
Support**

The Interpolation (n-D) Using PreLookup block accepts signals of types
double or single, but for any given block, the inputs must all be of the
same type. The **Table data** parameter must be of the same type as the
inputs. The output data type is set to the **Table data** data type.

**Parameters
and
Dialog
Box**
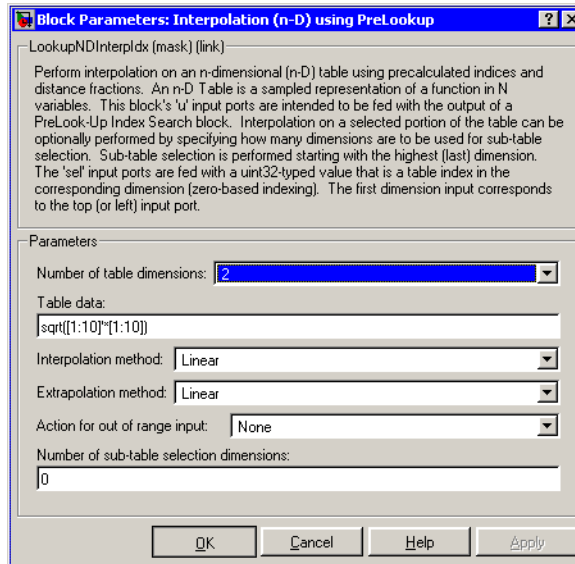
Number of table dimensions

The number of dimensions that the **Table data** parameter must
have. This determines the number of independent variables for
the table and hence the number of inputs to the block. If the
number of table dimensions exceeds four, select the More...
option to access the **Explicit number of table dimensions** field
and enter a number between 1 and 30.

Table data

The table of output values. The matrix size must match the
dimensions defined by the **Number of table dimensions**
parameter or by the **Explicit number of table dimensions**
parameter when the number of dimensions exceeds four. During

block diagram editing, you can leave the **Table data** field empty, but for running the simulation, you must match the number of dimensions in the **Table data** parameter to the **Number of table dimensions** or **Explicit number of table dimensions**. For information about how to construct multidimensional arrays in MATLAB, see "Multidimensional Arrays".

Interpolation method
None (flat) or Linear.

Extrapolation method
None (clip) or Linear.

Action for out of range input
Specifies whether to produce a warning or error message if the input is out of range. Options include:

- None

- Warning

- Error

- Error - No index checking in generated code

- Warning - No index checking in generated code

- None - No index checking in generated code

Number of sub-table selection dimensions
Number of dimensions of the subtable used to compute this block's output. Specify 0 to use the entire table specified by **Table data** parameter.

Characteristics

Direct Feedthrough	Yes
Sample Time	Inherited from driving blocks
Scalar Expansion	Yes
Zero Crossing	No

See Also   PreLookup Index Search

Interval Test

Purpose   Determine if a signal is in a specified interval

Library   Logic and Bit Operations

Description   The Interval Test block outputs TRUE if the input is between the values specified by the **Lower limit** and **Upper limit** parameters. The block outputs FALSE if the input is outside those values. The output of the block when the input is equal to the **Lower limit** or the **Upper limit** is determined by whether the boxes next to **Interval closed on left** and **Interval closed on right** are selected in the dialog box.
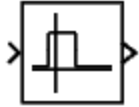
Data Type Support   The Interval Test block accepts signals of any data type supported by Simulink, including fixed-point data types.

Parameters and Dialog Box
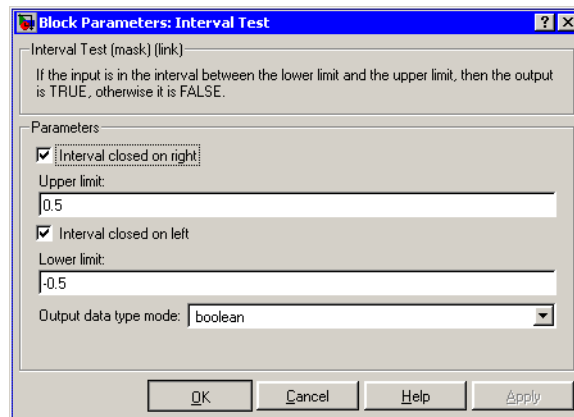
Interval closed on right
>   When you select this check box, the **Upper limit** is included in the interval for which the block outputs TRUE.

Upper limit
>   The upper limit of the interval for which the block outputs TRUE.

Interval closed on left
　　When you select this check box, the **Lower limit** is included in
　　the interval for which the block outputs TRUE.

Lower limit
　　The lower limit of the interval for which the block outputs TRUE.

Output data type mode
　　Select the output data type; `boolean` or `uint8`.

Characteristics

Direct Feedthrough	Yes
Scalar Expansion	Yes

See Also　　Interval Test Dynamic

Interval Test Dynamic

Purpose   Determine if a signal is in a specified interval

Library   Logic and Bit Operations

Description   The Interval Test Dynamic block outputs TRUE if the input is between the values of the external signals up and lo. The block outputs FALSE if the input is outside those values. The output of the block when the input is equal to the signal up or the signal lo is determined by whether the boxes next to **Interval closed on left** and **Interval closed on right** are selected in the dialog box.
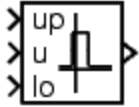
Data Type Support   The Interval Test Dynamic block accepts signals of any data type supported by Simulink, including fixed-point data types.

Parameters and Dialog Box
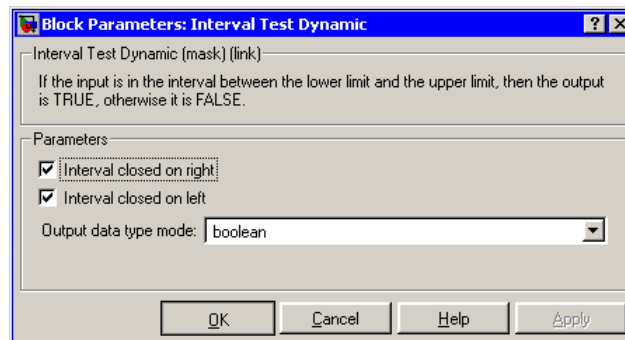
Interval closed on right
> When you select this check box, the value of the signal connected to the block's "up" input port is included in the interval for which the block outputs TRUE.

Interval closed on left
> When you select this check box, the value of the signal connected to the block's "lo" input port is included in the interval for which the block outputs TRUE.

Output data type mode
Select the output data type; boolean or uint8.

Characteristics

Direct Feedthrough	Yes
Scalar Expansion	Yes

See Also   Interval Test

Level-2 M-File S-Function

Purpose   Use a Level-2 M-file S-function in a model.

Library   User-Defined Functions

Description   This block allows you to use a Level-2 M-file S-function (see "Writing Level-2 M-File S-Functions") in a model. To do this, create an instance of this block in the model. Then enter the name of the Level-2 M-File S-function in the **M-file name** field of the block's parameter dialog box.

> **Note** Use the S-Function block to include a Level-1 M-file S-function in a block.

If the Level-2 M-file S-function defines any additional parameters, you can enter them in the **Parameters** field of the block's parameter dialog box. Enter them as MATLAB expressions that evaluate to their values in the order defined by the M-file S-function. Use commas to separate each expression.

Data Type Support   Depends on the M-file that defines the behavior of a particular instance of this block.

Parameters and Dialog Box
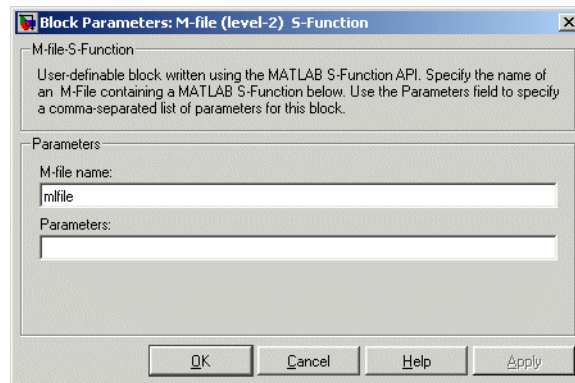
M-file name

Name of an M-file that defines the behavior of this block. The M-file must follow the Level-2 standard for writing M-file S-functions (see "Writing Level-2 M-File S-Functions").

Parameters

Values of the parameters of this block.

Characteristics

Direct Feedthrough	Depends on the M-file S-function
Sample Time	Depends on the M-file S-function
Scalar Expansion	Depends on contents M-file S-function
Dimensionalized	Depends on the M-file S-function
Zero Crossing	No

Logical Operator

Purpose   Perform the specified logical operation on the input

Library   Logic and Bit Operations

Description The Logical Operator block performs the specified logical operation
on its inputs. An input value is TRUE (1) if it is nonzero and FALSE
(0) if it is zero.

You select the Boolean operation connecting the inputs with the
Operator parameter list. If you select `rectangular` as the **Icon shape**
property, the block updates to display the name of the selected operator.
The supported operations are given below.

Operation	Description
AND	TRUE if all inputs are TRUE
OR	TRUE if at least one input is TRUE
NAND	TRUE if at least one input is FALSE
NOR	TRUE when no inputs are TRUE
XOR	TRUE if an odd number of inputs are TRUE
NOT	TRUE if the input is FALSE

If you select `distinctive` as the **Icon shape**, the block's appearance
indicates its function. Simulink displays a distinctive shape for the
selected operator, conforming to the IEEE Standard Graphic Symbols
for Logic Functions:
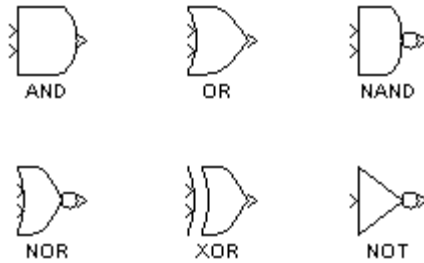
The number of input ports is specified with the **Number of input ports** parameter. The output type is specified with the **Output data type mode** and/or the **Output data type** parameters. An output value is 1 if TRUE and 0 if FALSE.

Note The output data type should represent zero exactly. Data types that satisfy this condition include signed and unsigned integers, and any floating-point data type.

The size of the output depends on input vector size and the selected operator:

- If the block has more than one input, any nonscalar inputs must have the same dimensions. For example, if any input is a 2-by-2 array, all other nonscalar inputs must also be 2-by-2 arrays.

  Scalar inputs are expanded to have the same dimensions as the nonscalar inputs.

  If the block has more than one input, the output has the same dimensions as the inputs (after scalar expansion) and each output element is the result of applying the specified logical operation to the corresponding input elements. For example, if the specified operation is AND and the inputs are 2-by-2 arrays, the output is a 2-by-2 array whose top left element is the result of applying AND to the top left elements of the inputs, etc.

Logical Operator

- For a single vector input, the block applies the operation (except the NOT operator) to all elements of the vector. The output is always a scalar.

- The NOT operator accepts only one input, which can be a scalar or a vector. If the input is a vector, the output is a vector of the same size containing the logical complements of the input vector elements.

When configured as a multi-input XOR gate, this block performs an addition- modulo-two operation as mandated by the IEEE Standard for Logic Elements.

Data Type Support

The Logical Operator block accepts real or complex signals of any data type supported by Simulink, including fixed-point data types.

For a discussion on the data types supported by Simulink, see "Data Types Supported by Simulink" in the Simulink documentation.

Parameters and Dialog Box

The **Main** pane of the Logical Operator block dialog appears as follows:
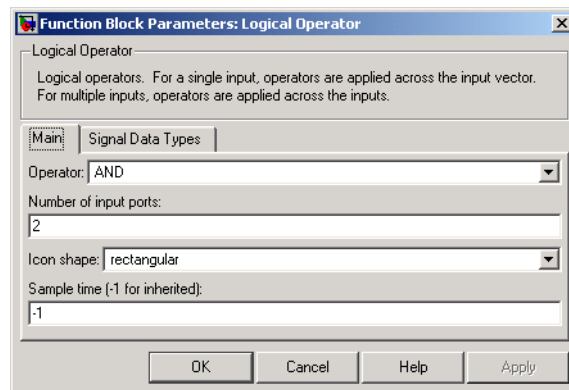
Operator

The logical operator to be applied to the block inputs. Valid choices are the operators listed previously.

Number of input ports

The number of block inputs. The value must be appropriate for the selected operator.

Icon shape

The shape of the block icon. Specifying `rectangular` (the default) results in a rectangular block that displays the name of the selected operator. The `distinctive` option uses the graphic symbol for the selected operator as specified by the IEEE standard.

Sample time (-1 for inherited)

Specify the time interval between samples. To inherit the sample time, set this parameter to `-1`. See "Specifying Sample Time" in the online documentation for more information.

The **Signal Data Types** pane of the Logical Operator block dialog appears as follows:
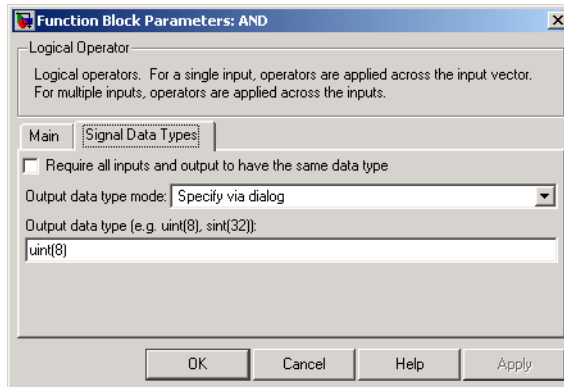
Require all inputs and output to have same data type

Select to require all inputs and the output to have the same data type.

Output data type mode

Select a method for specifying the output data type. Options are:

Logical Operator

Option	Description
Boolean	Specifies the output data type as `boolean`.
Logical	Use the **Implement logic signals as boolean data** model configuration parameter (see "Implement logic signals as boolean data (vs. double)") to specify the output data type. **Note** This option is intended to support models created before the `Boolean` option became available. Use one of the other options, preferably `Boolean`, for new models.
Specify via dialog	Selecting this option causes the block's dialog box to display an **Output data type** field (see below). Use this field to specify the block's output data type.

Output data type

Output data type. You should only use data types that represent zero exactly. Data types that satisfy this condition include signed and unsigned integers and any floating-point data type. This parameter is only visible if you select `Specify via dialog` for the **Output data type mode** parameter.

Characteristics

Direct Feedthrough	Yes
Sample Time	Specified in the **Sample time** parameter
Scalar Expansion	Yes, of inputs
Dimensionalized	Yes
Zero Crossing	No

Purpose   Approximate a one-dimensional function using the specified lookup method

Library   Lookup Tables

Description   The Lookup Table block computes an approximation to some function y=f(x) given data vectors x and y.
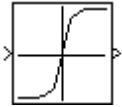
> **Note** To map two inputs to an output, use the Lookup Table (2-D) block.

The length of the x and y data vectors provided to this block must match. Also, the x data vector must be *strictly monotonically increasing* (i.e., the value of the next element in the vector is greater than the value of the preceding element) after conversion to the input's fixed-point data type. However, the x data vector may be *monotonically increasing* (i.e., the value of the next element in the vector is greater than or equal to the value of the preceding element) if all of the following apply:

- The input and output signals are both either single or double.
- The lookup method is Interpolation-Extrapolation.

Note that due to quantization, the x data vector may be strictly monotonic in doubles format, but not so after conversion to a fixed-point data type.

You define the table by specifying the **Vector of input values** parameter as a 1-by-n vector and the **Table data** parameter as a 1-by-n vector. The block generates output based on the input values using one of these methods selected from the **Look-up method** parameter list:

- Interpolation-Extrapolation—This is the default method; it performs linear interpolation and extrapolation of the inputs.
  - If a value matches the block's input, the output is the corresponding element in the output vector.

Lookup Table

- If no value matches the block's input, then the block performs linear interpolation between the two appropriate elements of the table to determine an output value. If the block input is less than the first or greater than the last input vector element, then the block extrapolates using the first two or last two points.

- `Interpolation-Use End Values`—This method performs linear interpolation as described above but does not extrapolate outside the end points of the input vector. Instead, the end-point values are used.

- `Use Input Nearest`—This method does not interpolate or extrapolate. Instead, the element in `x` nearest the current input is found. The corresponding element in `y` is then used as the output.

- `Use Input Below`—This method does not interpolate or extrapolate. Instead, the element in `x` nearest and below the current input is found. The corresponding element in `y` is then used as the output. If there is no element in `x` below the current input, then the nearest element is found.

- `Use Input Above`—This method does not interpolate or extrapolate. Instead, the element in `x` nearest and above the current input is found. The corresponding element in `y` is then used as the output. If there is no element in `x` above the current input, then the nearest element is found.

> **Note** Note that there is no difference among the `Use Input Nearest`, `Use Input Below`, and `Use Input Above` methods when the input `x` corresponds exactly to table breakpoints.

To create a table with step transitions, repeat an input value with different output values. For example, these input and output parameter values create the input/output relationship described by the plot that follows:

```
Vector of input values:  [-2 -1 -1  0 0 0 1 1 2]
Table data:              [-1 -1 -2 -2 1 2 2 1 1]
```
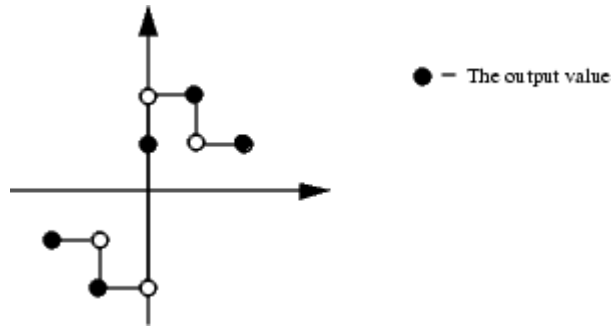
This example has three step discontinuities: at x = -1, 0, and +1.

When there are two output values for a given input value, the block chooses the output according to these rules:

- If the input signal u is less than zero, the block returns the output value associated with the last occurrence of the input value in the breakpoint data set. In this example, when u is -1, y is -2, marked with a solid circle.

- If the input signal u is greater than zero, the block returns the output value associated with the first occurrence of the input value in the breakpoint data set. In this example, when u is 1, y is 2, marked with a solid circle.

- If the input signal u is zero and there are two output values specified at the origin, the block returns the average of those output values. In this example, if there were no point defined at x = 0 and y = 1, the output would be 0, the average of the two points at u = 0. If there are three output values specified at the origin, the block generates the output associated with the middle point. In this example, the output at the origin is 1, marked with a solid circle.

The Lookup Table icon displays a graph of the input vector versus the output vector. When a parameter is changed on the block's dialog box, the graph is automatically redrawn when you click the **OK** or **Apply** button.

Lookup Table

To avoid parameter saturation errors, the automatic scaling script `autofixexp` employs a special rule for the Lookup Table block. `autofixexp` modifies the scaling by using the output lookup values in addition to the logged minimum and maximum simulation values. This prevents the data from being saturated to different values. The lookup values are given by the **Table data** parameter (the `YDataPoints` variable).

Data Type Support

The Lookup Table block supports all data types supported by Simulink, including fixed-point data types.

For a discussion on the data types supported by Simulink, see "Data Types Supported by Simulink" in the Simulink documentation.

Parameters and Dialog Box

The **Main** pane of the Lookup Table block dialog appears as follows:
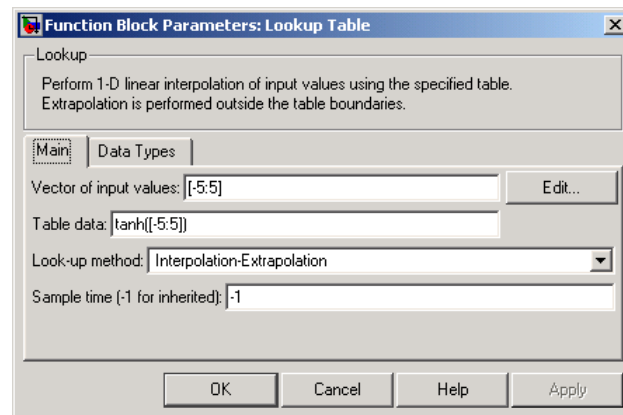
Vector of input values

Specify the vector of input values. The input values vector must be the same size as the output values vector. Also, the input values vector must be strictly monotonically increasing after conversion to the input's fixed-point data type, except in the following case. If the input values vector and the output signal are both either `single` or `double`, and if the lookup

method is `Interpolation-Extrapolation`, then the input values vector may be monotonically increasing rather than strictly monotonically increasing. Note that due to quantization, the input values vector may be strictly monotonic in doubles format, but not so after conversion to a fixed-point data type.

The **Vector of input values** parameter is converted from doubles to the input data type offline using round-to-nearest and saturation.

Click the **Edit** button to invoke the Lookup Table Editor (see "Lookup Table Editor" in the online Simulink documentation).

Table data

Specify the vector of output values. The table data must be the same size as the input values vector.

The **Table data** parameter is converted from doubles to the output data type offline using round-to-nearest and saturation.

Look-up method

Specify the lookup method. See Description for a discussion of the options for this parameter.

Sample time (-1 for inherited)

Specify the time interval between samples. To inherit the sample time, set this parameter to `-1`. See "Specifying Sample Time" in the online documentation for more information.

The **Data Types** pane of the Lookup Table block dialog appears as follows:

Lookup Table

Output data type mode
> You can set the output signal to a built-in data type from this drop-down list, or you can choose the output data type and scaling to be the same as the input. Alternatively, you can choose to inherit the output data type and scaling by backpropagation. Lastly, if you choose Specify via dialog, the **Output data type**, **Output scaling value**, and **Lock output scaling against changes by the autoscaling tool** parameters become visible.

Output data type
> Specify any data type, including fixed-point data types. This parameter is only visible if you select Specify via dialog for the **Output data type mode** parameter.

Output scaling value
> Set the output scaling using binary point-only or [Slope Bias] scaling. This parameter is only visible if you select Specify via dialog for the **Output data type mode** parameter.

Lock output scaling against changes by the autoscaling tool
Select to lock scaling of outputs. This parameter is only visible if you select Specify via dialog for the **Output data type mode** parameter.

Round integer calculations toward
Select the rounding mode for fixed-point look-up table calculations that occur during simulation or execution of code generated from the model.

Note that this option does not affect rounding of values of block parameters, such as **Table data**. Simulink rounds such values to the nearest representable integer value. To control the rounding of a block parameter, enter an expression using a MATLAB rounding function into the parameter's edit field on the block dialog box.

Saturate on integer overflow
Select to have overflows saturate.

Examples
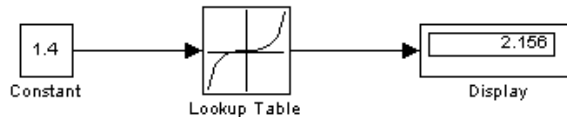
Suppose the Lookup Table block in the above model is configured to use a vector of input values given by [-5:5], and table data given by sinh([-5:5]). The following results are generated.

Lookup Method	Input	Output	Comment
Interpolation-Extrapolation	1.4	2.156	N/A
	5.2	83.59	N/A
Interpolation-Use End Values	1.4	2.156	N/A

Lookup Table

Lookup Method	Input	Output	Comment
	5.2	74.2	The value for `sinh(5.0)` was used.
Use Input Above	1.4	3.627	The value for `sinh(2.0)` was used.
	5.2	74.2	The value for `sinh(5.0)` was used.
Use Input Below	1.4	1.175	The value for `sinh(1.0)` was used.
	-5.2	-74.2	The value for `sinh(-5.0)` was used.
Use Input Nearest	1.4	1.175	The value for `sinh(1.0)` was used.

Characteristics

Direct Feedthrough	Yes
Sample Time	Inherited from driving block
Scalar Expansion	No
Dimensionalized	Yes
Zero Crossing	No

See Also   Lookup Table (2-D), Lookup Table (n-D)

Purpose   Approximate a two-dimensional function using a selected lookup method

Library   Lookup Tables
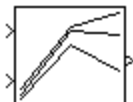
Description   The Lookup Table (2-D) block computes an approximation to some function z=f(x,y) given x, y, z data points.

The **Row index input values** parameter is a 1-by-m vector of x data points, the **Column index input values** parameter is a 1-by-n vector of y data points, and the **Table data** parameter is an m-by-n matrix of z data points. Both the row and column vectors must be *monotonically increasing* (i.e., the value of the next element in the vector is greater than or equal to the value of the preceding element). However, these vectors must be *strictly monotonically increasing* (i.e., the value of the next element in the vector is greater than the value of the preceding element) in the following cases:

• The input and output data types are both fixed-point.

• The input and output data types are different.

• The lookup method is not Interpolation-Extrapolation.

• The matrix of output values is complex.

• Minimum, maximum, and overflow logging is on.

The block generates output based on the input values using one of these methods selected from the **Look-up method** parameter list:

• Interpolation-Extrapolation—This is the default method; it performs linear interpolation and extrapolation of the inputs.

  ▪ If the inputs match row and column parameter values, the output is the value at the intersection of the row and column.

  ▪ If the inputs do not match row and column parameter values, then the block generates output by linearly interpolating between the appropriate row and column values. If either or both block inputs

Lookup Table (2-D)

are less than the first or greater than the last row or column values, the block extrapolates using the first two or last two points.

- **Interpolation-Use End Values**— This method performs linear interpolation as described above but does not extrapolate outside the end points of x and y. Instead, the end-point values are used.

- **Use Input Nearest**— This method does not interpolate or extrapolate. Instead, the elements in x and y nearest the current inputs are found. The corresponding element in z is then used as the output.

- **Use Input Below**— This method does not interpolate or extrapolate. Instead, the elements in x and y nearest and below the current inputs are found. The corresponding element in z is then used as the output. If there are no elements in x or y below the current inputs, then the nearest elements are found.

- **Use Input Above**— This method does not interpolate or extrapolate. Instead, the elements in x and y nearest and above the current inputs are found. The corresponding element in z is then used as the output. If there are no elements in x or y above the current inputs, then the nearest elements are found.

Note Note that there is no difference among the Use Input Nearest, Use Input Below, and Use Input Above methods when the input x corresponds exactly to table breakpoints.

For information about creating a table with step transitions, see the Lookup Table block reference pages.

To avoid parameter saturation errors, the automatic scaling script autofixexp employs a special rule for the Lookup Table (2-D) block. autofixexp modifies the scaling by using the output lookup values in addition to the logged minimum and maximum simulation values. The output lookup values are converted to the specified output data type. This prevents the data from being saturated to different values.

Data Type Support

The Lookup Table (2-D) block supports all data types supported by Simulink, including fixed-point data types.

For a discussion on the data types supported by Simulink, see "Data Types Supported by Simulink" in the Simulink documentation.

Parameters and Dialog Box

The **Main** pane of the Lookup Table (2-D) block dialog appears as follows:
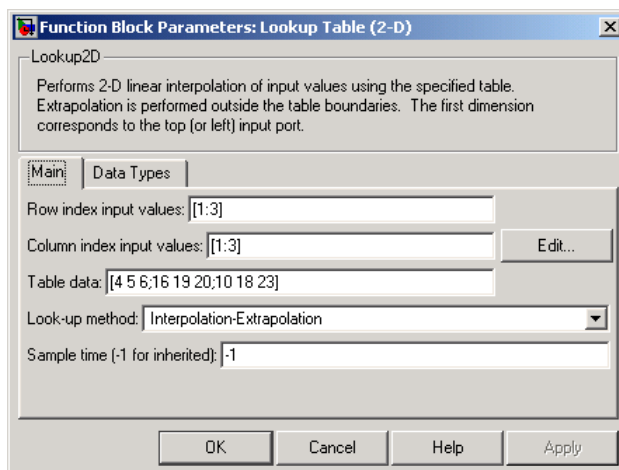
Row index input values

The row values for the table, entered as a vector. The vector values must increase monotonically.

Column index input values

The column values for the table, entered as a vector. The vector values must increase monotonically.

Click the **Edit** button to invoke the Lookup Table Editor (see "Lookup Table Editor" in the online Simulink documentation).

Table data

The table of output values. The matrix size must match the dimensions defined by the **Row** and **Column** parameters.

Lookup Table (2-D)

Look-up method
> Specify the lookup method. See Description for a discussion of the options for this parameter.

Sample time (-1 for inherited)
> Specify the time interval between samples. To inherit the sample time, set this parameter to -1. See "Specifying Sample Time" in the online documentation for more information.

The **Data Types** pane of the Lookup Table (2-D) block dialog appears as follows:

Require all inputs to have same data type
> Select to require all inputs to have the same data type.

Output data type mode
> You can set the output signal to a built-in data type from this drop-down list, or you can choose the output data type and scaling to be the same as the input. Alternatively, you can choose to inherit the output data type and scaling by backpropagation.

Lastly, if you choose Specify via dialog, the **Output data type**, **Output scaling value**, and **Lock output scaling against changes by the autoscaling tool** parameters become visible.

Output data type

Specify any data type, including fixed-point data types. This parameter is only visible if you select Specify via dialog for the **Output data type mode** parameter.

Output scaling value

Set the output scaling using binary point-only or [Slope Bias] scaling. This parameter is only visible if you select Specify via dialog for the **Output data type mode** parameter.

Lock output scaling against changes by the autoscaling tool

Select to lock scaling of outputs. This parameter is only visible if you select Specify via dialog for the **Output data type mode** parameter.

Round integer calculations toward

Select the rounding mode for fixed-point operations.

Note that block parameters such as **Table data** are always rounded to the nearest representable value. To control the rounding of a block parameter, enter an expression using a MATLAB rounding function into the mask field.

Saturate on integer overflow

Select to have overflows saturate.

Examples   In this example, the block parameters are defined as

```
Row index input values:     [1 2]
Column index input values:  [3 4]
Table data:                 [10 20; 30 40]
```

The first figure shows the block outputting a value at the intersection of block inputs that match row and column values. The first input is 1 and the second input is 4. These values select the table value at the

intersection of the first row (row parameter value 1) and second column (column parameter value 4).
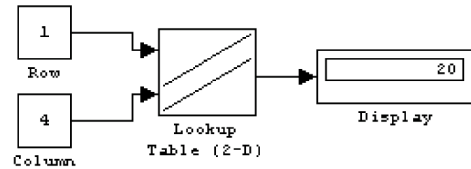
In the second figure, the first input is 1.7 and the second is 3.4. These values cause the block to interpolate between row and column values, as shown in the table at the left. The value at the intersection (28) is the output value.
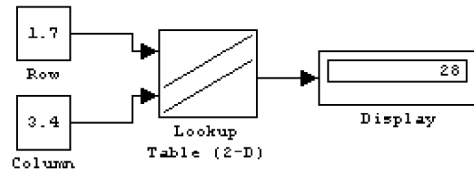
Characteristics

Direct Feedthrough	Yes
Sample Time	Specified in the **Sample time** parameter
Scalar Expansion	Yes, of one input if the other is a vector
Dimensionalized	Yes
Zero Crossing	No

See Also   Lookup Table, Lookup Table (n-D)

Lookup Table (n-D)

Purpose   Perform constant, linear, or spline interpolated mapping of N input values to a sampled representation of a function in N variables

Library   Lookup Tables
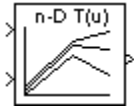
Description   The Lookup Table (n-D) block evaluates a sampled representation of a function in N variables by interpolating between samples to give an approximate value for $y = F(x1, x2, x3, ..., xn)$, even when the function F is known only empirically. The block efficiently maps the block inputs to the output value using interpolation on a table of values defined by the block's parameters. Interpolation methods supported are

- Flat (constant)

- Linear

- Natural (cubic) spline

You can apply any of these methods to 1-D, 2-D, 3-D, or higher dimensional tables.

You define a set of output values as the **Table data** parameter and the values that correspond to its rows, columns, and higher dimensions with the *N*th breakpoint set parameter. The block generates an output value by comparing the block inputs with the breakpoint set parameters. The first input identifies the first dimension (row) breakpoints, the second breakpoint set identifies a column, and so on, as shown by this figure.
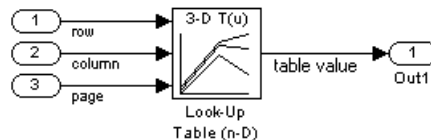
If you are unfamiliar with how to construct N-dimensional arrays in MATLAB, see "Multidimensional Arrays".

The block generates output based on the input values:

- If the inputs match breakpoint parameter values, the output is the table value at the intersection of the row, column, and higher dimensions breakpoints.

- If the inputs do not match row and column parameter values, the block generates output by interpolating between the appropriate table values. If any of the block inputs are outside the ranges of their respective breakpoint sets, the block limits the input values to the breakpoint set's range in that dimension. If extrapolation is enabled, it extrapolates linearly or by using a cubic polynomial (if you selected cubic spline extrapolation).

Note As an alternative, you can use the Lookup Table (n-D) block with the PreLookup Index Search block to have more flexibility and potentially much higher performance for linear interpolations in certain circumstances.

For noninterpolated table lookups, use the Direct Lookup Table (n-D) block when the lookup operation is a simple array access, for example, if you have an integer value k and you merely want the kth element of a table, *y = table(k)*.

Data Type Support

The Lookup Table (n-D) block accepts signals of types double or single, but for any given Lookup Table (n-D) block, the inputs must all be of the same type. Table data and Breakpoint set parameters must be of the same type as the inputs. The output data type is also set to the input data type.

Lookup Table (n-D)

Parameters and Dialog Box
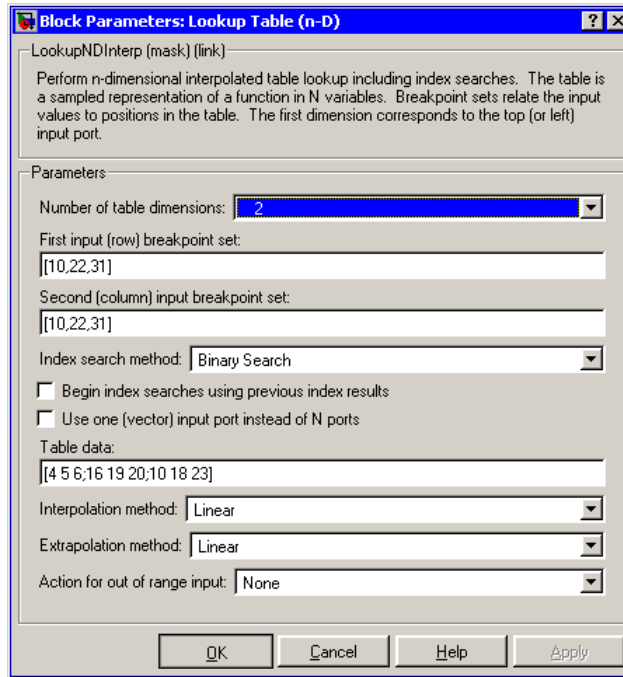
Number of table dimensions

The number of dimensions that the **Table data** parameter is to have. This determines the number of independent variables for the table and hence the number of inputs to the block (see descriptions for **Explicit Number of dimensions** and **Use one (vector) input port instead of N ports** following).

First input (row) breakpoint set

The row values represented in the table, entered as a vector. The vector values must increase monotonically. This field is always visible.

Second (column) input breakpoint set

The column values for the table, entered as a vector. The vector values must increase monotonically. This field is visible if the **Number of table dimensions** value is 2, 3, 4, or More.

Third input breakpoint set

The values corresponding to the third dimension for the table, entered as a vector. The vector values must increase monotonically. This field is visible if the **Number of table dimensions** is 3, 4, or More.

Fourth input breakpoint set

The values corresponding to the fourth dimension for the table, entered as a vector. The vector values must increase monotonically. This field is visible if the **Number of table dimensions** is 4 or More.

Fifth..Nth breakpoint sets (cell array)

The cell array of values corresponding to the fifth, sixth, or higher dimensions for the table, entered as a 1-D cell array of vectors. For example, `{[10:10:30], [0:10:100]}` is a cell array of two vectors that are used for the fifth and sixth dimensions' breakpoint sets. The vector values must increase monotonically. This field is visible if the **Number of table dimensions** is More.

Explicit number of dimensions

The number of table dimensions when the number is 5 or more. This field is visible if the **Number of table dimensions** is More. If you set the **Explicit number of dimensions** to 4 or fewer, the block disregards any unnecessary breakpoint data sets that you specified; however, the dimensionality of the **Table data** parameter must match the **Explicit number of dimensions** .

Index search method

Choose `Evenly Spaced Points`, `Linear Search`, or `Binary Search` (the default). Each search method has speed advantages over the others in different circumstances. A suboptimal choice of index search method can lead to slow performance in models that rely heavily on lookup tables. If the breakpoint data is evenly

spaced, e.g., 10, 20, 30, ..., you can achieve the greatest speed by selecting `Evenly Spaced Points` to directly calculate the indices into the table. For irregularly spaced breakpoint sets, if the input signals do not vary much from one time step to the next, selecting `Linear Search` and `Begin index searches using previous index results` at the same time will produce the best performance. For irregularly spaced breakpoint sets with rapidly varying input signals that jump more than one or two table intervals per time step, selecting `Binary Search` gives the best performance. Note that the `Evenly Spaced Points` algorithm only makes use of the first two breakpoints in determining the offset and spacing of the rest of the points.

Begin index searches using previous index results

Activating this option causes the block to initialize index searches using the index found on the previous time step. This is a huge performance improvement for the block when the input signals do not change much with respect to its position in the table from one time step to the next. When this option is deactivated, the linear search and binary search methods can take significantly longer, especially for large breakpoint data sets.

Use one (vector) input port instead of N ports

Instead of having one input port per independent variable, the block is configured with just one input port that expects a signal that is N elements wide for an N-dimensional table. This might be useful in removing line clutter on a block diagram with large numbers of tables.

Table data

The table of output values. To execute a model with this block, the matrix size must match the dimensions defined by the **N breakpoint set** parameter or by the **Explicit number of dimensions** parameter when the number of dimensions exceeds 4. During block diagram editing, you can leave this field blank because only the **Number of table dimensions** field is required to set the number of ports on the block.

Interpolation method
> None (flat), Linear, or Cubic Spline.

Extrapolation method
> None (clip), Linear, or Cubic Spline.

Action for out of range input
> None, Warning, or Error. An out-of-range condition during simulation results in warning messages in the command window if you select "Warning," and the simulation halts with an error message if you select "Error."

Characteristics

Direct Feedthrough	Yes
Sample Time	Inherited from driving blocks
Scalar Expansion	No
Dimensionalized	No
Zero Crossing	No

See Also   Lookup Table, Lookup Table (2-D), Lookup Table Dynamic

Lookup Table Dynamic

Purpose   Approximate a one-dimensional function using a selected lookup method and a dynamically specified table

Library   Lookup Tables

Description   The Lookup Table Dynamic block computes an approximation to some function y=f(x) given x, y data vectors. The lookup method can use interpolation, extrapolation, or the original values of the input.
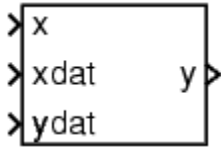
The x data vector must be *strictly monotonically increasing* (i.e., the value of the next element in the vector is greater than the value of the preceding element) after conversion to the input's fixed-point data type. Note that due to quantization, the x data vector may be strictly monotonic in doubles format, but not so after conversion to a fixed-point data type.

Note Unlike the Lookup Table block, the Lookup Table Dynamic block allows you to change the table data without stopping the simulation. For example, you may want to automatically incorporate new table data if the physical system you are simulating changes.

You define the lookup table by inputting the x and y table data to the block as 1-by-n vectors. To help reduce the ROM used by the code generated for this block, you can use different data types for the x table data and the y table data. However, these restrictions apply:

- The y table data and the output vector must have the same sign, the same bias, and the same fractional slope.

- The x table data and the x data vector must have the same sign, the same bias, and the same fractional slope. Additionally, the precision and range for the x data vector must be greater than or equal to the precision and range for the x table data.

The block generates output based on the input values using one of these methods selected from the **Look-Up Method** parameter list:

- `Interpolation-Extrapolation`—This is the default method; it performs linear interpolation and extrapolation of the inputs.

  - If a value matches the block's input, the output is the corresponding element in the output vector.

  - If no value matches the block's input, then the block performs linear interpolation between the two appropriate elements of the table to determine an output value. If the block input is less than the first or greater than the last input vector element, then the block extrapolates using the first two or last two points.

- `Interpolation-Use End Values`—This method performs linear interpolation as described above but does not extrapolate outside the end points of the input vector. Instead, the end-point values are used.

- `Use Input Nearest`—This method does not interpolate or extrapolate. Instead, the element in x nearest the current input is found. The corresponding element in y is then used as the output.

- `Use Input Below`—This method does not interpolate or extrapolate. Instead, the element in x nearest and below the current input is found. The corresponding element in y is then used as the output. If there is no element in x below the current input, then the nearest element is found.

- `Use Input Above`—This method does not interpolate or extrapolate. Instead, the element in x nearest and above the current input is found. The corresponding element in y is then used as the output. If there is no element in x above the current input, then the nearest element is found.

Note Note that there is no difference among the `Use Input Nearest`, `Use Input Below`, and `Use Input Above` methods when the input x corresponds exactly to table breakpoints.

The table data is converted from doubles to the x data type offline using round-to-nearest and saturation.

Lookup Table Dynamic

Data Type Support
The Lookup Table Dynamic block accepts signals of any data type supported by Simulink, including fixed-point data types.

Parameters and Dialog Box
The **Main** pane of the Lookup Table Dynamic block dialog appears as follows:
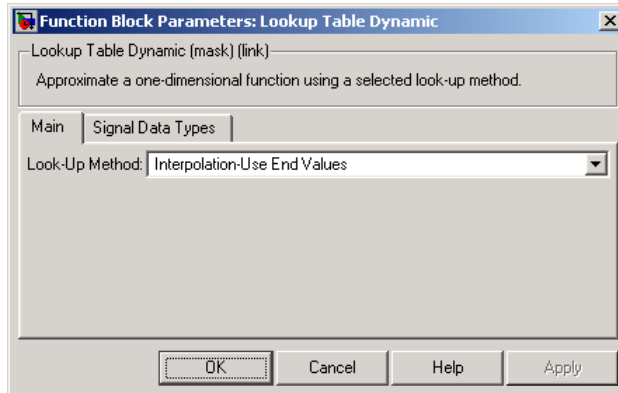
Look-Up Method
Specify the lookup method.

The **Signal Data Types** pane of the Lookup Table Dynamic block dialog appears as follows:

Output data type and scaling

Specify the output data type and scaling via the dialog box, or inherit the data type and scaling from the driving block or by backpropagation. If you choose Specify via dialog, the **Output data type** and **Output scaling** parameters appear.

Output data type

Set the output data type. This parameter is only visible if you select Specify via dialog for the **Output data type and scaling** parameter.

Output scaling

Set the output scaling using either binary point-only or [Slope Bias] scaling. This parameter is only visible if you select Specify via dialog for the **Output data type and scaling** parameter.

Lock output scaling so autoscaling tool can't change it

If you select this check box, the output scaling is locked.

Round toward

Rounding mode for the fixed-point output.

Lookup Table Dynamic

Saturate to max or min when overflows occur
If selected, fixed-point overflows saturate.

Examples   For an example that illustrates the lookup methods supported by this block, see the example included in the Lookup Table block reference pages.

Characteristics

Direct Feedthrough	Yes
Scalar Expansion	No

See Also   Lookup Table, Lookup Table (2-D), Lookup Table (n-D)

Purpose   Convert a magnitude and/or a phase angle signal to a complex signal

Library   Math Operations

Description   The Magnitude-Angle to Complex block converts magnitude and/or phase angle inputs to a complex-valued output signal. The inputs must be real-valued signals of type `double`. The angle input is assumed to be in radians. The data type of the complex output signal is `double`.

The inputs can both be signals of equal dimensions, or one input can be an array and the other a scalar. If the block has an array input, the output is an array of complex signals. The elements of a magnitude input vector are mapped to magnitudes of the corresponding complex output elements. An angle input vector is similarly mapped to the angles of the complex output signals. If one input is a scalar, it is mapped to the corresponding component (magnitude or angle) of all the complex output signals.

Data Type Support   See the preceding block description.

Parameters and Dialog Box

2-385
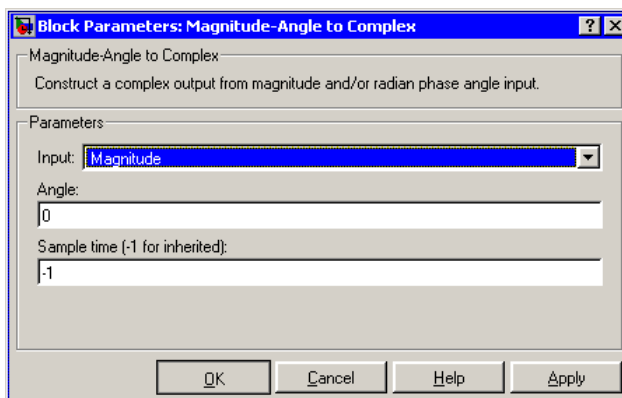
Magnitude-Angle to Complex

Input

    Specifies the kind of input: a magnitude input, an angle input, or both.

Angle (Magnitude)

    If the input is an angle signal, specifies the constant magnitude of the output signal. If the input is a magnitude, specifies the constant phase angle in radians of the output signal.

Sample time (-1 for inherited)

    Specify the time interval between samples. To inherit the sample time, set this parameter to -1. See "Specifying Sample Time" in the online documentation for more information.

Characteristics

Direct Feedthrough	Yes
Sample Time	Inherited from driving block
Scalar Expansion	Yes, of the input when the function requires two inputs
Dimensionalized	Yes
Zero Crossing	No

Purpose   Switch between two inputs

Library   Signal Routing
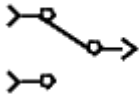
Description The Manual Switch block is a toggle switch that selects one of its
two inputs to pass through to the output. To toggle between inputs,
double-click the block (there is no dialog box). The selected input is
propagated to the output, while the unselected input is discarded. You
can set the switch before the simulation is started or throw it while the
simulation is executing to interactively control the signal flow. The
Manual Switch block retains its current state when the model is saved.

**Data Type   The Manual Switch block accepts real or complex signals of any data
Support**   type supported by Simulink, including fixed-point data types.

For a discussion on the data types supported by Simulink, see "Data
Types Supported by Simulink" in the Simulink documentation.

**Parameters   None
and
Dialog
Box**

Characteristics

Direct Feedthrough	Yes
Sample Time	Inherited from driving block
Scalar Expansion	N/A
Dimensionalized	Yes
Zero Crossing	No

Math Function

Purpose   Perform a mathematical function

Library   Math Operations

Description The Math Function block performs numerous common mathematical functions.

You can select one of the following functions from the **Function** parameter list.

- `exp`
- `log`
- `10^u`
- `log10`
- `magnitude^2`
- `square`
- `sqrt`
- `pow`
- `conj`
- `reciprocal`
- `hypot`
- `rem`
- `mod`
- `transpose`
- `hermitian`

The block output is the result of the operation of the function on the input or inputs.

The name of the function appears on the block. Simulink automatically draws the appropriate number of input ports.

Use the Math Function block instead of the Fcn block when you want vector or matrix output, because the Fcn block produces only scalar output.

Data Type Support

The following table shows which input data types are supported by each of the functions of the Math Function block.

Function	single	double	built-in integer	fixed point
exp	yes	yes	—	—
log	yes	yes	—	—
10^u	yes	yes	—	—
log10	yes	yes	—	—
magnitude^2	yes	yes	yes	yes
square	yes	yes	yes	yes
sqrt	yes	yes	—-	—-
pow	yes	yes	—-	—-
conj	yes	yes	yes	yes
reciprocal	yes	yes	yes	yes
hypot	yes	yes	—-	—-
rem	yes	yes	yes	—-
mod	yes	yes	yes	—-
transpose	yes	yes	yes	yes
hermitian	yes	yes	yes	yes

All supported modes accept both real and complex inputs, except for `reciprocal`, which does not accept complex fixed-point inputs. The output signal type of the block is real or complex, depending on the setting of the **Output signal type** parameter.

Math Function

Parameters and Dialog Box	The **Main** pane of the Math Function block dialog appears as follows:
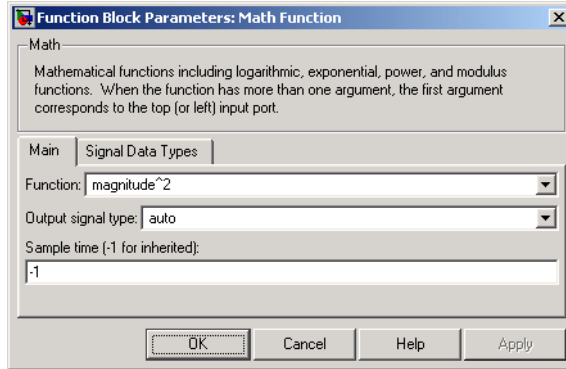
Function

Specify the mathematical function.

Output signal type

Select the output signal type of the Math Function block as `real`, `complex`, or `auto`.

	Input	**Output Signal Type**		
Function	**Signal**	**Auto**	**Real**	**Complex**
Exp, log, 10u, log10, square, sqrt, pow, reciprocal, conjugate, transpose, hermitian	real	real	real	complex
	complex	complex	error	complex

	Input	Output Signal Type		
Function	**Signal**	**Auto**	**Real**	**Complex**
magnitude squared	real	real	real	complex
	complex	real	real	complex
hypot, rem, mod	real	real	real	complex
	complex	error	error	error

Sample time (-1 for inherited)

Specify the time interval between samples. To inherit the sample time, set this parameter to -1. See "Specifying Sample Time" in the online documentation for more information.

The **Signal Data Types** pane of the Math Function block dialog appears as follows:
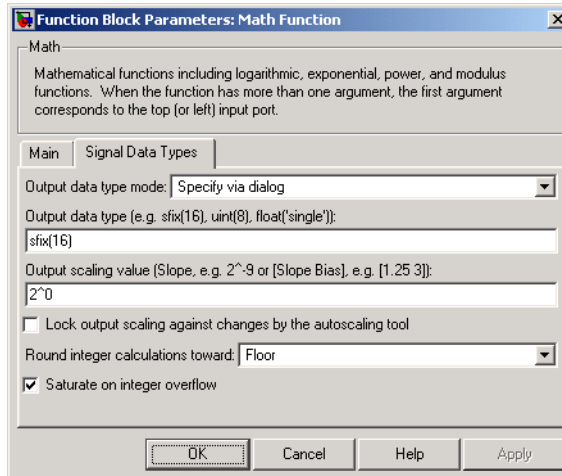
Math Function

Output data type mode
> Set the data type and scaling of the output to be a built-in data type, the same as that of the first input, or to be inherited via an internal rule or by backpropagation. Alternatively, choose to specify the data type and scaling of the output through the **Output data type** and **Output scaling value** parameters.

Output data type
> Set the output data type. This parameter is only visible if you select `Specify via dialog` for the **Output data type mode** parameter.

Output scaling value
> Set the output scaling using either binary point-only or [Slope Bias] scaling. This parameter is only visible if you select `Specify via dialog` for the **Output data type and scaling** parameter.

Lock output scaling against changes by the autoscaling tool
> If you select this check box, the output scaling is locked.

Round integer calculations toward
> Select the rounding mode for fixed-point operations.

Saturate on integer overflow
> If selected, fixed-point overflows saturate.

Characteristics

Direct Feedthrough	Yes
Sample Time	Specified in the **Sample time** parameter
Scalar Expansion	Yes, of the input when the function requires two inputs

Dimensionalized	Yes
Zero Crossing	No

MATLAB Fcn

Purpose   Apply a MATLAB function or expression to the input

Library   User-Defined Functions
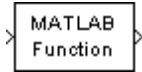
Description   The MATLAB Fcn block applies the specified MATLAB function or
expression to the input. The output of the function must match the
output dimensions of the block or an error occurs.

Here are some sample valid expressions for this block.

```
sin
atan2(u(1), u(2))
u(1)^u(2)
```

Note This block is slower than the Fcn block because it calls the
MATLAB parser during each integration step. Consider using built-in
blocks (such as the Fcn block or the Math Function block) instead, or
writing the function as an M-file or MEX-file S-function, then accessing
it using the S-Function block.

Data Type Support   The MATLAB Fcn block accepts one complex or real input of type
`double` and generates real or complex output of type `double`, depending
on the setting of the **Output signal type** parameter.

Parameters and Dialog Box
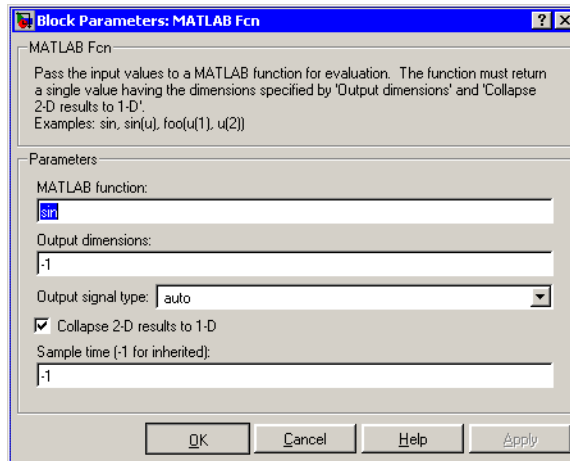
MATLAB function

The function or expression. If you specify a function only, it is not necessary to include the input argument in parentheses.

Output dimensions

Dimensions of the signal output by this block. If the output dimensions are to be the same as the dimensions of the input signal, specify -1. Otherwise, enter the dimensions of the output signal, e.g., 2 for a two-element vector. In either case, the output dimensions must match the dimensions of the value returned by the function or expression in the **MATLAB function** field.

Output signal type

The dialog allows you to select the output signal type of the MATLAB Fcn as real, complex, or auto. A value of auto sets the block's output type to be the same as the type of the input signal.

Collapse 2-D results to 1-D

Outputs a 2-D array as a 1-D array containing the 2-D array's elements in column-major order.

Sample time (-1 for inherited)

Specify the time interval between samples. To inherit the sample time, set this parameter to -1. See "Specifying Sample Time" in the online documentation for more information.

Characteristics

Direct Feedthrough	Yes
Sample Time	Inherited from driving block
Scalar Expansion	N/A
Dimensionalized	Yes
Zero Crossing	No

Purpose   Output the input from the previous time step

Library   Discrete

Description   The Memory block outputs its input from the previous time step,
                     applying a one integration step sample-and-hold to its input signal.
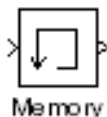
Memory

This sample model demonstrates how to display the step size used in
a simulation. The Sum block subtracts the time at the previous step,
generated by the Memory block, from the current time, generated by
the clock.
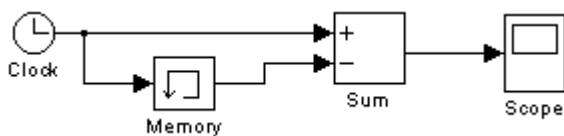
> **Note** Avoid using the Memory block when integrating with ode15s or
> ode113, unless the input to the block does not change.

Data Type   The Memory block accepts real or complex signals of any data type
Support   supported by Simulink, including fixed-point data types.

                     For a discussion on the data types supported by Simulink, see "Data
                     Types Supported by Simulink" in the Simulink documentation.

Memory

Parameters and Dialog Box
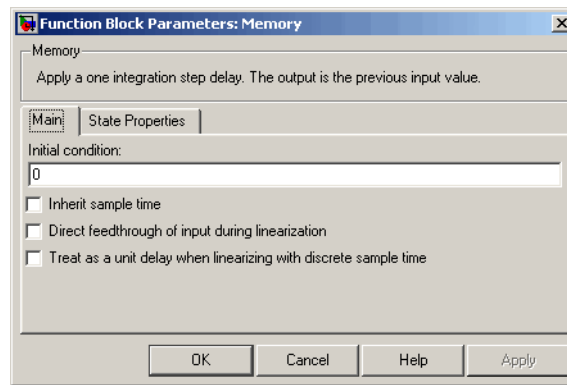
Initial condition

> The output at the initial integration step. This must be set to 0 if the input data type is user-defined. Simulink does not allow the initial output of this block to be inf or NaN.

Inherit sample time

> Check this check box to cause the sample time to be inherited from the driving block. If this option is not selected, the block's sample time depends on the type of solver used to simulate the model. If the solver is a variable-step solver, the sample time is continuous but fixed in minor time step ([0, 1]). If the solver is a fixed-step solver, this [0, 1] sample time is converted to the solver's step size after sample time propagation.

Direct feedthrough of input during linearization

> Causes the block to output its input during linearization and trim. This sets the block's mode to direct feedthrough.
>
> Enabling this check box can cause a change in the ordering of states in the model when using the functions linmod, dlinmod, or trim. To extract this new state ordering, use the following commands.
>
> First compile the model using the following command, where model is the name of the Simulink model.

```
[sizes, xO, x_str] = model([],[],[],'lincompile');
```

Next, terminate the compilation with the following command.

```
model([],[],[],'term');
```

The output argument, x_str, which is a cell array of the states in the Simulink model, contains the new state ordering. When passing a vector of states as input to the linmod, dlinmod, or trim functions, the state vector must use this new state ordering.

Treat as a unit delay when linearizing with discrete sample time
Select this check box to linearize the Memory block to a unit delay when the Memory block is driven by a signal with a discrete sample time.

The **State Properties** pane of this block pertains to code generation and has no effect on model simulation. See "Block States: Storing and Interfacing" in the Real-Time Workshop documentation for more information.

Characteristics

Direct Feedthrough	No, except when **Direct feedthrough of input during linearization is enabled**.
Sample Time	Continuous, but inherited from the driving block if you select the **Inherit sample time** check box
Scalar Expansion	Yes, of the **Initial condition** parameter
Dimensionalized	Yes
Zero Crossing	No

Merge

Purpose   Combine multiple signals into a single signal

Library   Signal Routing
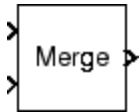
Description The Merge block combines its inputs into a single output line whose
value at any time is equal to the most recently computed output of its
driving blocks. You can specify any number of inputs by setting the
block's **Number of inputs** parameter.

> **Note** Merge blocks facilitate creation of alternately executing
> subsystems. See "Creating Alternately Executing Subsystems" for an
> application example.

A Merge block does not accept signals whose elements have been
reordered. For example, in the following diagram, the Merge block does
not accept the output of the Selector block because the Selector block
interchanges the first and fourth elements of the vector signal.
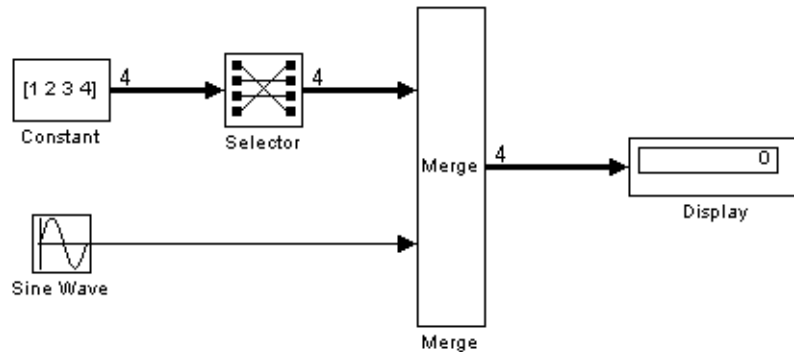
If the **Allow unequal port widths** parameter is not selected, the block
accepts only inputs of equal dimensions and outputs a signal of the
same dimensions as the inputs. If you select the **Allow unequal port
widths** option, the block accepts scalars and vectors (but not matrices)

having differing numbers of elements. Further, the block allows you to specify an offset for each input signal relative to the beginning of the output signal. The width of the output signal is

$$\mathtt{max(w_1+o_1,\ w_2+o_2,\ \dots\ w_n+o_n)}$$

where $\mathtt{w_1,\ \dots\ w_n}$ are the widths of the input signals and $\mathtt{o_1,\ \dots\ o_n}$ are the offsets for the input signals. For example, the Merge block in the following diagram merges signals v1 and v2 to produce signal v3.
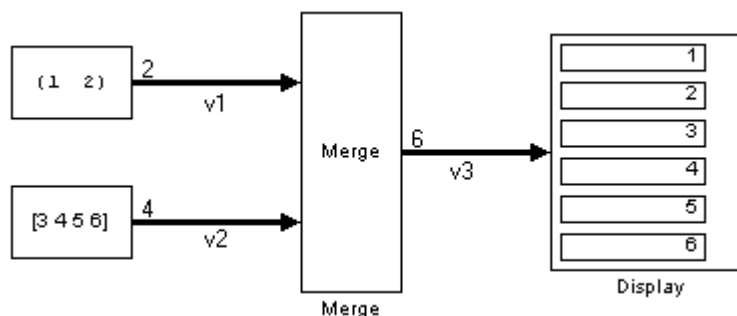
In this example, the offset of v1 is 0 and the offset of v2 is 2, resulting in an output signal six elements wide. The Merge block maps the elements of v1 to the first two elements of v3 and the elements of v2 to the last four elements of v3.

You can specify an initial output value by setting the block's **Initial output** parameter. If you do not specify an initial output and one or more of the driving blocks do, the Merge block's initial output equals the most recently evaluated initial output of the driving blocks.

Merging S-Function Outputs

The Merge block can merge a signal from an S-Function block only if the memory used to store the S-Function block's output is reusable. Simulink displays an error message if you attempt to update or simulate a model that connects a nonreusable port of an S-Function block to a Merge block. See ssSetOutputPortOptimOpts for more information.

Merge

Muxing Signals to be Merged

Instead of connecting signals directly to a Merge block, you can connect them via a Mux block as illustrated in the following example.
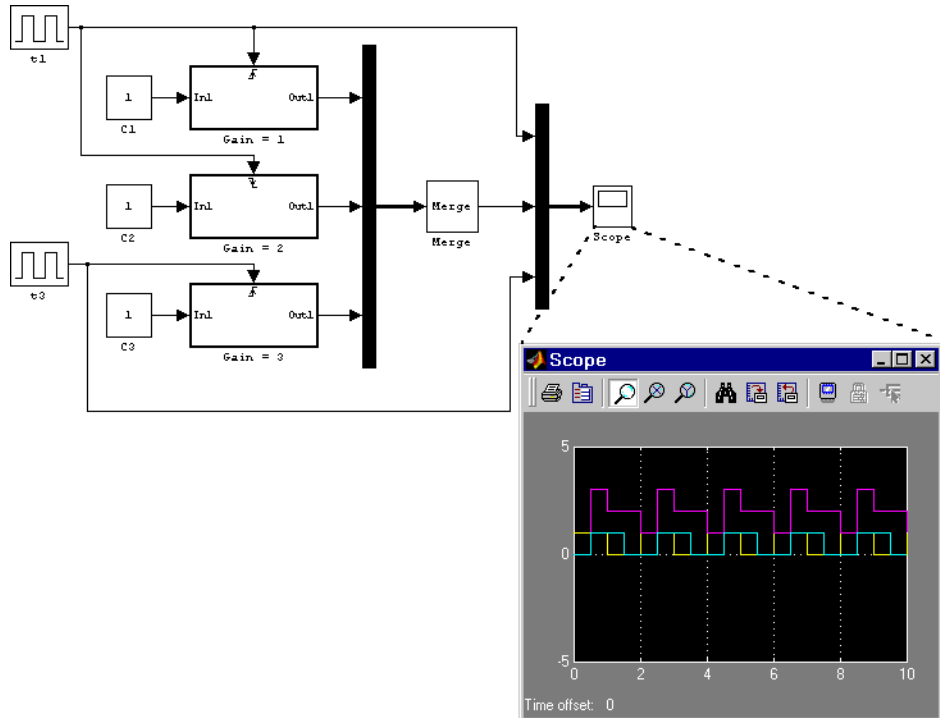
This example connects three amplifiers to a Merge block via a Mux block. The top and bottom amplifiers trigger on a rising pulse; the middle, on a falling pulse. The trigger signal connected to the bottom amplifier has a phase delay of .5 s compared to the trigger signal connected to the top amplifier. The output of the Merge block at each time step equals that of the amplifier triggered at that time step. Muxing the signals to be merged rather than connecting them directly to the Merge block can result in a clearer diagram.

Merge

**Data Type
Support**

The Merge block accepts real or complex signals of any data type
supported by Simulink, including fixed-point data types.

For a discussion on the data types supported by Simulink, see"Data
Types Supported by Simulink" in the Simulink documentation.

**Parameters
and
Dialog
Box**
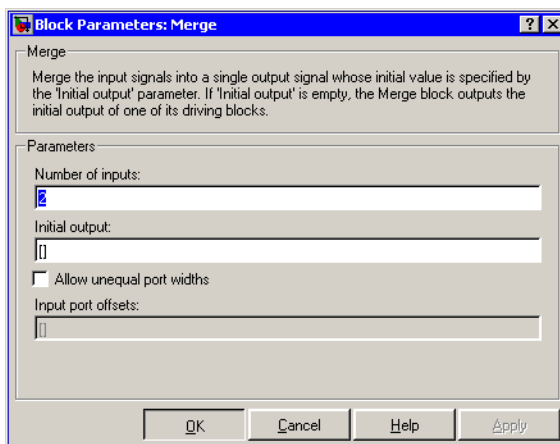
Number of inputs

    The number of input ports to merge.

Initial output

    Initial value of output. If unspecified, the initial output equals the
initial output, if any, of one of the driving blocks. Simulink does
not allow you to set the initial output of this block to inf or NaN.

Allow unequal port widths

    Allows the block to accept inputs having different numbers of
elements.

Input port offsets

    Vector specifying the offset of each input signal relative to the
beginning of the output signal.

Merge

Characteristics

Direct Feedthrough	Yes
Sample Time	Inherited from the driving block
Scalar Expansion	No
Dimensionalized	Yes
Zero Crossing	No

Purpose   Output the minimum or maximum input value

Library   Math Operations

Description   The MinMax block outputs either the minimum or the maximum
element or elements of the inputs. You can choose the function to apply
by selecting one of the choices from the **Function** parameter list.

> min >

If the block has one input port, the input must be a scalar or a vector.
The block outputs a scalar equal to the minimum or maximum element
of the input vector.

If the block has multiple input ports, the nonscalar inputs must all have
the same dimensions. The block expands any scalar inputs to have the
same dimensions as the nonscalar inputs. The block outputs a signal
having the same dimensions as the input. Each output element equals
the minimum or maximum of the corresponding input elements.

**Data Type
Support**   The MinMax block accepts and outputs real signals of any data type
supported by Simulink, except Boolean. The MinMax block supports
fixed-point data types.

For a discussion on the data types supported by Simulink, see "Data
Types Supported by Simulink" in the Simulink documentation.

MinMax

Parameters and Dialog Box

The **Main** pane of the MinMax block dialog appears as follows:
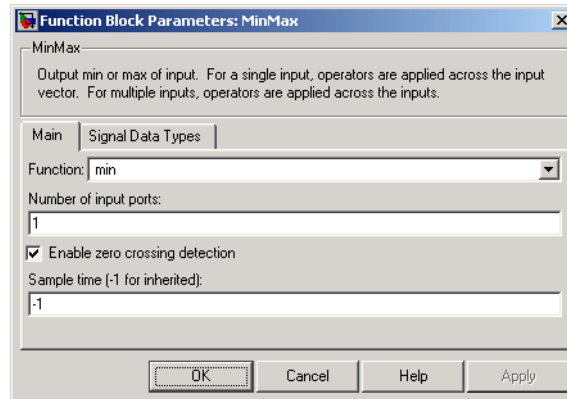
Function

Specify whether to apply the function `min` or `max` to the input.

Number of input ports

Specify the number of inputs to the block.

Enable zero crossing detection

Select to enable zero crossing detection to detect minimum and maximum values. For more information, see Zero Crossing Detection in the "How Simulink Works" chapter of the Using Simulink documentation.

Sample time (-1 for inherited)

Specify the time interval between samples. To inherit the sample time, set this parameter to -1. See "Specifying Sample Time" in the online documentation for more information.

The **Signal Data Types** pane of the MinMax block dialog appears as follows:
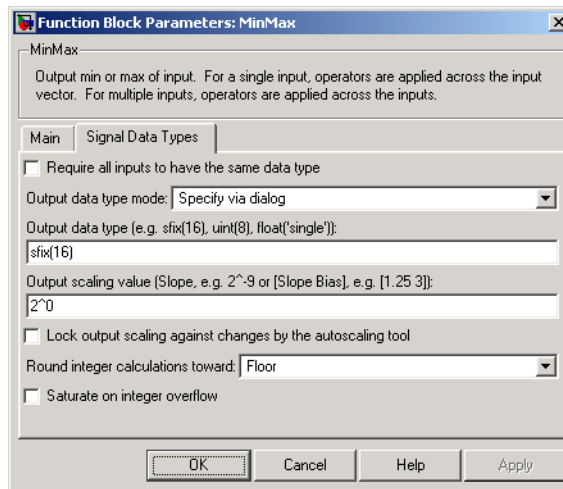
Require all inputs to have same data type
> Select this parameter to require that all inputs must have the same data type.

Output data type mode
> Specify the output data type and scaling by choosing a built-in data type from the drop-down list, or inherit the data type and scaling by an internal rule or by backpropagation. Lastly, if you select Specify via dialog, the **Output data type**, **Output scaling value**, and **Lock output scaling against changes by the autoscaling tool** parameters become visible.

Output data type
> Specify any data type, including fixed-point data types. This parameter is only visible if you select Specify via dialog for the **Output data type mode** parameter.

Output scaling value
> Set the output scaling using binary point-only or [Slope Bias] scaling. This parameter is only visible if you select Specify via dialog for the **Output data type mode** parameter.

Lock output scaling against changes by the autoscaling tool
Select to lock scaling of outputs. This parameter is only visible if you select Specify via dialog for the **Output data type mode** parameter.

Round integer calculations toward
Select the rounding mode for fixed-point operations.

Saturate on integer overflow
Select to have overflows saturate.

Characteristics

Direct Feedthrough	Yes
Sample Time	Specified in the **Sample time** parameter
Scalar Expansion	Yes, of the inputs
Dimensionalized	Yes
Zero Crossing	Yes, if enabled.

MinMax Running Resettable

Purpose	Determine the minimum or maximum of a signal over time
Library	Math Operations

Description

The MinMax Running Resettable block outputs the minimum or maximum of all past inputs u. You specify whether the block outputs the minimum or the maximum with the **Function** parameter.
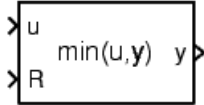
The block can reset its state based on an external reset signal R. When the reset signal R is TRUE, the block resets the output to the value of the **Initial condition** parameter.

Data Type Support

The MinMax Running Resettable block accepts signals of any data type supported by Simulink, including fixed-point data types.

Parameters and Dialog Box
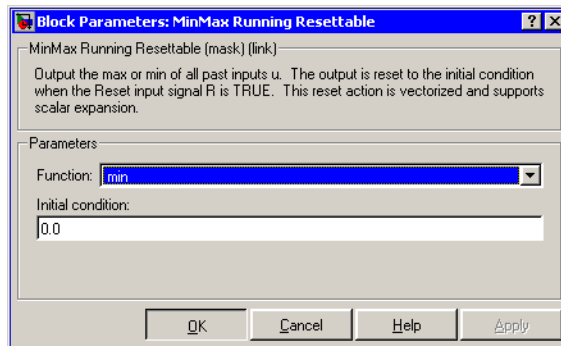
Function
Specify whether the block outputs the minimum or the maximum.

Initial condition
Initial condition.

Characteristics

Direct Feedthrough	Yes
Scalar Expansion	Yes

Model

Purpose   Include a model as a block in another model.

Library   Ports & Subsystems

Description   The Model block allows you to include a model as a block in another
model. The Model block displays input ports and output ports
corresponding to the model's top-level input and output ports. This
allows you to connect the included model to other blocks in the
containing model.

During simulation, Simulink invokes an S-function called the
simulation target to compute the model's outputs. If the simulation
target does not exist at the beginning of a simulation or when you
update the model's block diagram, Simulink generates the target from
the referenced model. If the target exists, Simulink checks whether
the included model has changed since the last time the target was
built. If so, Simulink regenerates the target to reflect changes in the
model. Simulink uses the same simulation target for all instances of
an included model whether in the same model or different model. See
"Referencing Models" for more information.

**Data Type
Support**   Determined by the root-level inputs and outputs of the model referenced
by the Model block.

Parameters and Dialog Box
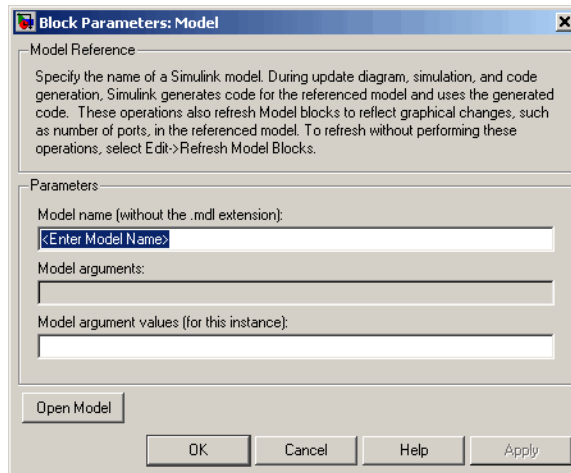
Model Name (without the .mdl extensions)

Name of the model referenced by this block. This name must be a valid MATLAB identifier. The model must exist on the MATLAB path and the MATLAB path must contain no other model having the same name.

Model arguments

Names of model arguments accepted by the model referenced by this block (see "Parameterizing Model References" for more information).

Model argument values (for this instance)

Values to be passed as model arguments to the model referenced by this block each time the model is invoked during a simulation. Enter the values in this field as a comma-separated list in the same order as the corresponding argument names appear in the **Model arguments** field.

Model

Characteristics	Direct Feedthrough	Depends on model referenced by this block.
	Scalar Expansion	Depends on model referenced by this block.

Purpose   Display revision control information in a model

Library   Model-Wide Utilities

Description   The Model Info block displays revision control information about
a model as an annotation block in the model's block diagram. The
following diagram illustrates use of a Model Info block to display
information about the vdp model.
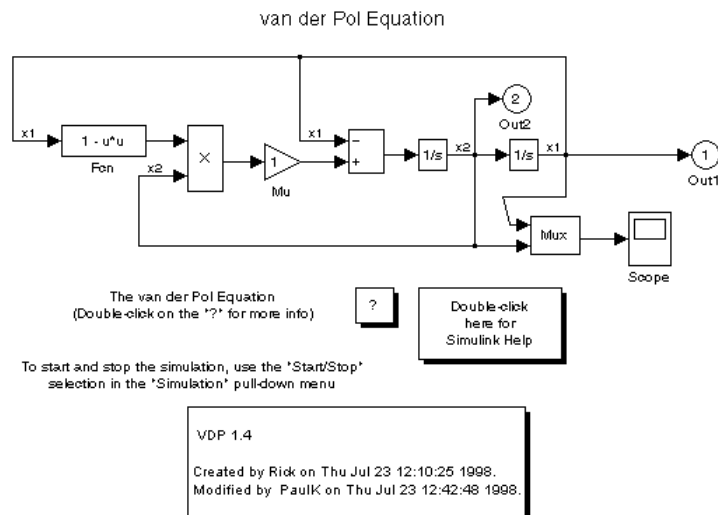
A Model Info block can show revision control information embedded in
the model itself and/or information maintained by an external revision
control or configuration management system. A Model Info block's
dialog allows you to specify the content and format of the text displayed
by the block.

**Data Type
Support**   Not applicable.

Model Info

Parameters and Dialog Box
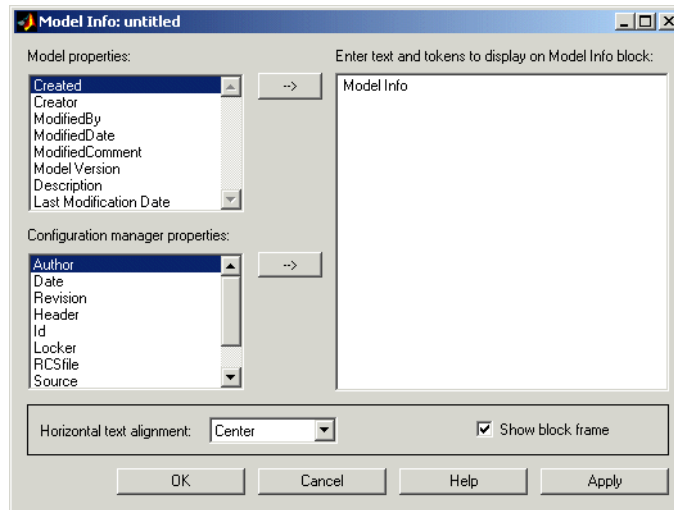
The Model Info block dialog box includes the following fields:

Editable text

Enter the text to be displayed by the Model Info block in this field. You can freely embed variables of the form %<propname>, where propname is the name of a model or revision control system property, in the entered text. The value of the property replaces the variable in the displayed text. For example, suppose that the current version of the model is 1.1. Then the entered text

```
Version %<ModelVersion>
```

appears as

```
Version 1.1
```

in the displayed text. The model and revision control system properties that you can reference in this way are listed in the **Model properties** and **Configuration manager properties** fields.

Model properties

Lists revision control properties stored in the model. Selecting a property and then selecting the adjacent arrow button enters the corresponding variable in the **Editable text** field. For example, selecting CreatedBy enters %<CreatedBy%> in the **Editable text** field. See "Version Control Properties" for a description of the usage of the properties specified in this field.

Configuration manager properties

This field appears only if you previously specified an external configuration manager for this model on the MATLAB **Preferences** dialog box for the model (see "**Specify Source Control System in MATLAB**" in the online documentation) or by setting the model's ConfigurationManager property. The field lists version control information maintained by the external system that you can include in the Model Info block. To include an item from the list, select it and then click the adjacent arrow button.

Note The selected item does not appear in the Model Info block until you check the model in or out of the repository maintained by the configuration manager and you have closed and reopened the model.

Multiport Switch

Purpose   Choose between multiple block inputs

Library   Signal Routing
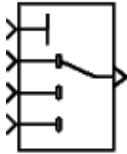
Description   The Multiport Switch block chooses between a number of inputs. The first (top) input is called the *control input*, while the rest of the inputs are called *data inputs*. The value of the control input determines which data input is passed through to the output port.

If the control input is an integer value, then the specified data input is passed through to the output. For example, suppose the **Use zero-based indexing** parameter is not selected. If the control input is 1, then the first data input is passed through to the output. If the control input is 2, then the second data input is passed through to the output, and so on. If the control input is not an integer value, the block first truncates the value to an integer by rounding to floor. If the truncated control input is less than 1 or greater than the number of input ports, an out-of-bounds error is returned.

You specify the number of data inputs with the **Number of input ports** parameter. The data inputs can be scalar or vector. The block output is determined by these rules:

- If you specify only one data input and that input is a vector, the block behaves as an "index selector," and not as a multi-port switch. The block output is the vector element that corresponds to the value of the control input.

- If you specify more than one data input, the block behaves like a multi-port switch. The block output is the data input that corresponds to the value of the control input. If at least one of the data inputs is a vector, the block output is a vector. Any scalar inputs are expanded to vectors.

- If the inputs are scalar, the output is a scalar.

The Index Vector block, also in the Signal Routing library, is another implementation of the Multiport Switch block that has different default parameter settings.

Data type support

The control and data inputs of a Multiport Switch block can be signals of any data type supported by Simulink, except `Boolean`. The Multiport Switch block supports fixed-point data types.

The control inputs must be real. The data inputs can be real or complex.

For a discussion on the data types supported by Simulink, see "Data Types Supported by Simulink" in the Simulink documentation.

Parameters and Dialog Box

The **Main** pane of the Multiport Switch block dialog appears as follows:
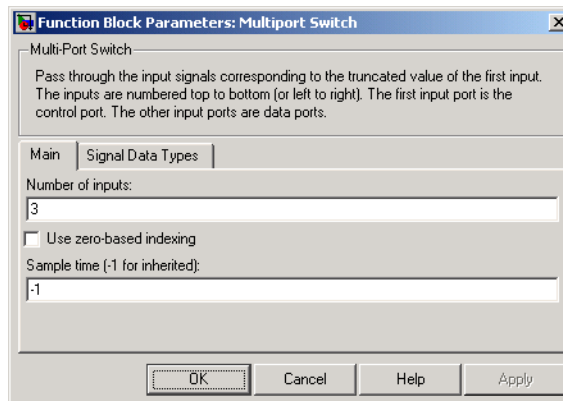
Number of input ports
Specify the number of data inputs to the block.

Use zero based indexing
If selected, the block uses zero-based indexing. Otherwise, the block uses one-based indexing.

Sample time (-1 for inherited)
Specify the time interval between samples. To inherit the sample time, set this parameter to -1. See "Specifying Sample Time" in the online documentation for more information.

The **Signal Data Types** pane of the Multiport Switch block dialog appears as follows:

Multiport Switch
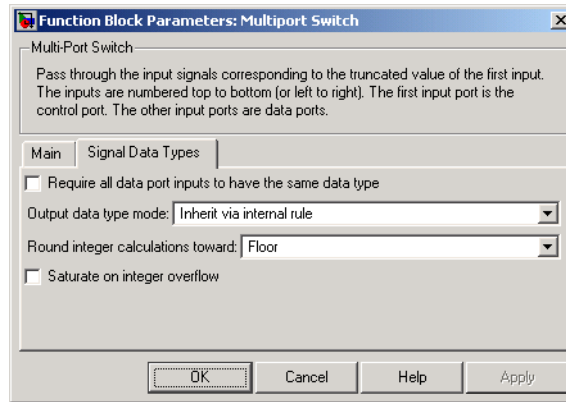
Require all data port inputs to have same data type
> Select to require all data port inputs to have the same data type.

Output data type mode
> You can choose to inherit the output data type and scaling by backpropagation or by an internal rule. The internal rule causes the output of the block to have the same data type and scaling as the input with the larger positive range.

Round integer calculations toward
> Select the rounding mode for fixed-point operations.

Saturate on integer overflow
> Select to have overflows saturate.

Characteristics

Direct Feedthrough	Yes
Sample Time	Specified in the **Sample time** parameter
Scalar Expansion	Yes
Dimensionalized	Yes
Zero Crossing	No

Purpose   Combine several input signals into a vector

Library   Signal Routing

Description   The Mux block combines its inputs into a single vector output. An input can be a scalar or vector signal. All inputs should be of the same data type and numeric type.

Note The Mux block allows you to connect signals of differing data and numeric types and matrix signals to its inputs. In this case, the Mux block outputs a bus signal combining the inputs. In other words, the Mux block behaves like a Bus Creator block. Nevertheless, you should use Bus Creator blocks in such cases to ensure that your model will run in future releases of Simulink, which may not support the use of Mux blocks as Bus Creators. If your model currently uses Mux blocks as Bus Creators, you may want to consider replacing the Mux blocks with equivalent Bus Creator blocks (see Mux blocks used to create bus signals for more information).

The Mux block's **Number of Inputs** parameter allows you to specify input signal names and sizes as well as the number of inputs. You can use any of the following formats to specify this parameter:

- Scalar

  Specifies the number of inputs to the Mux block. When this format is used, the block accepts scalar or vector signals of any size. Simulink assigns each input the name signalN, where N is the input port number.

- Vector

  The length of the vector specifies the number of inputs. Each element specifies the size of the corresponding input. A positive value specifies that the corresponding port can accept only vectors of that size. For example, [2 3] specifies two input ports of sizes 2 and 3,

Mux

respectively. If an input signal width does not match the expected width, Simulink displays an error message. A value of -1 specifies that the corresponding port can accept scalars or vectors of any size.

- Cell array

  The length of the cell array specifies the number of inputs. The value of each cell specifies the size of the corresponding input. A scalar value N specifies a vector of size N. A value of -1 means that the corresponding port can accept scalar or vector signals of any size.

- Signal name list

  You can enter a list of signal names separated by commas. Simulink assigns each name to the corresponding port and signal. For example, if you enter position,velocity, the Mux block will have two inputs, named position and velocity.

Note Simulink hides the name of a Mux block when you copy it from the Simulink block library to a model.

Data Type Support

The Mux block accepts real or complex signals of any data type supported by Simulink, including fixed-point data types.

For a discussion on the data types supported by Simulink, see "Data Types Supported by Simulink" in the Simulink documentation.

Parameters and Dialog Box
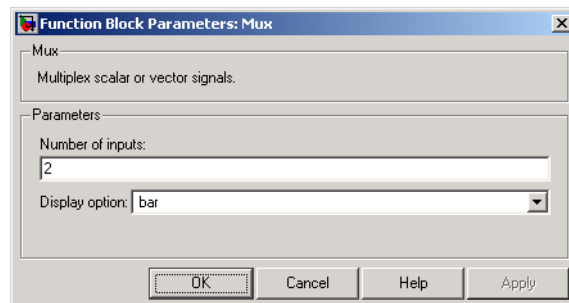
Number of inputs

    The number and size of inputs. You can enter a comma-separated list of signal names for this parameter field.

Display option

    The appearance of the block in the model.

Display Option	Appearance of Block in Model
none	Mux appears inside the block
signals	Displays signal names next to each port
bar	Displays the block in a solid foreground color

Outport

Purpose   Create an output port for a subsystem or an external output

Library   Ports & Subsystems, Sinks

Description   Outport blocks are the links from a system to a destination outside
the system.
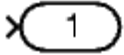
Simulink assigns Outport block port numbers according to these rules:

- It automatically numbers the Outport blocks within a top-level
  system or subsystem sequentially, starting with 1.

- If you add an Outport block, it is assigned the next available number.

- If you delete an Outport block, other port numbers are automatically
  renumbered to ensure that the Outport blocks are in sequence and
  that no numbers are omitted.

Outport Blocks in a Subsystem

Outport blocks in a subsystem represent outputs from the subsystem.
A signal arriving at an Outport block in a subsystem flows out of the
associated output port on that Subsystem block. The Outport block
associated with an output port on a Subsystem block is the block whose
Port number parameter matches the relative position of the output
port on the Subsystem block. For example, the Outport block whose
Port number parameter is 1 sends its signal to the block connected to
the topmost output port on the Subsystem block.

If you renumber the **Port number** of an Outport block, the block
becomes connected to a different output port, although the block
continues to send the signal to the same block outside the subsystem.

When you create a subsystem by selecting existing blocks, if more
than one Outport block is included in the grouped blocks, Simulink
automatically renumbers the ports on the blocks.

The Outport block name appears in the Subsystem icon as a port label.
To suppress display of the label, select the Outport block and choose
Hide Name from the **Format** menu.

Outport Blocks in a Conditionally Executed Subsystem

When an Outport block is in an enabled subsystem, you can specify what happens to its output when the subsystem is disabled: it can be reset to an initial value or held at its most recent value. The **Output when disabled** pop-up menu provides these options. The **Initial output** parameter is the value of the output before the subsystem executes and, if the reset option is chosen, while the subsystem is disabled.

Outport Blocks in a Top-Level System

Outport blocks in a top-level system have two uses: to supply external outputs to the workspace, which you can do by using either the **Configuration Parameters** dialog box or the sim command, and to provide a means for analysis functions to obtain output from the system.

- To supply external outputs to the workspace, use the **Configuration Parameters** dialog box (see Exporting Output Data to the MATLAB Workspace) or the sim command (see sim). For example, if a system has more than one Outport block and the save format is array, the following command

  ```
  [t,x,y] = sim(...);
  ```

  writes y as a matrix, with each column containing data for a different Outport block. The column order matches the order of the port numbers for the Outport blocks.

  If you specify more than one variable name after the second (state) argument, data from each Outport block is written to a different variable. For example, if the system has two Outport blocks, to save data from Outport block 1 to speed and the data from Outport block 2 to dist, you could specify this command:

  ```
  [t,x,speed,dist] = sim(...);
  ```

- To provide a means for the linmod and trim analysis functions to obtain output from the system (see "Linearizing Models")

Outport

Data Type Support

The Outport block accepts complex or real signals of any data type supported by Simulink. An Outport block can also accept fixed-point data types if it is not a root-level output port. The complexity and data type of the block's output are the same as those of its input. For a discussion on the data types supported by Simulink, see "Data Types Supported by Simulink" in the Simulink documentation.

The elements of a signal array connected to an Outport block can be of differing complexity and data types except in the following circumstance: If the output port is in a conditionally executed subsystem and the initial output is specified, all elements of an input array must be of the same complexity and data types.

Typical Simulink data type conversion rules apply to an output port's **Initial output** parameter. If the initial output value is in the range of the block's output data type, Simulink converts the initial output to the output data type. If the specified initial output is out of the range of the output data type, Simulink halts the simulation and signals an error.

**Parameters
and
Dialog
Box**

The **Main** pane of the Outport block dialog appears as follows:
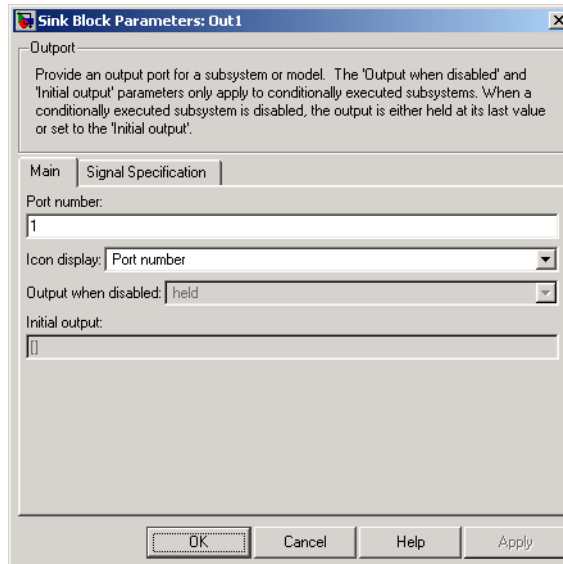
Port number
Specify the port number of the Outport block.

Icon Display
Specify the information to be displayed on the icon of this Outport block. The options are:

Port number	Displays port number of this Outport block.
Signal name	Displays the name of the signal connected to this Outport block (or signals if a bus is connected to this block).
Port name and signal name	Displays both the port number and the name or names of the signals connected to this Outport block.

Output when disabled

This option is enabled only if the Outport resides in an Enabled Subsystem. It specifies what happens to the block output when the system is disabled.

Initial output

For conditionally executed subsystems, specify the block output before the subsystem executes and while it is disabled. You can specify [ ] if your model does not depend on the initial output of the conditionally executed subsystem. Simulink does not allow the initial output of this block to be inf or NaN.

The **Signal Specification** pane of the Output block dialog appears as follows:
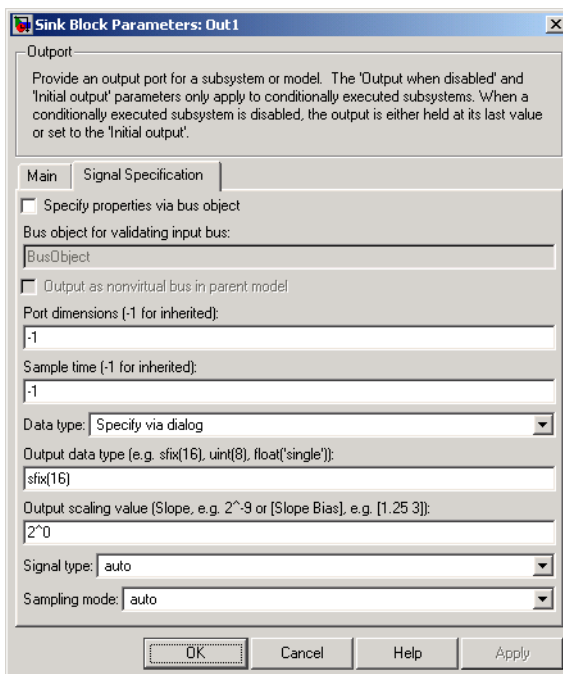
Specify properties via bus object

Select this option to use a bus object (see "Working with Data Objects" and `Simulink.Bus` class in the online documentation) to define the properties of a bus connected to this Outport block.

Bus object for validating input bus

Specifies the name of the bus object that defines the structure that a bus must have to be connected to this Outport block. At the beginning of a simulation or when you update the model's diagram, Simulink checks whether the bus connected to this block has the specified structure. If not, Simulink displays an error message.

Outport

Output as structure in parent model

Select this option if you want code generated from this model to use a C structure to define the structure of the bus signal output by this block.

Port dimensions (-1 for inherited)

Specifies the dimensions that a signal must have in order to be connected to this Outport block. Valid values are:

`-1`	A signal of any dimensions can be connected to this port.
`N`	The signal connected to this port must be a vector of size `N`.
`[R C]`	The signal connected to this port must be a matrix having `R` rows and `C` columns.

Sample time (-1 for inherited)

Specify the sample time of this Outport block. See "Specifying Sample Time" in the online documentation for information on specifying sample times. The output of this block changes at the specified rate to reflect the value of its input.

Data type

Specify the data type of the signal output by this block. To output any data type, set this parameter to `auto`.

Output data type

Specify any data type, including fixed-point data types. This parameter is only visible if you select `Specify via dialog` for the **Data type** parameter.

Output scaling value

Set the output scaling using binary point-only or [Slope Bias] scaling. This parameter is only visible if you select `Specify via dialog` for the **Data type** parameter.

Signal type

Specifies the numeric type of the signal output by this block. The options are:

real	This Outport block outputs a real-valued signal. The signal connected to this block must be real. If it is not, Simulink displays an error if you try to update the diagram or simulate the model that contains this block.
complex	This Outport block outputs a complex signal. The signal connected to this block must be complex. If it is not, Simulink displays an error if you try to update the diagram or simulate the model that contains this block.
auto	This block outputs the numeric type of the signal that is connected to its input.

Sampling mode

Specify the sampling mode (Sample based or Frame based) that the input signal must match. To accept any sampling mode, set this parameter to auto. This parameter is intended to support signal processing applications based on Simulink. See the documentation for the buffer function provided by the Signal Processing Toolbox or "Frame-Based Operations" in the documentation for the Signal Processing Blockset for information about frame-based signals.

Characteristics

Sample Time	Inherited from driving block
Dimensionalized	Yes

Polynomial

Purpose   Perform evaluation of polynomial coefficients on input values

Library   Math Operations

Description

The Polynomial block uses a coefficients parameter to evaluate a real polynomial for the input value.
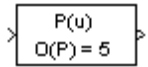
You define a set of polynomial coefficients in the form accepted by the MATLAB polyval command. The block then calculates *P(u)* at each time step for the input *u*. Inputs and coefficients must be real.

Data Type Support

The Polynomial block accepts real signals of types double or single. The **Polynomial coefficients** parameter must be of the same type as the inputs. The output data type is set to the input data type.

Parameters and Dialog Box
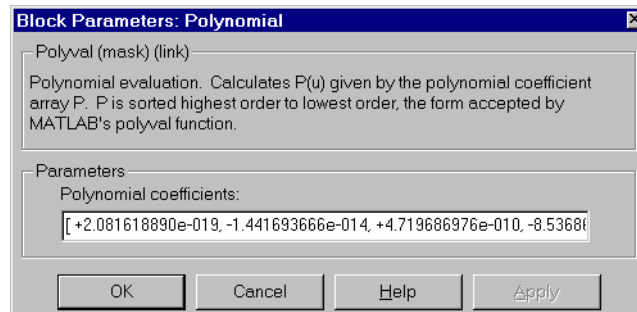
Polynomial coefficients

Values are in coefficients of a polynomial in MATLAB polyval form, with the first coefficient representing x^N, then decreasing in order until the last coefficient, which represents the constant for the polynomial. See polyval in the MATLAB documentation for more information.

Characteristics

Direct Feedthrough	Yes
Sample Time	Inherited from driving block

Scalar Expansion	No
Dimensionalized	Yes
Zero Crossing	No

PreLookup Index Search

Purpose   First stage of high-performance constant or linear interpolation that performs index search and interval fraction calculation for input on a breakpoint set

Library   Lookup Tables
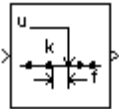
Description   The PreLookup Index Search block is intended for use with the Interpolation (n-D) Using PreLookup block. The PreLookup Index Search block calculates the index and interval fraction that specifies how its input value relates to the breakpoint data set. You feed the resulting (index, fraction) pair into an Interpolation (n-D) Using PreLookup block to interpolate an *n*-dimensional table. This combination of blocks performs the equivalent operation that a single instance of the Lookup Table (n-D) block performs. But by using these blocks instead, you can potentially increase the simulation performance of models that use many interpolation blocks.

To use this block, you must define a set of breakpoint values. In normal use, this breakpoint data set corresponds to one dimension of a **Table data** parameter in an Interpolation (n-D) Using PreLookup block. The block generates a pair of outputs for each input value by calculating the index of the breakpoint set element that is less than or equal to the input value and the resulting fractional value that is a number $0 \leq f < 1$ that represents the input value's normalized position between the index and the next index value for in-range input.

For example, if the breakpoint data is

    [0 5 10 20 50 100]

and the input value u is 55, the (index, fraction) pair is (4, 0.1), denoted as k and f on the block. Note that the index value is zero-based.

Note The interval fraction can be negative or greater than 1 for out-of-range input. See the documentation for the block's **Process out of range input parameter** for more information.

**Data Type
Support**
The PreLookup Index Search block accepts signals of types double or single, but for any given block the inputs must all be of the same type. The **Breakpoint data** parameter must be of the same type as the inputs. The output data type is set to the input data type.

**Parameters
and
Dialog
Box**
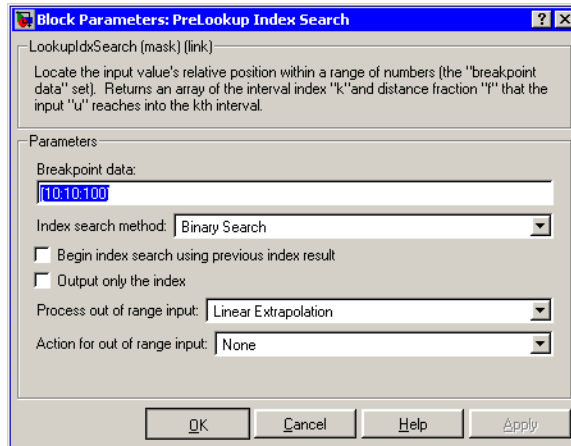
Breakpoint data
The set of numbers to search.

Index search method
Binary search, evenly spaced points, or linear search. Use linear search in combination with **Begin index search using previous index result** for higher performance than a binary search when the input values do not change much from one time step to the next. For large breakpoint sets, a linear search can be very slow if the input value changes by more than a few intervals from one time step to the next.

Begin index search using previous index result
Select this option if you want the block to start its search using the index that was found on the previous time step. For inputs that change slowly with respect to the interval size, you can realize a large performance gain.

PreLookup Index Search

Output only the index

If this block is not being used to feed an Interpolation (n-D) Using PreLookup block, the interval fraction output can be dropped and the resulting index value output is either an `int32` or `uint32` instead.

Process out of range input

Specifies how to handle out-of-range input. Options include:

- `Clip to Range`

  If the input is less than the first breakpoint, return the index of the first breakpoint (i.e., `0`) and `0` for the interval fraction. If the input is greater than the last breakpoint, return the index of the next-to-the-last breakpoint and `1` for the interval fraction. For example, suppose the range is `[1 2 3]` and you select this option. Then, if the input is `0.5`, the block returns `[0 0]`; if the input is `3.5`, the block returns `[1 1]`.

- `Linear Extrapolation`

  If the input is less than the first breakpoint, return the index of the first breakpoint and an interval fraction representing the linear distance from the input to the first breakpoint. If the input is greater than the last breakpoint, return the index of the next-to-the-last breakpoint and an interval fraction that represents the linear distance from the next-to-the-last breakpoint to the input. For example, suppose the range is `[1 2 3]` and you select this option. Then, if the input is `0.5`, the block returns `[0 -0.5]`; if the input is `3.5`, the block returns `[1 1.5]`.

Action for out of range input

Specifies whether to produce a warning or error message if the input is out of range. The options are `None` (the default, no warning or error message), `Warning` (display a warning message in the MATLAB command window and continue the simulation), `Error` (halt the simulation and display an error message in the Simulation Diagnostics Viewer).

Characteristics

Direct Feedthrough	Yes
Sample Time	Inherited from driving blocks
Scalar Expansion	Yes
Dimensionalized	Yes
Zero Crossing	No

See Also   Interpolation (n-D) Using PreLookup

Product

Purpose	Multiply or divide inputs
Library	Math Operations

Description

The Product block performs multiplication or division of its inputs.
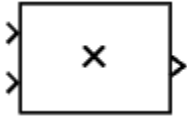
This block produces outputs using either element-wise or matrix multiplication, depending on the value of the **Multiplication** parameter. You specify the operations with the **Number of inputs** parameter. Multiply(*) and divide(/) characters indicate the operations to be performed on the inputs:

- If there are two or more inputs, then the number of characters must equal the number of inputs. For example, "*/*" requires three inputs. For this example, if the **Multiplication** parameter is set to Element-wise, the block divides the elements of the first (top) input by the elements of the second (middle) input, and then multiplies by the elements of the third (bottom) input. In this case, all nonscalar inputs to this block must have the same dimensions.

   If, however, the **Multiplication** parameter is set to Matrix, the block output is the matrix product of the inputs marked "*" and the inverse of inputs marked "/", with the order of operations following the entry in the **Number of inputs** parameter. The dimensions of the inputs must be such that the matrix product is defined.

   Note To perform a dot product on input vectors, use the Dot Product block.

- If only multiplication of inputs is required, then a numeric parameter value equal to the number of inputs can be supplied instead of "*" characters. This may be used in conjunction with either element-wise or matrix multiplication.

- If a single vector is input and the **Multiplication** parameter is set to Element-wise, then a single "*" will cause the block to output the

scalar product of the vector elements. A single "/" will cause the block to output the inverse of the scalar product of the vector elements.

- If a single matrix is input and the **Multiplication** parameter is set to Element-wise, then a single "*" or "/" will cause the block to error out. If, however, the **Multiplication** parameter is set to Matrix, then a single "*" will cause the block to output the matrix unchanged, and a single "/" will cause the block to output the inverse of the matrix.

The Product block first performs the specified multiply or divide operations on the inputs, and then converts the results to the output data type using the specified rounding and overflow modes.

Data Type Support

The Product block accepts real or complex signals of any data type supported by Simulink including fixed-point data types.

For a discussion on the data types supported by Simulink, see "Data Types Supported by Simulink" in the Simulink documentation.

Parameters and Dialog Box

The **Main** pane of the Product dialog appears as follows:

Product
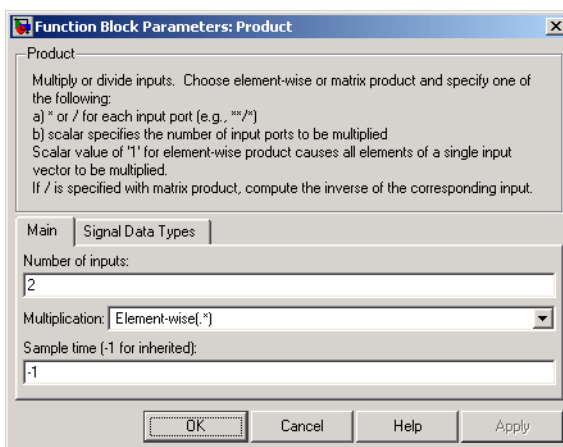
Number of inputs
Enter the number of inputs or a combination of "*" and "/" symbols. See Description above for a complete discussion of this parameter.

Multiplication
Specify element-wise or matrix multiplication. See Description above for a complete discussion of this parameter.

Sample time (-1 for inherited)
Specify the time interval between samples. To inherit the sample time, set this parameter to -1. See "Specifying Sample Time" in the online documentation for more information.

The **Signal Data Types** pane of the Product dialog appears as follows:

Require all inputs to have same data type
Select this parameter to require that all inputs have the same data type.

Product

Lock output scaling against changes by the autoscaling tool
Select to lock scaling of outputs. This parameter is only visible
if you select Specify via dialog for the **Output data type
mode** parameter.

Round integer calculations toward
Select the rounding mode for fixed-point operations.

Saturate on integer overflow
Select to have overflows saturate.

Characteristics

Direct Feedthrough	Yes
Sample Time	Specified in the **Sample time** parameter
Scalar Expansion	Yes
Dimensionalized	Yes
Zero Crossing	No

Purpose   Multiply or divide inputs

Library   Math Operations

Description   The Product of Elements block is an implementation of the Product
block. See `Product` for more information.

Probe

Purpose   Output a signal's attributes, including width, dimensionality, sample time, and/or complex signal flag

Library   Signal Attributes

Description   The Probe block outputs selected information about the signal on its input. The block can output the input signal's width, dimensionality, sample time, and/or a flag indicating whether the input is a complex-valued signal. The block has one input port. The number of output ports depends on the information that you select for probing, that is, signal dimensionality, sample time, and/or complex signal flag. Each probed value is output as a separate signal on a separate output port. The block accepts real or complex-valued signals of any built-in data type. It outputs signals of type double. During simulation, the block's icon displays the probed data.

Data Type Support   The Probe block accepts and outputs any data type supported by Simulink, including fixed-point data types.

For a discussion on the data types supported by Simulink, see "Data Types Supported by Simulink" in the Simulink documentation.

Parameters and Dialog Box   The **Main** pane of the Probe block dialog appears as follows:
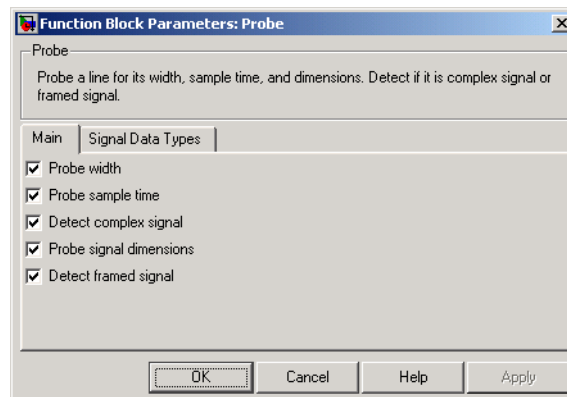
Probe width
>	Select to output the width, or number of elements, of the probed signal.

Probe sample time
>	Select to output the sample time of the probed signal. The output is a 2x1 vector that specifies the period and offset of the sample time, respectively. See "Specifying Sample Time" for more information.

Probe complex signal
>	Select to output 1 if the probed signal is complex; otherwise, 0.

Probe signal dimensions
>	Select to output the dimensions of the probed signal.

Detect framed signal
>	Select to output 1 if the probed signal is framed; otherwise, 0.

The **Signal Data Types** pane of the Probe block dialog appears as follows:
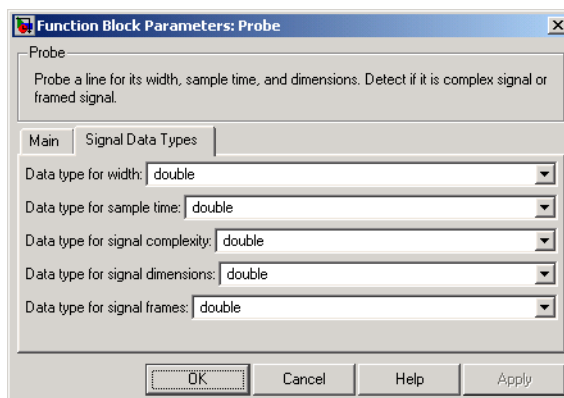
Probe

Note The Probe block ignores the **Data Type Override** setting of the Fixed-Point Settings interface.

Data type for width
  Select the output data type for the width information.

Data type for sample time
  Select the output data type for the sample time information.

Data type for signal complexity
  Select the output data type for the complexity information.

Data type for signal dimensions
  Select the output data type for the dimensions information.

Data type for signal frames
  Select the output data type for the frames information.

Characteristics

Direct Feedthrough	Yes
Sample Time	Inherited from driving block
Scalar Expansion	Yes
Dimensionalized	Yes
Zero Crossing	No

Purpose   Generate square wave pulses at regular intervals

Library   Sources

Description The Pulse Generator block generates square wave pulses at regular
intervals. The block's waveform parameters, **Amplitude**, **Pulse
Width**, **Period**, and **Phase Delay**, determine the shape of the output
waveform. The following diagram shows how each parameter affects
the waveform.
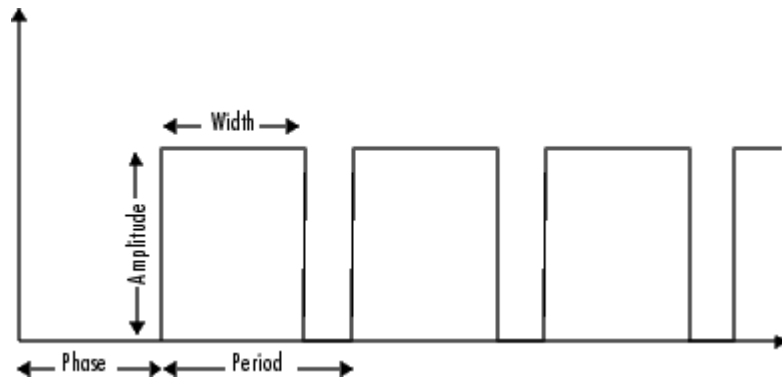
The Pulse Generator can emit scalar, vector, or matrix signals of any
real data type. To cause the block to emit a scalar signal, use scalars
to specify the waveform parameters. To cause the block to emit a
vector or matrix signal, use vectors or matrices, respectively, to specify
the waveform parameters. Each element of the waveform parameters
affects the corresponding element of the output signal. For example,
the first element of a vector amplitude parameter determines the
amplitude of the first element of a vector output pulse. All the waveform
parameters must have the same dimensions after scalar expansion. The
data type of the output is the same as the data type of the **Amplitude**
parameter.

The block's **Pulse type** parameter allows you to specify whether
the block's output is time-based or sample-based. If you select
sample-based, the block computes its outputs at fixed intervals that you

Pulse Generator

specify. If you select *time-based*, Simulink computes the block's outputs only at times when the output actually changes. This can result in fewer computations being required to compute the block's output over the simulation time period.

Depending on the pulse's waveform characteristics, the intervals between changes in the block's output can vary. For this reason, a time-based Pulse Generator block is said to have a variable sample time. Simulink uses yellow as the sample time color of such blocks (see "Displaying Sample Time Colors" for more information).

Simulink cannot use a fixed solver to compute the output of a time-based pulse generator. If you specify a fixed-step solver for models that contain time-based pulse generators, Simulink computes a fixed sample time for the time-based pulse generators. It then simulates the time-based pulse generators as sample-based.

Note If you use a fixed-step solver and the **Pulse type** is `time-based`, you must choose the step size such that the period, phase delay, and pulse width (in seconds) are integer multiples of the step size. For example, suppose that the period is 4 seconds, the pulse width is 75% (i.e., 3 s), and the phase delay is 1 s. In this case, the computed sample time is 1 s. Therefore, you must choose a fixed-step size that is 1 or that divides 1 exactly (e.g., `0.25`). You can guarantee this by setting the fixed-step solver's step size to `auto` on the **Configuration Parameters** dialog box.

If you select time-based as the block's pulse type, you must specify the pulse's phase delay and period in units of seconds. If you specify sample-based, you must specify the block's sample time in seconds, using the **Sample Time** parameter, then specify the block's phase delay and period as integer multiples of the sample time. For example, suppose that you specify a sample time of 0.5 second. And suppose you want the pulse to repeat every two seconds. In this case, you would specify 4 as the value of the block's **Period** parameter.
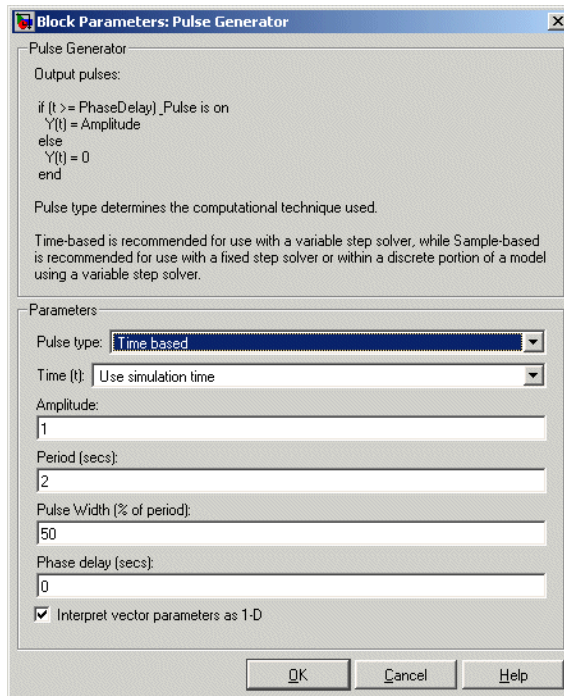
Pulse Generator

Time

Specifies whether to use simulation time or an external signal as the source of values for the output signal's time variable. If you specify an external source, the block displays an input port for connecting the source.

Amplitude

The pulse amplitude. The default is 1.

Period

The pulse period specified in seconds if the pulse type is time-based or as number of sample times if the pulse type is sample-based. The default is 2.

Pulse width

The duty cycle specified as the percentage of the pulse period that the signal is on if time-based or as number of sample times if sample-based. The default is 50 percent.

Phase delay

The delay before the pulse is generated specified in seconds if the pulse type is time-based or as number of sample times if the pulse type is sample-based. The default is 0 seconds.

Sample Time

The length of the sample time for this block in seconds. This parameter appears only if the block's pulse type is sample-based. See "Specifying Sample Time" for more information.

Interpret vector parameters as 1-D

If you select this option and the other parameters are one-row or one-column matrices, after scalar expansion, the block outputs a 1-D signal (vector). Otherwise the output dimensionality is the same as that of the other parameters. See "Determining the Output Dimensions of Source Blocks" in the "Working with Signals" chapter of the Using Simulink documentation.

Characteristics

Sample Time	Inherited
Scalar Expansion	Yes, of parameters
Dimensionalized	Yes
Zero Crossing	No

Quantizer

Purpose   Discretize input at a specified interval

Library   Discontinuities
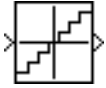
Description   The Quantizer block passes its input signal through a stair-step function
so that many neighboring points on the input axis are mapped to one
point on the output axis. The effect is to quantize a smooth signal into a
stair-step output. The output is computed using the round-to-nearest
method, which produces an output that is symmetric about zero.

```
y = q * round(u/q)
```

where y is the output, u the input, and q the **Quantization interval**
parameter.

**Data Type
Support**   The Quantizer block accepts and outputs real or complex signals of
type single or double.

**Parameters
and
Dialog
Box**
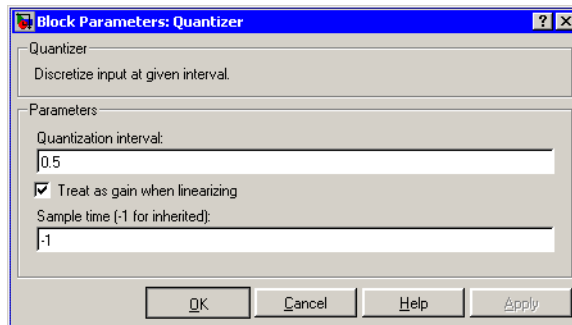
Quantization interval
> The interval around which the output is quantized. Permissible
> output values for the Quantizer block are n*q, where n is an
> integer and q the **Quantization interval**. The default is 0.5.

Treat as gain when linearizing

Simulink by default treats the Quantizer block as unity gain when linearizing. This is the large signal linearization case. If you clear this box, the linearization routines assume the small signal case and set the gain to zero.

Sample time (-1 for inherited)

Specify the sample time of this Outport block. See "Specifying Sample Time" in the online documentation for information on specifying sample times. The output of this block changes at the specified rate to reflect the value of its input.

Characteristics

Direct Feedthrough	Yes
Sample Time	Inherited from driving block
Scalar Expansion	Yes, of parameter
Dimensionalized	Yes
Zero Crossing	No

Ramp

Purpose	Generate constantly increasing or decreasing signal
Library	Sources

Description

The Ramp block generates a signal that starts at a specified time and value and changes by a specified rate. The block's **Slope**, **Start time**, and **Initial output** parameters determine the characteristics of the output signal. All must have the same dimensions after scalar expansion.

Data Type Support

The Ramp block outputs signals of type double.
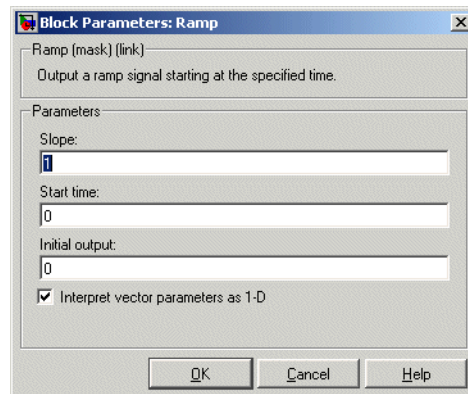
Parameters and Dialog Box

Opening this dialog box causes a running simulation to pause. See "Changing Source Block Parameters" in the online Simulink documentation for details.

Slope
    The rate of change of the generated signal. The default is 1.

Start time
    The time at which the signal begins to be generated. The default is 0.

Initial output

The initial value of the signal. The default is 0.

Interpret vector parameters as 1-D

If you select this option and the other parameters are one-row or one-column matrices, after scalar expansion, the block outputs a 1-D signal (vector). Otherwise, the output dimensionality is the same as that of the other parameters. See "Determining the Output Dimensions of Source Blocks" in the "Working with Signals" chapter of the Using Simulink documentation.

Characteristics

Sample Time	Inherited from driven block
Scalar Expansion	Yes
Dimensionalized	Yes
Zero Crossing	Yes

Random Number

Purpose   Generate normally distributed random numbers

Library   Sources

Description   The Random Number block generates normally distributed random
                   numbers. The seed is reset to the specified value each time a simulation
                   starts.

                   By default, the sequence produced has a mean of 0 and a variance of 1,
                   although you can vary these parameters. The sequence of numbers is
                   repeatable and can be produced by any Random Number block with the
                   same seed and parameters. To generate a vector of random numbers
                   with the same mean and variance, specify the **Initial seed** parameter
                   as a vector.

                   To generate uniformly distributed random numbers, use the Uniform
                   Random Number block.

                   Avoid integrating a random signal, because solvers are meant to
                   integrate relatively smooth signals. Instead, use the Band-Limited
                   White Noise block.

                   All the block's numeric parameters must be of the same dimension after
                   scalar expansion.

**Data Type   The Random Number block accepts and outputs signals of type `double`.
Support**
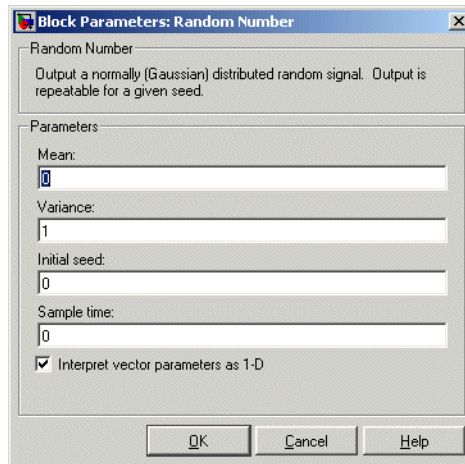
Parameters and Dialog Box

Opening this dialog box causes a running simulation to pause. See "Changing Source Block Parameters" in the online Simulink documentation for details.

Mean
The mean of the random numbers. The default is 0.

Variance
The variance of the random numbers. The default is 1.

Initial seed
The starting seed for the random number generator. The seed must be 0 or a positive integer. The default is 0.

Sample time
The time interval between samples. The default is 0, causing the block to have continuous sample time. See "Specifying Sample Time" in the online documentation for more information.

Interpret vector parameters as 1-D
If you select this option and the other parameters are one-row or one-column matrices, after scalar expansion, the block outputs a 1-D signal (vector). Otherwise, the output dimensionality is the same as that of the other parameters. See "Determining

Random Number

the Output Dimensions of Source Blocks" in the "Working with Signals" chapter of the Using Simulink documentation.

Characteristics

Sample Time	Specified in the **Sample time** parameter
Scalar Expansion	Yes, of parameters
Dimensionalized	Yes
Zero Crossing	No

Purpose   Limit the rate of change of a signal

Library   Discontinuities
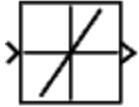
Description   The Rate Limiter block limits the first derivative of the signal passing through it. The output changes no faster than the specified limit. The derivative is calculated using this equation.

$$rate = \frac{u(i) - y(i-1)}{t(i) - t(i-1)}$$

$u(i)$ and $t(i)$ are the current block input and time, and $y(i-1)$ and $t(i-1)$ are the output and time at the previous step. The output is determined by comparing $rate$ to the **Rising slew rate** and **Falling slew rate** parameters:

- If $rate$ is greater than the **Rising slew rate** parameter (R), the output is calculated as

$$y(i) = \Delta t \cdot R + y(i-1)$$

- If $rate$ is less than the **Falling slew rate** parameter (F), the output is calculated as

$$y(i) = \Delta t \cdot F + y(i-1)$$

- If $rate$ is between the bounds of R and F, the change in output is equal to the change in input:

$$y(i) = u(i)$$

Data Type Support   The Rate Limiter block accepts and outputs signals of any data type supported by Simulink, except `Boolean`. The Rate Limiter block supports fixed-point data types.

Rate Limiter

Parameters and Dialog Box
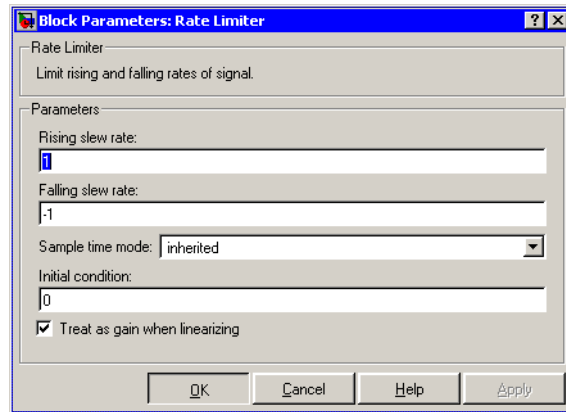
Rising slew rate

Specify the limit of the derivative of an increasing input signal. This parameter is tunable for fixed-point inputs.

Falling slew rate

Specify the limit of the derivative of a decreasing input signal. This parameter is tunable for fixed-point inputs.

Sample time mode

Specify the sample time mode, continuous or inherited from the driving block.

Initial condition

Set the initial output of the simulation. Simulink does not allow you to set the initial condition of this block to inf or NaN.

Treat as gain when linearizing

Linearization commands in Simulink treat this block as a gain in state space. Select this check box to cause the linearization commands to treat the gain as 1; otherwise, the commands treat the gain as 0.

Characteristics

Direct Feedthrough	Yes
Sample Time	Continuous or inherited (specified in the **Sample time mode** parameter)
Scalar Expansion	Yes, of input and parameters
Dimensionalized	Yes
Zero Crossing	No

See Also   Rate Limiter Dynamic

Rate Limiter Dynamic

Purpose　　　Limit the rising and falling rates of the signal

Library　　　Discontinuities

Description　　The Rate Limiter Dynamic block limits the rising and falling rates of the signal.
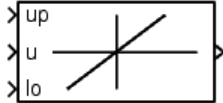
The external signal up sets the upper limit on the rising rate of the signal.

The external signal lo sets the lower limit on the falling rate of the signal.

Note You cannot use a variable-step solver to simulate models that contain this block. You must use a fixed-step solver.

Data Type Support　　The Rate Limiter Dynamic block accepts signals of any data type supported by Simulink, including fixed-point data types.

Parameters and Dialog Box
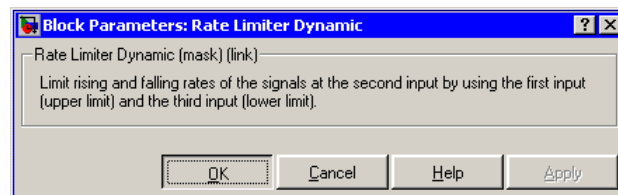
Characteristics

Direct Feedthrough	Yes
Scalar Expansion	Yes

See Also　　Rate Limiter

Purpose   Handle transfer of data between blocks operating at different rates

Library   Signal Attributes
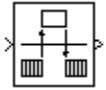
Description The Rate Transition block transfers data from the output of a block
operating at one rate to the input of another block operating at a
different rate. The Rate Transition block's parameters allows you to
specify options that trade data integrity and deterministic transfer for
faster response and/or lower memory requirements.

Note See "Data Transfer Problems" in the online Real-Time Workshop
documentation for a discussion of data integrity and deterministic data
transfer.

In particular, the block supports the following options:

• Deterministic transfer of data with data integrity between blocks
  operating at different speeds at the cost of maximum latency of data
  transfer

  This is the default option.

• Nondeterministic data transfer with minimum latency and assured
  data integrity but increased memory requirements

  To specify this option, check the **Ensure data integrity during
  data transfer** parameter and uncheck the **Ensure deterministic
  data transfer** parameter.

• Minimum latency and target size at the cost of nondeterministic data
  transfer and possible loss of data integrity

  To specify this option, uncheck the **Ensure data integrity
  during data transfer** and **Ensure deterministic data transfer**
  parameters.

Rate Transition

The behavior of the Rate Transition block depends on the sample times of the ports between which it is connected, the priorities of the tasks corresponding to the source and destination sample times (see "Sample time properties"), and whether the model specifies a fixed- or variable-step solver. Updating the diagram causes a label to appear on the block that indicates its behavior during simulation as follows:

Label	Block Behavior
ZOH	Acts as a zero-order hold
1/z	Acts as a unit delay
Buf	Copies input to output under semaphore control
Db_buf	Copies input to output, using double buffers
Copy	Unprotected copy of input to output
NoOp	Does nothing

The behavior label lets you see at a glance the method that the Rate Transition block uses to ensure safe transfer of data between tasks operating at different rates. You can use Simulink's sample-time colors feature (see "Displaying Sample Time Colors") to display the relative rates that the block bridges. Consider, for example, the following diagram.
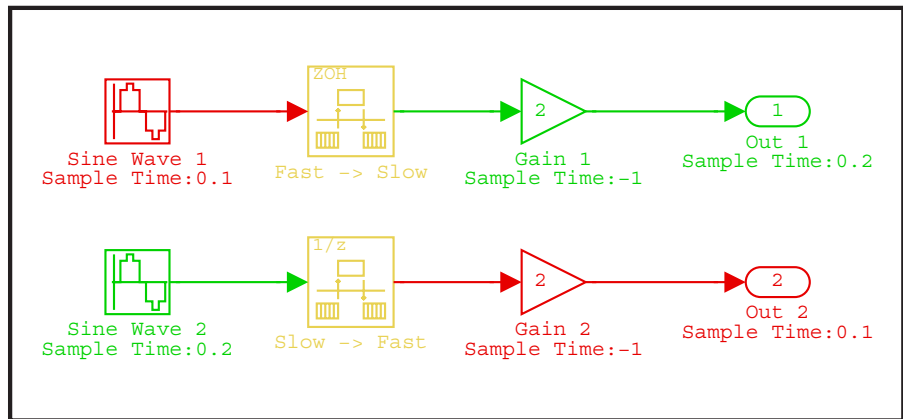
Sample-time colors and the block behavior label allow you to see at a glance that the Rate Transition block at the top of the diagram acts as a zero-order hold in a fast-to-slow transition and the bottom Rate Transition block acts as a unit delay in a slow-to-fast transition.

See "Sample Rate Transitions" in the online Real-Time Workshop documentation for more information.

Note The Zero-Order Hold and Unit Delay blocks also enable transfer of data between blocks operating at different rates. However, you should use the Rate Transition block for this purpose because it offers a wider range of options and is easier to use.

Data Type Support

The Rate Transition block accepts signals of any data type supported by Simulink, including fixed-point data types.

For a discussion on the data types supported by Simulink, see "Data Types Supported by Simulink" in the Simulink documentation.

Rate Transition

Parameters and Dialog Box
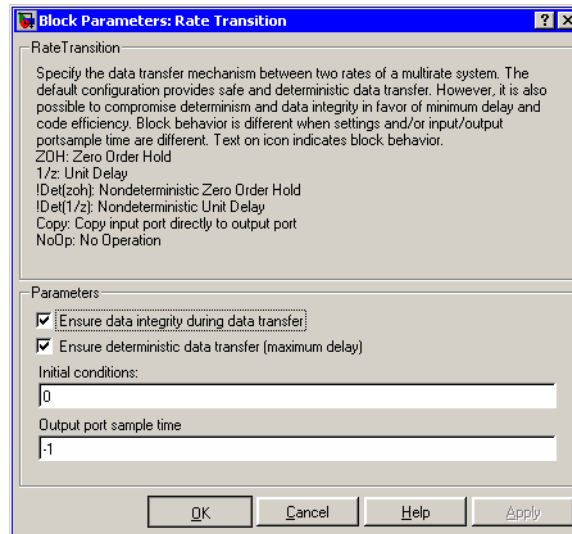
Ensure data integrity during data transfer

Selecting this option results in generation of code that ensures the integrity of data transferred by the Rate Transition block. If you select this option and the transfer is nondeterministic (see **Ensure deterministic data transfer** option below), the generated code uses double-buffering to prevent the fast block from interrupting the data transfer. Otherwise the generated code uses a copy operation to effect the data transfer. The copy operation consumes less memory than double-buffering but is also interruptible and hence can lead to loss of data during nondeterministic data transfers. Thus, you should select this option if you want the generated code to operate both with maximum responsiveness (i.e., nondeterministically) and assured data integrity. See "Rate Transition Block Options" in the online Real-Time Workshop documentation for more information.

Ensure deterministic data transfer (maximum delay)

Selecting this option causes code generation to generate code that transfers data at the sample rate of the slower block, i.e.,

deterministically. If this option is not selected, data transfers occur as soon as new data is available from the source block and the receiving block is ready to receive the data. This avoids the need to delay transfers, thus ensuring that the system operates with maximum responsiveness. However, it also means that transfers can occur unpredictably, which is undesirable in some applications. See "Rate Transition Block Options" in the online Real-Time Workshop documentation for more information.

Initial conditions

This parameter applies only to Slow to fast transitions. It specifies the Rate Transition's initial output at the beginning of a transition when there is not yet any output from the slow block connected to the Rate Transition block's input. Simulink does not allow the initial output of this block to be inf or NaN.

Output port sample time

Specifies the output rate to which the input rate is converted. The default value (-1) specifies that the output rate is inherited from the block to which the Rate Transition block's output port is connected. See "Specifying Sample Time" in the online documentation for information on how to specify the output rate.

Characteristics

Direct Feedthrough	No for slow-to-fast transitions that are protected, i.e., for which you have checked the **Ensure data integrity during data transfer** option; otherwise, yes.
Sample Time	This block supports discrete-to-discrete and discrete-to-continuous transitions.
Scalar Expansion	Yes, of input.
Dimensionalized	Yes
Zero Crossing	No

Real-Imag to Complex

Purpose   Convert real and/or imaginary inputs to a complex signal

Library   Math Operations

Description   The Real-Imag to Complex block converts real and/or imaginary inputs to a complex-valued output signal.
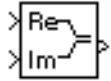
The inputs can both be arrays (vectors or matrices) of equal dimensions, or one input can be an array and the other a scalar. If the block has an array input, the output is a complex array of the same dimensions. The elements of the real input are mapped to the real parts of the corresponding complex output elements. The imaginary input is similarly mapped to the imaginary parts of the complex output signals. If one input is a scalar, it is mapped to the corresponding component (real or imaginary) of all the complex output signals.

The input signals and real or imaginary output parameter can be of any data type supported by Simulink, except `Boolean`. The Real-Imag to Complex block supports fixed-point data types. The output is of the same type as the input or parameter that determines the output.

For a discussion on the data types supported by Simulink, see "Data Types Supported by Simulink" in the Simulink documentation.

Data Type Support   See the preceding description.

Parameters and Dialog Box
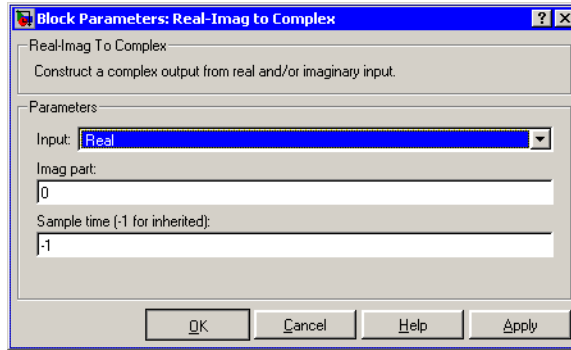
Input

Specifies the kind of input: a real input, an imaginary input, or both.

Real (Imag) part

If the input is a real-part signal, this parameter specifies the constant imaginary part of the output signal. If the input is the imaginary part, this parameter specifies the constant real part of the output signal. Note that the title of this field changes to reflect its usage.

Sample time (-1 for inherited)

Specify the time interval between samples. To inherit the sample time, set this parameter to -1. See "Specifying Sample Time" in the online documentation for more information.

Characteristics

Direct Feedthrough	Yes
Sample Time	Inherited from driving block
Scalar Expansion	Yes, of the input when the function requires two inputs
Dimensionalized	Yes
Zero Crossing	No

Relational Operator

Purpose   Perform the specified relational operation on the inputs

Library   Logic and Bit Operations

Description The Relational Operator block performs the specified comparison of its two inputs.
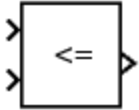
You select the relational operator connecting the two inputs with the **Relational Operator** parameter. The block updates to display the selected operator. The supported operations are given below.

Operation	Description
==	TRUE if the first input is equal to the second input
~=	TRUE if the first input is not equal to the second input
<	TRUE if the first input is less than the second input
<=	TRUE if the first input is less than or equal to the second input
>=	TRUE if the first input is greater than or equal to the second input
>	TRUE if the first input is greater than the second input

You can specify inputs as scalars, arrays, or a combination of a scalar and an array:

- For scalar inputs, the output is a scalar.

- For array inputs, the output is an array of the same dimensions, where each element is the result of an element-by-element comparison of the input arrays.

- For mixed scalar/array inputs, the output is an array, where each element is the result of a comparison between the scalar and the corresponding array element.

The input with the smaller positive range is converted to the data type of the other input offline using round-to-nearest and saturation. This conversion is performed prior to comparison.

The output data type is specified with the **Output data type mode** and **Output data type** parameters. The output equals 1 for TRUE and 0 for FALSE.

Note The output data type selected should represent zero exactly. Data types that satisfy this condition include signed and unsigned integers and any floating-point data type.

Data Type Support

The Relational Operator block accepts real or complex signals of any data type supported by Simulink, including fixed-point data types. One input can be real and the other complex if the operator is == or !=.

For a discussion on the data types supported by Simulink, see "Data Types Supported by Simulink" in the Simulink documentation.

Parameters and Dialog Box

The **Main** pane of the Relational Operator block appears as follows:
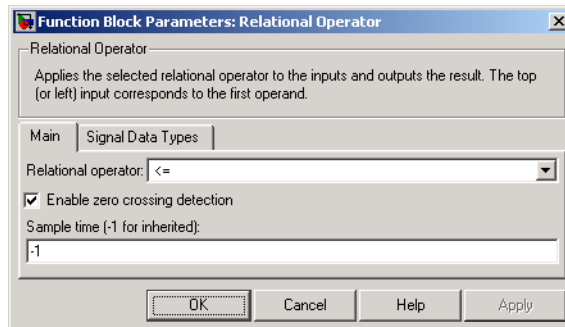
Relational Operator

Designate the relational operator used to compare the two inputs.

Relational Operator

Enable zero crossing detection

Select to enable zero crossing detection. For more information, see Zero Crossing Detection in the "How Simulink Works" chapter of the Using Simulink documentation.

Sample time (-1 for inherited)

Specify the time interval between samples. To inherit the sample time, set this parameter to -1. See "Specifying Sample Time" in the online documentation for more information.

The **Signal Data Types** pane of the Relational Operator block appears as follows:
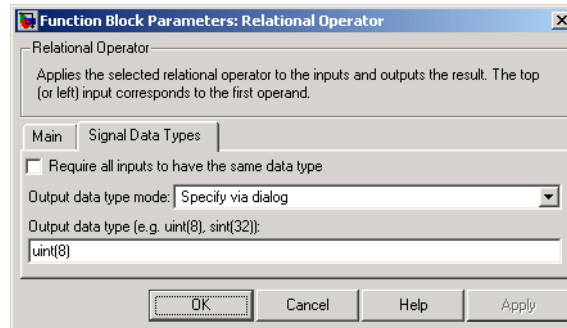
Require all inputs to have same data type

Select to require inputs to have the same data type.

Output data type mode

Select a method for specifying the output data type. Options are:

Option	Description
Boolean	Specifies the output data type as boolean.

Option	Description
Logical	Use the **Implement logic signals as boolean data** model configuration parameter (see "Implement logic signals as boolean data (vs. double)") to specify the output data type.
	Note This option is intended to support models created before the Boolean option became available. Use one of the other options, preferably Boolean, for new models.
Specify via dialog	Selecting this option causes the block's dialog box to display an **Output data type** field (see below). Use this field to specify the block's output data type.

Output data type
Specify the output data type. You should only use data types that represent zero exactly. Data types that satisfy this condition include signed and unsigned integers and any floating-point data type. This parameter appears only if you select Specify via dialog for the **Output data type mode** parameter.

Characteristics

Direct Feedthrough	Yes
Sample Time	Specified in the **Sample time** parameter
Scalar Expansion	Yes, of inputs
Dimensionalized	Yes
Zero Crossing	Yes, if enabled.

Relay

Purpose　　　　Switch output between two constants

Library　　　　Discontinuities
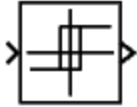
Description　　The Relay block allows its output to switch between two specified values. When the relay is on, it remains on until the input drops below the value of the **Switch off point** parameter. When the relay is off, it remains off until the input exceeds the value of the **Switch on point** parameter. The block accepts one input and generates one output.

The **Switch on point** value must be greater than or equal to the **Switch off point**. Specifying a **Switch on point** value greater than the **Switch off point** value models hysteresis, whereas specifying equal values models a switch with a threshold at that value.

Data Type Support　　The Relay block accepts real or complex signals of any data type supported by Simulink. The Relay block supports fixed-point data types.

For a discussion on the data types supported by Simulink, see "Data Types Supported by Simulink" in the Simulink documentation.

Parameters and Dialog Box

The **Main** pane of the Relay block dialog appears as follows:
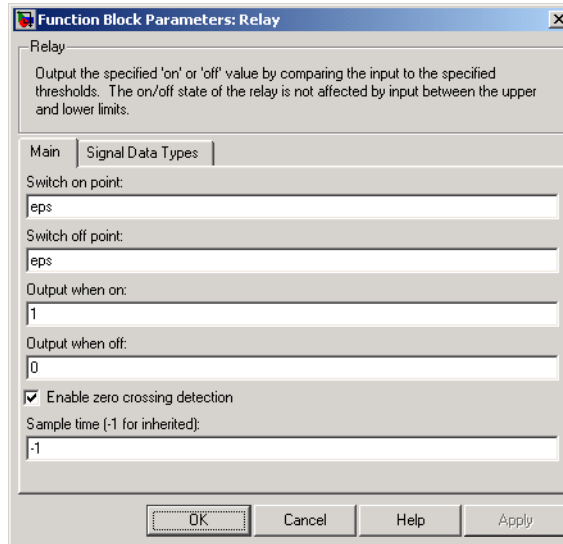
Switch on point

    The "on" threshold for the relay. The **Switch on point** parameter is converted to the input data type offline using round-to-nearest and saturation.

Switch off point

    The "off" threshold for the relay. The **Switch off point** parameter is converted to the input data type offline using round-to-nearest and saturation.

Output when on

    The output when the relay is on.

Output when off

    The output when the relay is off.

Enable zero crossing detection

    Select to enable zero crossing detection to detect switch-on and switch-off points. For more information, see Zero Crossing

Relay

Detection in the "How Simulink Works" chapter of the Using Simulink documentation.

Sample time (-1 for inherited)

Specify the time interval between samples. To inherit the sample time, set this parameter to -1. See "Specifying Sample Time" in the online documentation for more information.

The **Signal Data Types** pane of the Relay block dialog appears as follows:
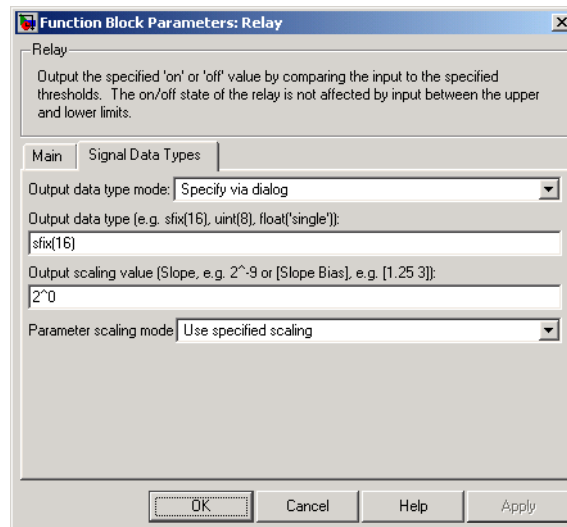
Output data type mode

Specify the output data type and scaling to be the same as the inputs, or inherit the data type and scaling by backpropagation. Lastly, if you choose Specify via dialog, the **Output data type**, **Output scaling value**, and **Parameter Scaling** parameters become visible.

Output data type

Specify any data type, including fixed-point data types. This parameter is only visible if you select `Specify via dialog` for the **Output data type mode** parameter.

Output scaling value

Set the output scaling using binary point-only or [Slope Bias] scaling. This parameter is only visible if you select `Specify via dialog` for the **Output data type mode** parameter, and is only enabled if you select `Use specified scaling` for the **Parameter Scaling** parameter.

Parameter scaling mode

- `Use Specified Scaling`— This mode allows you to specify the output scaling in the **Output scaling value** parameter

- `Best Precision:  Vector-wise`— This mode produces a common binary point for each element of the output vector based on the best precision for the largest value of the vector.

  This parameter is only visible if you select `Specify via dialog` for the **Output data type mode** parameter.

Characteristics

Direct Feedthrough	Yes
Sample Time	Specified in the **Sample time** parameter
Scalar Expansion	Yes
Dimensionalized	Yes
Zero Crossing	Yes, if enabled.

Repeating Sequence

Purpose   Generate an arbitrarily shaped periodic signal

Library   Sources

Description The Repeating Sequence block outputs a periodic scalar signal having
a waveform that you specify. You can specify any waveform, using
the block dialog's **Time values** and **Output values** parameters.
The **Times value** parameter specifies a vector of sample times. The
Output values parameter specifies a vector of signal amplitudes
at the corresponding sample times. Together, the two parameters
specify a sampling of the output waveform at points measured from the
beginning of the interval over which the waveform repeats (i.e., the
signal's period). For example, by default, the **Time values** and **Output
values** parameters are both set to [0 2]. This default setting specifies
a sawtooth waveform that repeats every 2 seconds from the start of
the simulation and has a maximum amplitude of 2. The Repeating
Sequence block uses linear interpolation to compute the value of the
waveform between the specified sample points.

Data Type Support   The Repeating Sequence block outputs real signals of type double.
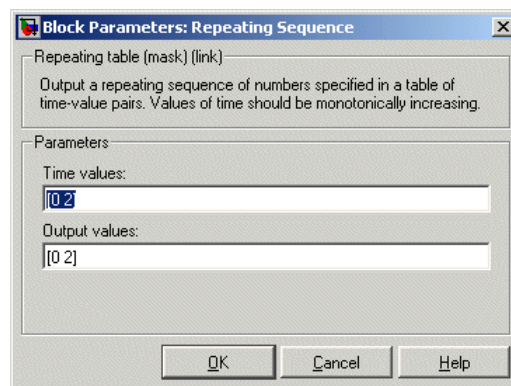
Parameters and Dialog Box

Opening this dialog box causes a running simulation to pause. See "Changing Source Block Parameters" in the online Simulink documentation for details.

Time values

A vector of monotonically increasing time values. The default is [0 2].

Output values

A vector of output values. Each corresponds to the time value in the same column. The default is [0 2].

Characteristics

Sample Time	Continuous
Scalar Expansion	No
Dimensionalized	No
Zero Crossing	No

See Also   Repeating Sequence Interpolated, Repeating Sequence Stair

Repeating Sequence Interpolated

Purpose   Output discrete-time sequence and repeat, interpolating between data points

Library   Sources

Description   The Repeating Sequence Interpolated block outputs a discrete-time sequence and then repeats it. Between data points, the block uses the method specified by the **Look-Up Method** parameter to determine the output.

Data Type Support   The Repeating Sequence Interpolated block accepts signals of any data type supported by Simulink, including fixed-point data types.

Parameters and Dialog Box   The **Main** pane of the Repeating Sequence Interpolated block dialog appears as follows:
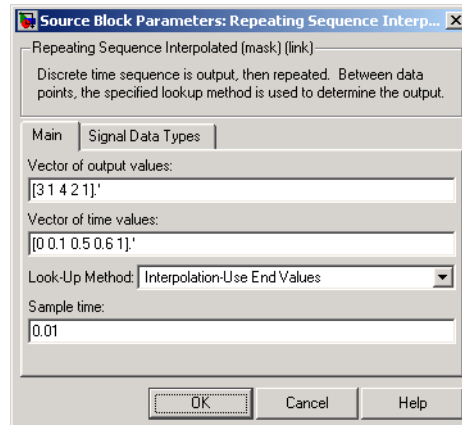
Vector of output values
    Column vector containing output values of the discrete time sequence.

Vector of time values

Column vector containing time values. The time values must be a strictly increasing and the vector must have the same size as the vector of output values.

Look-Up Method

Specify the lookup method to determine the output between data points.

Sample time (-1 for inherited)

Specify the time interval between samples. To inherit the sample time, set this parameter to -1. See "Specifying Sample Time" in the online documentation for more information.

The **Signal Data Types** pane of the Repeating Sequence Interpolated block dialog appears as follows:
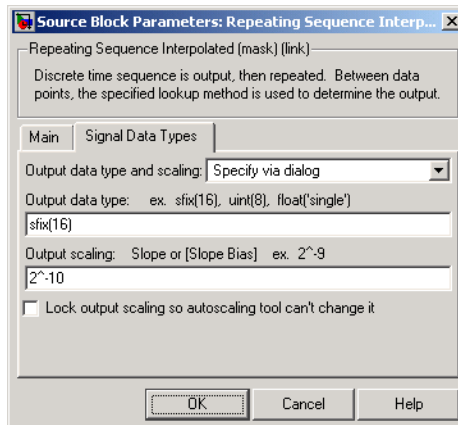
Output data type and scaling

Select a method for specify the output data type. The options are:

- Specify via dialog

- Inherit via back propagation

Repeating Sequence Interpolated

The first option allows you to specify the output data type and scaling (see below). The second option allows Simulink to determine the output data type and scaling based on the block's connections to other blocks.

Output data type
Enter an expression that specifies the block's output data type, such as uint(8) or sfix(16).

Output scaling
Specify the slope or slope and bias factors used to scale the block's output. This option appears only if you specify a fixed-point data type as the output data type of this block.

Lock output scaling so autoscaling tool can't change it
Check to lock output scaling for this block. This option appears only if you specify a fixed-point data type as the output data type of this block.

Characteristics

Sample Time	Specified in the **Sample time** parameter
Scalar Expansion	Yes

See Also Repeating Sequence, Repeating Sequence Stair

Purpose   Output and repeat the discrete time sequence

Library   Sources

Description   The Repeating Sequence Stair block outputs and repeats a discrete
time sequence.

You can specify the stair sequence with the **Vector of output values**
parameter. For example, the vector can be specified as `[3 1 2 4 1]'`,
producing the stair sequence shown in the plot.
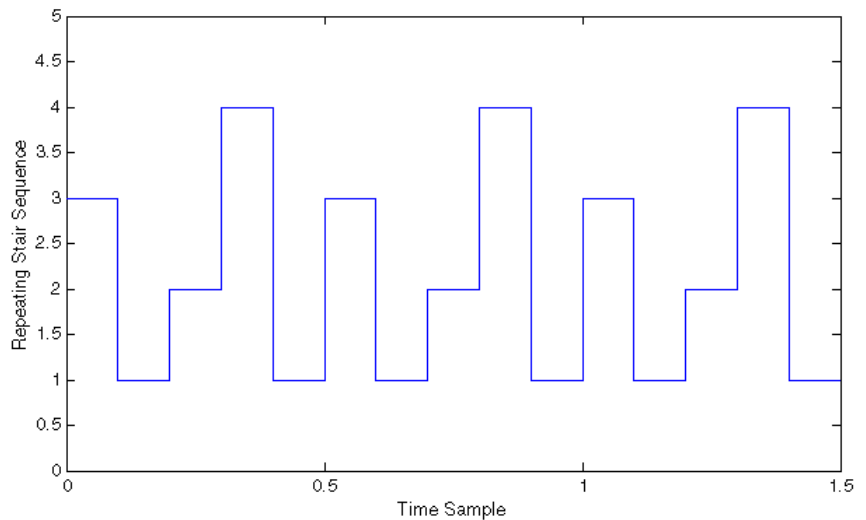
Data Type Support   The Repeating Sequence Stair block accepts signals of any data type
supported by Simulink, including fixed-point data types.

Repeating Sequence Stair

Parameters and Dialog Box

The **Main** pane of the Repeating Sequence Stair block dialog appears as follows:
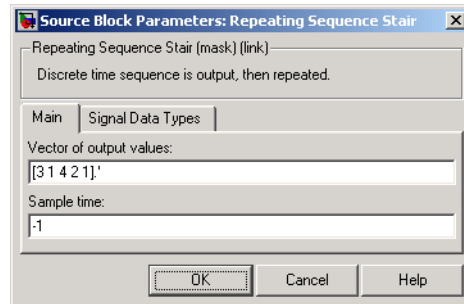
Vector of output values

Vector containing values of the repeating stair sequence.

Sample time (-1 for inherited)

Specify the time interval between samples. To inherit the sample time, set this parameter to -1. See "Specifying Sample Time" in the online documentation for more information.

The **Signal Data Types** pane of the Repeating Sequence Stair block dialog appears as follows:
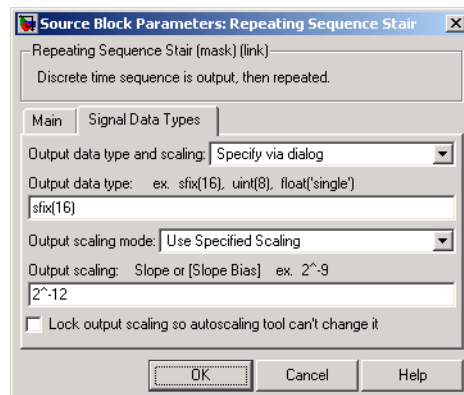
Output data type and scaling

Select a method for specify the output data type. The options are:

- Specify via dialog

- Inherit via back propagation

The first option allows you to specify the output data type and scaling (see below). The second option allows Simulink to determine the output data type and scaling based on the block's connections to other blocks.

Output data type

Enter an expression that specifies the block's output data type, such as uint(8) or sfix(16).

Output scaling

Specify the slope or slope and bias factors used to scale the block's output. This option appears only if you specify a fixed-point data type as the output data type of this block.

Lock output scaling so autoscaling tool can't change it

Check to lock output scaling for this block. This option appears only if you specify a fixed-point data type as the output data type of this block.

Characteristics

Sample Time	Specified in the **Sample time** parameter
Scalar Expansion	No

See Also   Repeating Sequence, Repeating Sequence Interpolated

Reshape

Purpose   Change the dimensionality of a signal

Library   Math Operations
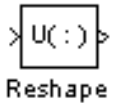
Description   The Reshape block changes the dimensionality of the input signal
to a dimensionality that you specify, using the block's **Output
dimensionality** parameter. For example, you can use the block to
change an N-element vector to a 1-by-N or N-by-1 matrix signal, and
vice versa.

The **Output dimensionality** parameter lets you select any of the
following output options.

Output Dimensionality	Description
1-D array	Converts a matrix (2-D array) to a vector (1-D array) array signal. The output vector consists of the first column of the input matrix followed by the second column, etc. (This option leaves a vector input unchanged.)
Column vector	Converts a vector or matrix input signal to a column matrix, i.e., an M-by-1 matrix, where M is the number of elements in the input signal. For matrices, the conversion is done in column-major order.

Output Dimensionality	Description
Row vector	Converts a vector or matrix input signal to a row matrix, i.e., a 1-by-N matrix where N is the number of elements in the input signal. For matrices, the conversion is done in column-major order.
Customize	Converts the input signal to an output signal whose dimensions you specify, using the **Output dimensions** parameter. The value of the **Output dimensions** parameter can be a one- or two-element vector. A value of `[N]` outputs a vector of size N. A value of `[M N]` outputs an M-by-N matrix. The number of elements of the input signal must match the number of elements specified by the **Output dimensions** parameter. For matrices, the conversion is done in column-major order.

Data Type Support

The Reshape block accepts and outputs signals of any data type supported by Simulink, including fixed-point data types.

For a discussion on the data types supported by Simulink, see "Data Types Supported by Simulink" in the Simulink documentation.

Reshape

Parameters and Dialog Box
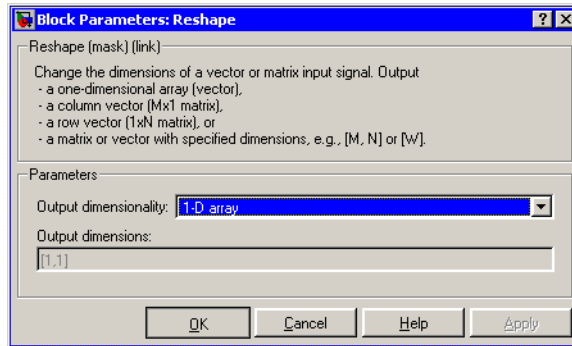
Output dimensionality
> The dimensionality of the output signal.

Output dimensions
> Specifies a custom output dimensionality. This option is enabled only if you select Customize as the value of the **Output dimensionality** parameter.

Characteristics

Direct Feedthrough	Yes
Sample Time	Inherited from driving block
Scalar Expansion	N/A
Dimensionalized	Yes
Zero Crossing	No

Purpose   Apply a rounding function to a signal

Library   Math Operations

Description The Rounding Function block applies a rounding function to the input signal to produce the output signal.

> floor

You can select one of the following rounding functions from the **Function** list:

- `floor`

  Rounds each element of the input signal to the nearest integer value towards minus infinity.

- `ceil`

  Rounds each element of the input signal to the nearest integer towards positive infinity.

- `round`

  Rounds each element of the input signal to the nearest integer.

- `fix`

  Rounds each element of the input signal to the nearest integer towards zero.

The name of the selected function appears on the block.

The input signal can be a scalar, vector, or matrix signal having real- or complex-valued elements of type `double`. The output signal has the same dimensions, data type, and numeric type as the input. Each element of the output signal is the result of applying the selected rounding function to the corresponding element of the input signal.

Use the Rounding Function block instead of the Fcn block when you want vector or matrix output, because the Fcn block can produce only scalar output.

Rounding Function

Data Type Support

The Rounding Function block accepts and outputs real signals of type `double` or `single`.

Parameters and Dialog Box
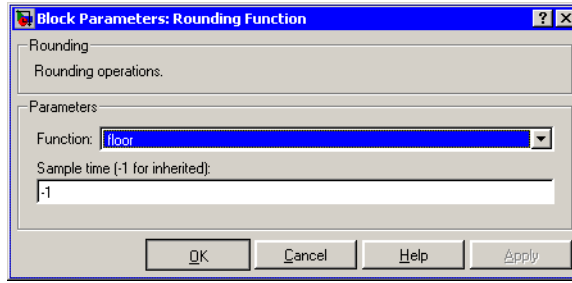
Function

The rounding function.

Sample time (-1 for inherited)

Specify the time interval between samples. To inherit the sample time, set this parameter to -1. See "Specifying Sample Time" in the online documentation for more information.

Characteristics

Direct Feedthrough	Yes
Sample Time	Inherited from driving block
Scalar Expansion	N/A
Dimensionalized	Yes
Zero Crossing	No

Purpose   Limit the range of a signal

Library   Discontinuities
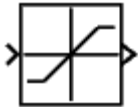
Description   The Saturation block imposes upper and lower bounds on a signal. When the input signal is within the range specified by the **Lower limit** and **Upper limit** parameters, the input signal passes through unchanged. When the input signal is outside these bounds, the signal is clipped to the upper or lower bound.

When the **Lower limit** and **Upper limit** parameters are set to the same value, the block outputs that value.

Data Type Support   The Saturation block accepts real signals of any data type supported by Simulink, except `Boolean`. The Saturation block supports fixed-point data types. The output data type is the same as the input data type.

For a discussion on the data types supported by Simulink, see "Data Types Supported by Simulink" in the Simulink documentation.

Parameters and Dialog Box
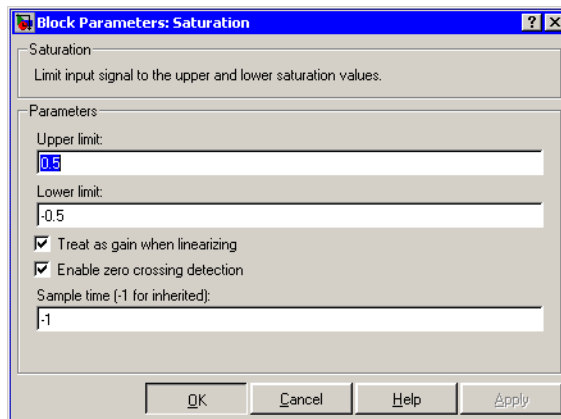
Saturation

Upper limit
> Specify the upper bound on the input signal. When the input signal to the Saturation block is above this value, the output of the block is clipped to this value.
>
> The **Upper limit** parameter is converted to the input data type offline using round-to-nearest and saturation.

Lower limit
> Specify the lower bound on the input signal. When the input signal to the Saturation block is below this value, the output of the block is clipped to this value.
>
> The **Lower limit** parameter is converted to the input data type offline using round-to-nearest and saturation.

Treat as gain when linearizing
> Linearization commands in Simulink treat this block as a gain in state space. Select this parameter to cause the linearization commands to treat the gain as 1; otherwise, the commands treat the gain as 0.

Enable zero crossing detection
> Select to enable zero crossing detection. For more information, see "Zero-Crossing Detection" in the "How Simulink Works" chapter of the Using Simulink documentation.

Sample time (-1 for inherited)
> Specify the time interval between samples. To inherit the sample time, set this parameter to -1. See "Specifying Sample Time" in the online documentation for more information.

Characteristics

Direct Feedthrough	Yes
Sample Time	Specified in the **Sample time** parameter
Scalar Expansion	Yes, of parameters and input

Dimensionalized	Yes
Zero Crossing	Yes, if enabled.

See Also   Saturation Dynamic

Saturation Dynamic

Purpose   Bound the range of the input

Library   Discontinuities

Description   The Saturation Dynamic block bounds the range of the input signal to upper and lower saturation values. The input signal outside of these limits saturates to one of the bounds where
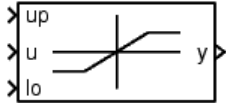
- The input below the lower limit is set to the lower limit.

- The input above the upper limit is set to the upper limit.

The input for the upper limit is the up port, and the input for the lower limit is the lo port.

Data Type Support   The Saturation Dynamic block accepts signals of any data type supported by Simulink, including fixed-point data types.

Parameters and Dialog Box
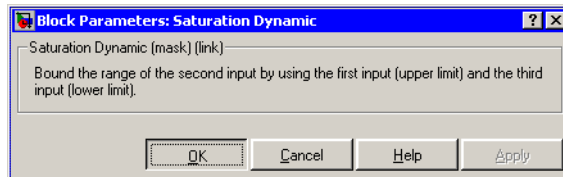
Characteristics

Direct Feedthrough	Yes
Scalar Expansion	Yes

See Also   Saturation

Scope, Floating Scope, Signal Viewer Scope

Purpose   Display signals generated during a simulation

Library   Sinks

Description   The Scope block displays its input with respect to simulation time. The Scope block can have multiple axes (one per port); all axes have a common time range with independent *y*-axes. The Scope allows you to adjust the amount of time and the range of input values displayed. You can move and resize the Scope window and you can modify the Scope's parameter values during the simulation.

When you start a simulation, Simulink does not open Scope windows, although it does write data to connected Scopes. As a result, if you open a Scope after a simulation, the Scope's input signal or signals will be displayed.

If the signal is continuous, the Scope produces a point-to-point plot. If the signal is discrete, the Scope produces a stair-step plot.

The Scope provides toolbar buttons that enable you to zoom in on displayed data, display all the data input to the Scope, preserve axis settings from one simulation to the next, limit data displayed, and save data to the workspace. The toolbar buttons are labeled in this figure, which shows the Scope window as it appears when you open a Scope block.
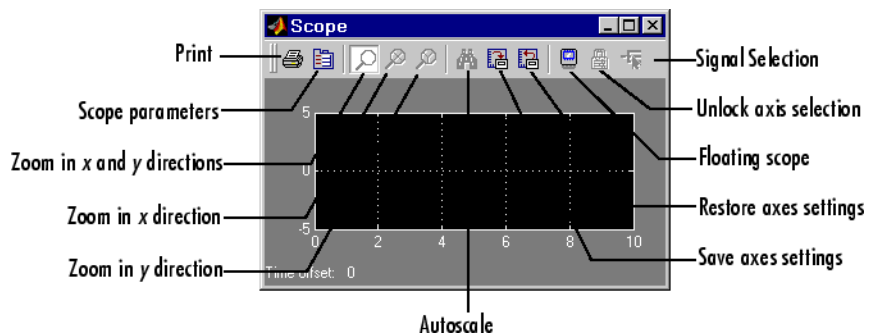
Scope, Floating Scope, Signal Viewer Scope

Note Do not use Scope blocks inside library blocks that you create. Instead, provide the library blocks with output ports to which scopes can be connected to display internal data.

Displaying Vector Signals

When displaying a vector or matrix signal, the Scope assigns colors to each signal element in this order: yellow, magenta, cyan, red, green, and dark blue. When more than six signals are displayed, the Scope cycles through the colors in the order listed.

Y-Axis Limits

You set *y*-limits by right-clicking an axis and choosing **Axes Properties**. The following dialog box appears.
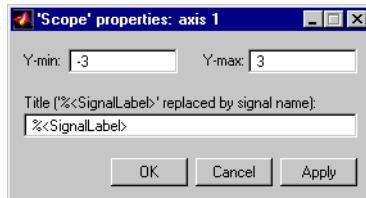
Y-min
      Enter the minimum value for the *y*-axis.

Y-max
      Enter the maximum value for the *y*-axis.

Title
      Enter the title of the plot. You can include a signal label in the title by typing %<SignalLabel> as part of the title string (%<SignalLabel> is replaced by the signal label).

Time Offset

This figure shows the Scope block displaying the output of the vdp model. The simulation was run for 40 seconds. Note that this scope shows the final 20 seconds of the simulation. The **Time offset** field displays the time corresponding to 0 on the horizontal axis. Thus, you have to add the offset to the fixed time range values on the *x*-axis to get the actual time.
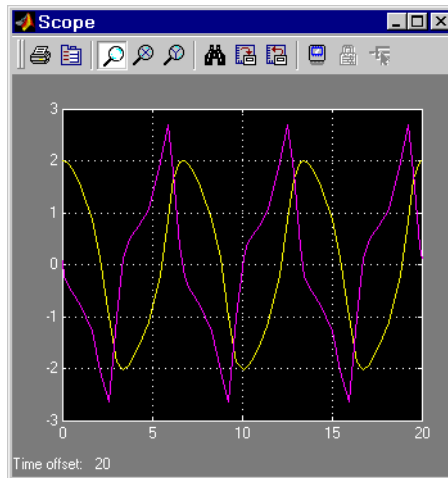
Autoscaling the Scope Axes

This figure shows the same output after you click the **Autoscale** toolbar button, which automatically scales both axes to display all stored simulation data. In this case, the *y*-axis was not scaled because it was already set to the appropriate limits.

Scope, Floating Scope, Signal Viewer Scope
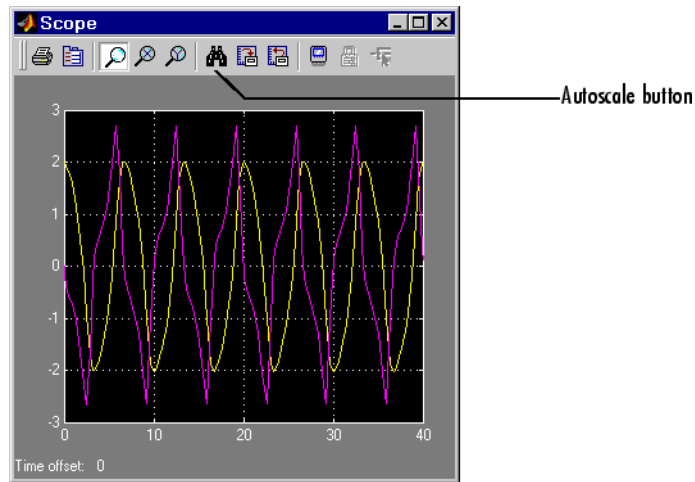
Autoscale button

If you click the **Autoscale** button while the simulation is running, the axes are autoscaled based on the data displayed on the current screen, and the autoscale limits are saved as the defaults. This enables you to use the same limits for another simulation.

Note Simulink does not buffer the data that it displays on a floating Scope. It can therefore scale the contents of a floating Scope only when data is being displayed, i.e., when a simulation is running. When a simulation is not running, Simulink disables (grays) the **Zoom** button on the toolbar of a floating Scope to indicate that it cannot scale its contents.

Zooming

You can zoom in on data in both the *x* and *y* directions at the same time, or in either direction separately. The zoom feature is not active while the simulation is running.

To zoom in on data in both directions at the same time, make sure you select the leftmost **Zoom** toolbar button. Then, define the zoom region

using a bounding box. When you release the mouse button, the Scope displays the data in that area. You can also click a point in the area you want to zoom in on.

If the scope has multiple y-axes, and you zoom in on one set of x-y axes, the x-limits on all sets of x-y axes are changed so that they match, because all x-y axes must share the same time base (x-axis).

This figure shows a region of the displayed data enclosed within a bounding box.
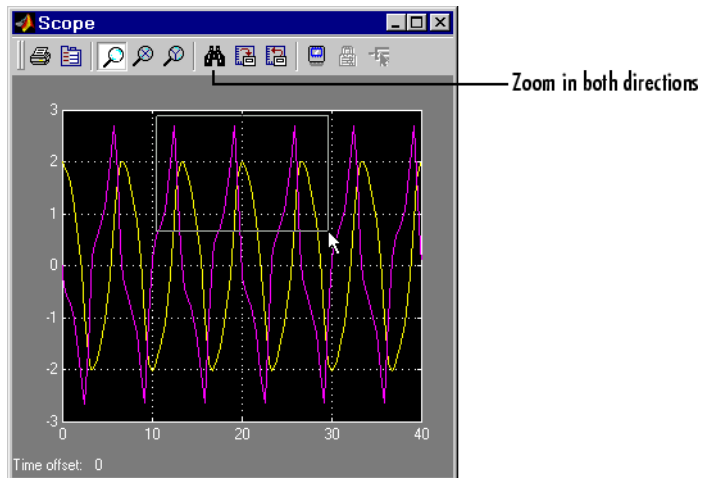
This figure shows the zoomed region, which appears after you release the mouse button.

Scope, Floating Scope, Signal Viewer Scope
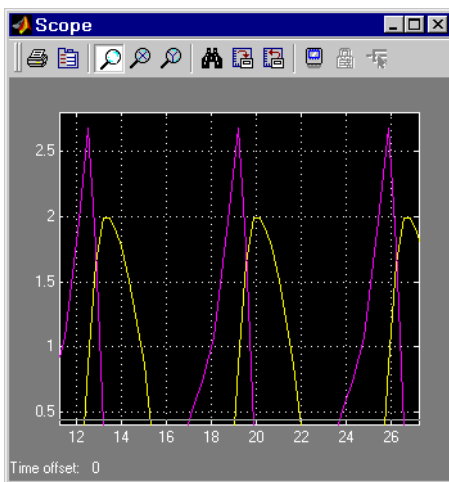
To zoom in on data in just the *x* direction, click the middle **Zoom** toolbar button. Define the zoom region by positioning the pointer at one end of the region, pressing and holding down the mouse button, then moving the pointer to the other end of the region. This figure shows the Scope after you define the zoom region, but before you release the mouse button.
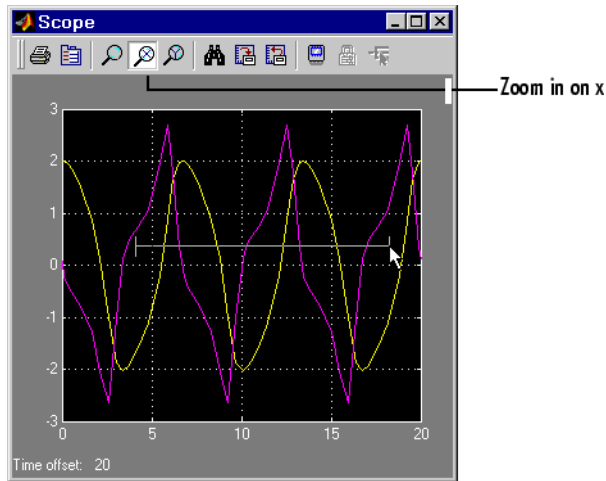
When you release the mouse button, the Scope displays the magnified region. You can also click a point in the area you want to zoom in on.

Zooming in the *y* direction works the same way except that you click the rightmost **Zoom** toolbar button before defining the zoom region. Again, you can also click a point in the area you want to zoom in on.

Note Simulink does not buffer the data that it displays on a floating scope. It therefore cannot zoom the contents of a floating scope. To indicate this, Simulink disables (grays) the **Zoom** button on the toolbar of a floating scope.

Saving the Axes Settings

The **Save axes settings** toolbar button enables you to store the current *x*- and *y*-axis settings so you can apply them to the next simulation.

You might want to do this after zooming in on a region of the displayed data so you can see the same region in another simulation. The time range is inferred from the current *x*-axis limits.

Scope Parameters

The **Scope Parameters** dialog box lets you change axis limits, set the number of axes, time range, tick labels, sampling parameters, and saving options. To display the dialog, select the **Parameters** button on the toolbar of the Scope block's display

Parameters

or by double-clicking on the Scope viewer's display. The appearance of the dialog box depends on whether the scope is a Scope block or a Scope viewer created by the Signal and Scope Manager. If the scope is a Scope block, this dialog appears.
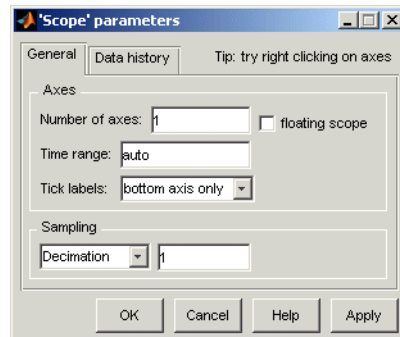
The dialog box has two panes: **General** and **Data history**. See the next topic for information on the **General** parameters pane. See "Data History Parameters Pane" on page 2-506 for information on the **Data History** parameters pane.

If the scope is a Scope viewer, this dialog box appears.
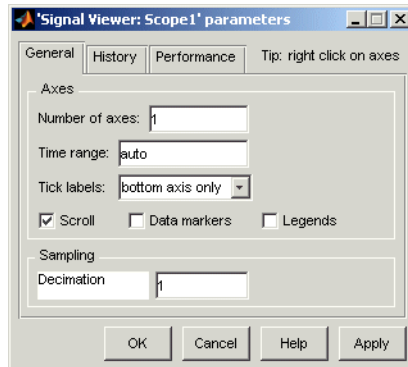
The dialog box has three panes: **General**, **History,** and **Performance**. See the next topic for information on the General parameters pane. See "History Pane" on page 2-508 for information on the **History** parameters pane. See "Performance Parameters Pane" on page 2-507 for information on the **Performance** parameters pane.

General Parameters Pane

You can set the axis parameters, time range, and tick labels in the **General** pane.

Number of axes

Set the number of *y*-axes in this data field. With the exception of the floating scope, there is no limit to the number of axes the Scope block can contain. All axes share the same time base (*x*-axis), but have independent *y*-axes. Note that the number of axes is equal to the number of input ports.

Time range

Change the *x*-axis limits by entering a number or auto in the **Time range** field. Entering a number of seconds causes each screen to display the amount of data that corresponds to that number of seconds. Enter auto to set the *x*-axis to the duration of the simulation. Do not enter variable names in these fields.

Tick labels

Specifies whether to label axes tics. The options are:

Scope, Floating Scope, Signal Viewer Scope

all	Label tics on the outside of all axes
inside	Place tic labels inside all axes (available only on scope viewers)
bottom-axis only	Place tic labels outside the bottom (or only) axes
none	Do not label tics (available only on Scope blocks)

Note The next three options appear only for the dialog box for a Scope viewer.

Scroll

When this option is selected, the scope continuously scrolls the displayed signals to the left so as to keep as much of them in view as will fit on the screen at any one time. When this option is not selected, the scope draws a screenful of data from left to right until the screen is full, erases the screen and draws the next screenful of data, and so on, until the end of simulation time. Note that the effects of this option are discernible only when drawing is slow, for example, when the model is very large or has a very small step size.

Data Markers

Displays a marker at each data point on the scope viewer screen.
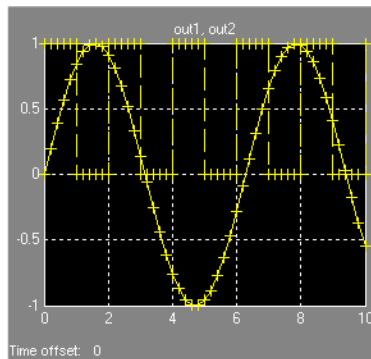
Legends

Displays a legend on the scope that indicates the line style used to display each signal.
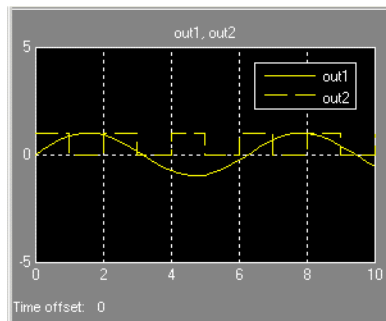
Floating scope

This option appears only on the **General** parameters pane for the Scope block.

Selecting this option turns a Scope block into a floating scope. A floating scope is a Scope block that can display the signals carried on one or more lines. You can create a Floating Scope block in a model either by copying a Scope block from the Simulink Sinks library into a model and selecting this option or, more simply, by

copying the Floating Scope block from the Sinks library into the model window. The Floating Scope block has the **Floating scope** parameter selected by default.

To use a floating scope during a simulation, first open the scope. To display the signals carried on a line, select the line. Hold down the **Shift** key while clicking another line to select multiple lines. It might be necessary to click the **Autoscale data** button on the floating scope's toolbar to find the signal and adjust the axes to the signal values. Or you can use the floating scope's Signal Selector (see "The Signal Selector" in the online Simulink documentation) to select signals for display. To display a floating scope's Signal Selector, first start the simulation of your model with the floating scope open. Then right-click your mouse in the floating scope and select **Signal Selection** from the pop-up menu that appears.

You can have more than one floating scope in a model, but only one set of axes in one scope can be active at a given time. Active floating scopes show the active axes by making them blue. Selecting or deselecting lines affects the active floating scope only. Other floating scopes continue to display the signals that you selected when they were active. In other words, inactive floating scopes are locked, in that their signal displays cannot change.

To specify display of a signal on one of the axes of a multiaxis floating scope, click the axis. Simulink draws a blue border around the axis.
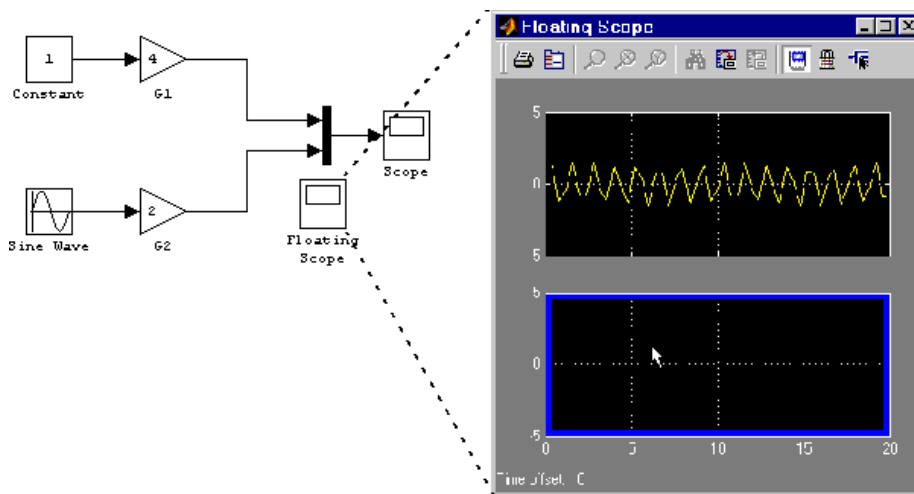
Then click the signal you want to display in the block diagram or the Signal Selector. When you run the model, the selected signal appears in the selected axis.
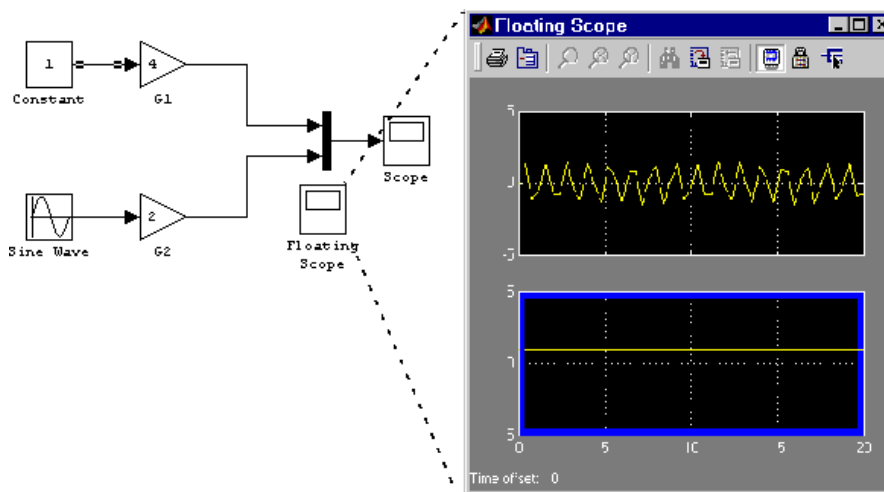
If you plan to use a floating scope during a simulation, you should disable signal storage reuse. See "Signal storage reuse" in "The Optimization Pane" for more information.

Sampling

To specify a decimation factor, enter a number in the data field to the right of the **Decimation** choice. To display data at a sampling interval, select the **Sample time** choice and enter a number in the data field.

Data History Parameters Pane

The **Data History** parameters pane appears only on the **Parameters** dialog box for the Scope block. The pane appears as follows.
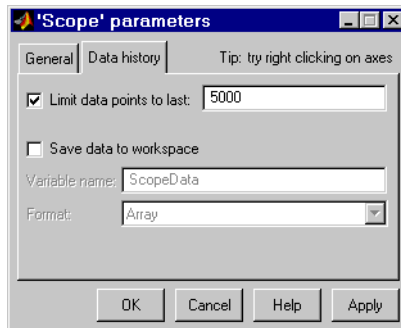
This pane lets you control the amount of data that the Scope stores and displays. You can also choose to save data to the workspace in this pane. You apply the current parameters and options by clicking the **Apply** or **OK** button. The values that appear in these fields are the values that are used in the next simulation.

Limit data points to last

You can limit the number of data points saved to the workspace by selecting the **Limit data points to last** check box and entering a value in its data field. The Scope relies on its data history for zooming and autoscaling operations. If the number of data points

is limited to 1,000 and the simulation generates 2,000 data points, only the last 1,000 are available for regenerating the display.

Save data to workspace

You can automatically save the data collected by the Scope at the end of the simulation by selecting the **Save data to workspace** check box. If you select this option, the **Variable name** and **Format** fields become active.

Variable name

Enter a variable name in the **Variable name** field. The specified name must be unique among all data logging variables being used in the model. Other data logging variables are defined on other Scope blocks, To Workspace blocks, and simulation return variables such as time, states, and outputs. Being able to save Scope data to the workspace means that it is not necessary to send the same data stream to both a Scope block and a To Workspace block.

Format

Data can be saved in one of three formats: `Array`, `Structure`, or `Structure with time`. Use `Array` only for a Scope with one set of axes. For Scopes with more than one set of axes, use `Structure` if you do not want to store time data and use `Structure with time` if you want to store time data.

Performance Parameters Pane

The **Performance** parameters pane appears only on the **Parameters** dialog box for the Scope viewer. The pane appears as follows.

Scope, Floating Scope, Signal Viewer Scope
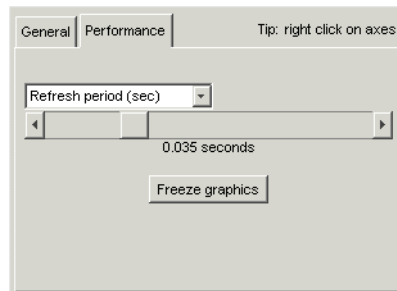
This pane lets you control how frequently Simulink refreshes the Scope viewer. Reducing the refresh rate can speed up the simulation in some cases. The pane contains the following controls.

Refresh Period

This list control lets you select the units in which the refresh period is expressed. Options are either seconds or frames where a frame is the width of the scope's screen in seconds, i.e., it equals the value of the scope's **Time range** parameter.

Refresh Slider

Drag the slider button to the right to increase the refresh period and hence decrease the refresh rate.

Freeze Button

Click the button to freeze (stop refreshing) or unfreeze the Scope viewer.

History Pane

The **History** parameters pane appears only on the **Parameters** dialog box for the Scope viewer.
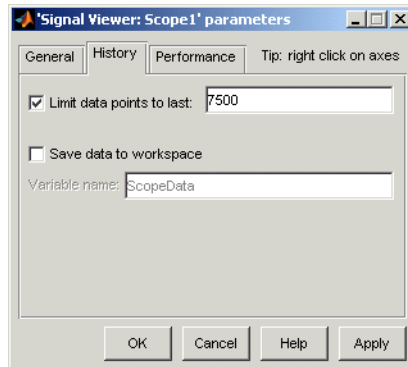
This pane lets you control the amount of data that the Scope viewer stores and displays. You can also choose to save data to the workspace in this pane. You apply the current parameters and options by clicking the **Apply** or **OK** button. The values that appear in these fields are the values that are used in the next simulation.

Limit data points to last

You can limit the number of data points saved to the workspace by selecting the **Limit data points to last** check box and entering a value in its data field. The Scope relies on its data history for zooming and autoscaling operations. If the number of data points is limited to 1,000 and the simulation generates 2,000 data points, only the last 1,000 are available for regenerating the display.

Save data to workspace

Check this option to save data displayed on the scope viewer at the end of the simulation. Simulink saves the data in the Simulink.ModelDataLogs object used to log data for the model (see "Logging Signals" for more information). For this option to take effect, you must also enable signal logging for the model as a whole, i.e., you must check the **Signal logging** option on the **Data Import/Export** pane of the model's **Configuration Parameters** dialog box.

Variable name

> Specifies the name under which to store the viewer's data in the model's `Simulink.ModelDataLogs` object. The name must be different from the log names specified by other signal viewers or for other signals, subsystems, or model references logged in the model's `Simulink.ModelDataLogs` object.

Printing the Contents of a Scope Window

To print the contents of a Scope window, open the **Print** dialog box by clicking the **Print** icon, the leftmost icon on the Scope toolbar.

Data Type Support

The Scope block accepts real signals of any data type supported by Simulink, including fixed-point data types. The Scope block accepts homogeneous vectors.

For a discussion on the data types supported by Simulink, see "Data Types Supported by Simulink" in the Simulink documentation.

Characteristics

Sample Time	Inherited from driving block or can be set
States	0

Purpose Select input elements from a vector or matrix signal

Library Signal Routing

Description The Selector block generates as output selected elements of an input vector or matrix.

A Selector block accepts either vector or matrix signals as input. Set the **Input type** parameter to the type of signal (Vector or Matrix) that the block should accept in your model. The parameter dialog box and the block's appearance change to reflect the type of input that you select. The way the block determines the elements to select differs slightly, depending on the type of input.

Vector Input

If the input type is vector, a Selector block outputs a vector of selected elements specified by element indices. The meaning of the indices depends on the setting of the **Index mode** parameter. If the setting is One-based (the default), the index of the first input element is 1, the second 2, and so on. If the setting is Zero-based, the index of the first element is 0, the second element 1, and so on.

The block determines the indices of the elements to select either from the block's **Elements** parameter or from an external signal. Set the **Source of element indices** parameter to the source (Internal, i.e., parameter value, or External) that you prefer. If you select External, the block adds an input port for the external index signal.

In either case, the elements to be selected must be specified as a vector unless only one element or a range of elements is being selected. For example, this model shows the Selector block and the output for an input vector of [2 4 6 8 10] and an **Elements** parameter value of [5 1 3].

Selector
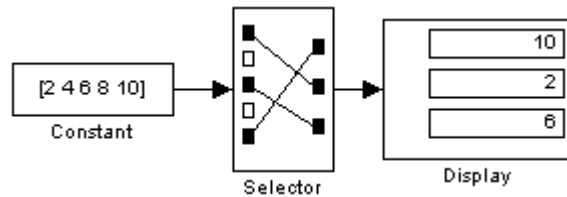
If the block is large enough, it displays the ordering of input vector elements graphically.

If **Use index as starting value** is checked, **Elements** must specify the starting index of a range of elements that starts at the specified index and whose length is specified by **Output port dimensions**. For example, suppose that you want the block to select elements 2 through 4 from a six-element input vector. You could do this by selecting the **Use index as starting value** option, setting the **Output port dimensions** to 3, and setting **Elements** to 2.

If you select External as the source for element indices, the block adds an input port for the element indices signal. The signal should specify the elements to be selected in the same way they are specified, using the **Elements** parameter.

If the input type is vector, you must specify the width of the input signal or -1, using the **Input port width** parameter. If you specify a width greater than 0, the width of the input signal must equal the specified width. Otherwise, the block reports an error. If you specify a width of -1, the block accepts a vector signal of any width.

Matrix Input

If the input type is matrix, the Selector block outputs a matrix of elements selected from the input matrix. The block determines the row and column indices of the elements to select either from its **Rows** and **Columns** parameters or from external signals. Set the block's **Source of row indices** and **Source of column indices** to the source that you prefer (Internal or External). If you set either source to External, the block adds an input port for the external indices signal. If you set both sources to External, the block adds two input ports.

In either case, the indices of the row and columns to be selected must be specified as vectors (or a scalar if only one row or column is to be selected or you select the **Use index as starting value** option) of one-based or zero-based indices, depending on the setting of the **Index mode** parameter.

For example, if the **Index mode** is One-based (the default), the **Rows** expression [2 1] and the **Columns** expression [1 3] specify output of a 2-by-2 matrix whose first row contains the first and third elements of the input matrix's second row and whose second row contains the first and third elements of the input matrix's first row.

Data Type Support
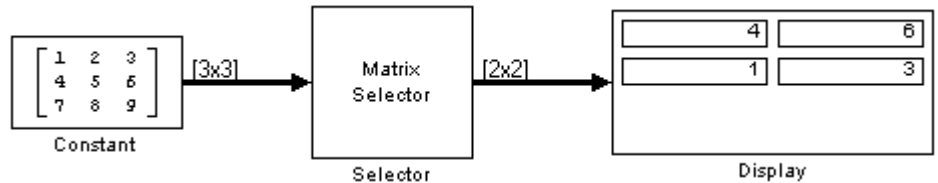
The data port of the Selector block accepts signals of any signal type and any data type supported by Simulink, including fixed-point data types. The data port accepts mixed-type signal vectors. The index port accepts only built-in data types. The elements of the output vector have the same type as the corresponding selected input elements.

For a discussion on the data types supported by Simulink, see"Data Types Supported by Simulink" in the Simulink documentation.

Selector

Parameters and Dialog Box

The parameter dialog box appears as follows when you select vector input mode.
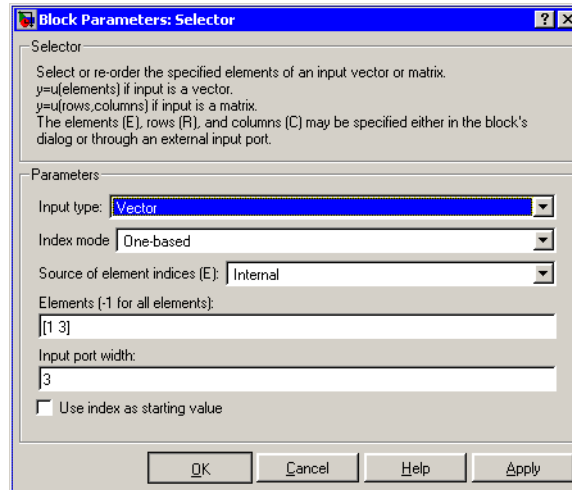
Input type

    The type of the input signal: Vector or Matrix.

Index mode

    Specifies the indexing mode: One-based or Zero-based. If One-based is selected, an index of 1 specifies the first element of the input vector, 2, the second element, and so on. If Zero-based is selected, an index of 0 specifies the first element of the input vector, 1, the second element, and so on.

Source of element indices

    The source of the indices specifying the elements to select, either Internal, i.e., the **Elements** parameter, or External, i.e., an input signal.

Elements

    The elements to be included in the output vector.

Input port width

> The number of elements in the input vector.

Use index as starting value

> Specifies that the value in the Elements field or the external
> index source is the starting index of a range of elements whose
> length is the same as the length specified in the **Output port
> dimensions** field (see next option).

Output port dimensions

> This field appears only if you check **Use index as starting value**.
> It specifies the width of the block's output signal.

The dialog box appears as follows when you select matrix input mode.
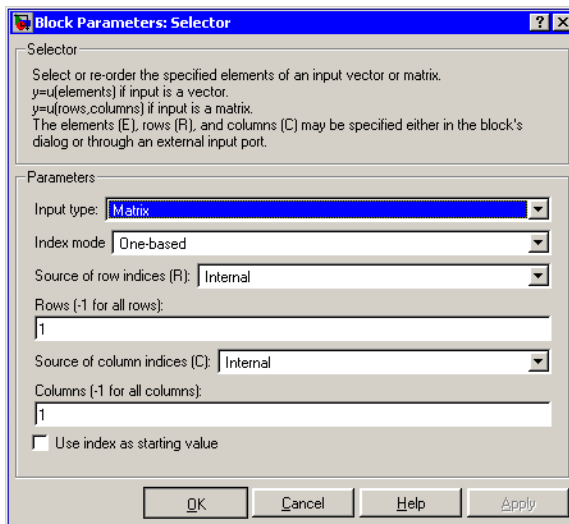
Input type

> The type of the input signal: Vector or Matrix.

Index mode

> Specifies the indexing mode: One-based or Zero-based. If
> One-based is selected, an index of 1 specifies the first row (or

column) of the input matrix, 2, the second row, and so on. If `Zero-based` is selected, an index of 0 specifies the first row (or column) of the input matrix, 0, the second row, and so on.

Source of row indices

The source of the indices specifying the rows to select from the input matrix, either `Internal`, i.e., the **Rows** parameter, or `External`, i.e., an input signal.

Rows

Indices of the rows from which to select elements to be included in the output matrix.

Source of column indices

The source of the indices specifying the columns to select from the input matrix, either `Internal`, i.e., the **Columns** parameter, or `External`, i.e., an input signal.

Columns

Indices of the columns from which to select elements to be included in the output matrix.

Use index as starting value

Specifies that the values in the `Row` and `Column` fields or external index sources specify the starting row and column indexes of a range of elements whose length is the same as the dimensions specified in the **Output port dimensions** field (see next option).

Output port dimensions

This field appears only if you check **Use index as starting value**. It specifies the dimensions of the block's output signal as a two-element vector: `[R C]`.

Characteristics

Sample Time	Inherited from driving block
Dimensionalized	Yes

S-Function

Purpose   Include an S-function in a model.

Library   User-Defined Functions
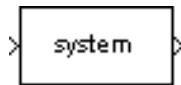
Description The S-Function block provides access to S-functions from a block
diagram. The S-function named as the **S-function name** parameter
can be a Level-1 M-file or a Level-1 or Level-2 C MEX-file S-function
(see Overview of S-Functions" in *Writing S-Functions* for information on
how to create S-functions).

> **Note** Use the M-File S-Function block to include a Level-2 M-file
> S-function in a block diagram.

The S-Function block allows additional parameters to be passed directly
to the named S-function. The function parameters can be specified
as MATLAB expressions or as variables separated by commas. For
example,

```
A, B, C, D, [eye(2,2);zeros(2,2)]
```

Note that although individual parameters can be enclosed in brackets,
the list of parameters must not be enclosed in brackets.

The S-Function block displays the name of the specified S-function
and the number of input and output ports specified by the S-function.
Signals connected to the inputs must have the dimensions specified
by the S-function for the inputs.

Data Type Support   Depends on the implementation of the S-Function block.

S-Function

Parameters and Dialog Box
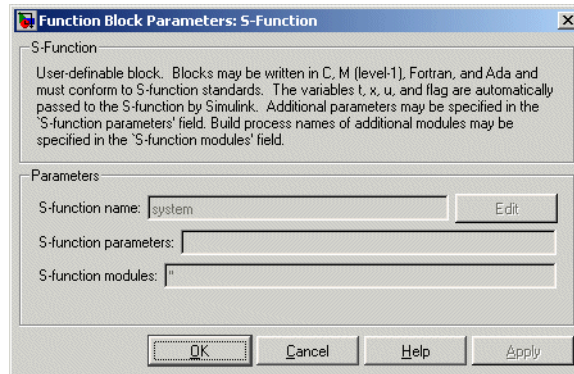
S-function name

The S-function name.

S-function parameters

Additional S-function parameters. See the preceding block description for information on how to specify the parameters.

S-function modules

This parameter applies only if this block represents a C MEX-file S-function and you intend to use the Real-Time Workshop to generate code from the model containing the block. See "Specifying Additional Source Files for an S-Function" in the Real-Time Workshop online documentation for information on using this parameter.

Characteristics

Direct Feedthrough	Depends on contents of S-function
Sample Time	Depends on contents of S-function
Scalar Expansion	Depends on contents of S-function
Dimensionalized	Depends on contents of S-function
Zero Crossing	No

S-Function Builder

Purpose
Create an S-function from C code that you provide

Library
User-Defined Functions

Description

The S-Function Builder block creates a C MEX-file S-function from specifications and C source code that you provide. See "Building S-Functions Automatically" for detailed instructions on using the S-Function Builder block to generate an S-function.

Instances of the S-Function Builder block also serve as wrappers for generated S-functions in Simulink models. When simulating a model containing instances of an S-Function Builder block, Simulink invokes the generated S-function associated with each instance to compute the instance's output at each time step.

Data Type Support

The S-Function Builder can accept and output complex, 1-D or 2-D signals of any data type supported by Simulink.

For a discussion on the data types supported by Simulink, see "Data Types Supported by Simulink" in the Simulink documentation.

Parameters and Dialog Box

See "S-Function Builder Dialog Box" in the online documentation for information on using the S-Function Builder block's parameter dialog box.

Shift Arithmetic

Purpose   Shift the bits and/or binary point of a signal

Library   Logic and Bit Operations

Description   The Shift Arithmetic block can be used to shift the bits or the binary point of a signal, or both.

For example, the effects of binary point shifts two places to the right and two places to the left on an input of data type sfix(8) are shown below.

Shift Operation	Binary Value	Decimal Value
No shift (original number)	11001.011	-6.625
Binary point shift right by two places	1100101.1	-26.5
Binary point shift left by two places	110.01011	-1.65625

This block performs arithmetic bit shifts on signed numbers. Therefore, the most significant bit is recycled for each bit shift. The effects of bit shifts two places to the right and two places to the left on an input of data type sfix(8) follow.

Shift Operation	Binary Value	Decimal Value
No shift (original number)	11001.011	-6.625
Bit shift right by two places	11110.010	-1.75
Bit shift left by two places	00101.100	5.5

Data Type Support   The Shift Arithmetic block accepts signals of any data type supported by Simulink, including fixed-point data types, except boolean type.

Parameters and Dialog Box

Function Block Parameters: Shift Arithmetic ✕

Shift Arithmetic (mask)

This block can arithmetically shift the bits and/or the binary point of a signal.
The effect of these actions can be interpreted as a combination of a multiplication by a power of two and a change in scaling. The power of two multiplication term is
2^(NumBinaryPointShiftsRight - NumBitShiftsRight)
Negative values for shifts right are actually positive shift lefts.
If the input is a floating point type, the power of two multiplication is carried out, but no change in scaling is applied.

Parameters

Number of bits to shift right (use negative value to shift left):

|8|

Number of places by which binary point shifts right (use negative value to shift left):

|0|

| OK | Cancel | Help | Apply |

Number of bits to shift right

> The number of places the bits of the input signal is shifted. A positive value indicates a shift right, while a negative value indicates a shift left.

Number of places by which binary point shifts right

> The number of places the binary point of the input signal is shifted. A positive value indicates a shift right, while a negative value indicates a shift left.

Characteristics

Direct Feedthrough	Yes
Sample Time	Inherited
Scalar Expansion	Yes

Sign

Purpose   Indicate the sign of the input

Library   Math Operations

Description   The Sign block indicates the sign of the input:
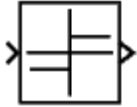
- The output is 1 when the input is greater than zero.
- The output is 0 when the input is equal to zero.
- The output is -1 when the input is less than zero.

Data Type Support   The Sign block accepts real or complex signals of any data type supported by Simulink, including fixed-point data types. The output is a signed data type with the same number of bits as the input, and with nominal scaling (a slope of one and a bias of zero).

For a discussion on the data types supported by Simulink, see"Data Types Supported by Simulink" in the Simulink documentation.

Parameters and Dialog Box

Enable zero crossing detection

    Select to enable zero crossing detection. For more information, see "Zero-Crossing Detection" in the "How Simulink Works" chapter of the Using Simulink documentation.

Sample time (-1 for inherited)

Specify the time interval between samples. To inherit the sample time, set this parameter to -1. See "Specifying Sample Time" in the online documentation for more information.

Characteristics

Direct Feedthrough	Yes
Sample Time	Specified in the **Sample time** parameter
Scalar Expansion	N/A
Dimensionalized	Yes
Zero Crossing	Yes, if enabled.

Signal Builder

Purpose   Create and generate interchangeable groups of signals whose
            waveforms are piecewise linear

Library   Sources

Description   The Signal Builder block allows you to create interchangeable groups of
            piecewise linear signal sources and use them in a model. See "Working
            with Signal Groups" in the "Working with Signals" chapter of the Using
            Simulink documentation.

Data Type Support   The Signal Builder block outputs a scalar or array of real signals of
            type `double`.

Parameters and Dialog Box   The Signal Builder block has the same dialog box as that of a Subsystem
            block. To display the dialog box, select **SubSystem Parameters** from
            the block's context menu.

Characteristics

Sample Time	Continuous
Scalar Expansion	Yes, of parameters
Dimensionalized	Yes
Zero Crossing	Yes

Purpose   Convert a signal to a new type without altering signal values.

Library   Signal Attributes

Description   The Signal Conversion block converts a signal from one type to another. The block's **Output** parameter lets you select the type of conversion to be performed.

Data Type Support   The Signal Conversion block accepts virtual or nonvirtual signals of any data type.

Parameters and Dialog Box
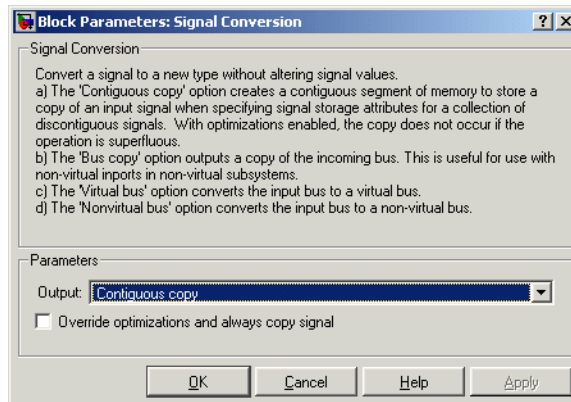
Output
>   Specifies the type of conversion to be performed. The options are:

- Contiguous copy

  Converts a muxed signal whose elements occupy discontiguous areas of memory to a vector signal whose elements occupy contiguous areas of memory. The block does this by allocating a contiguous area of memory for the elements of the muxed signal and copying the values from the discontiguous areas (represented by the block's input) to the contiguous areas (represented by the block's output) at each time step.

Signal Conversion

- Bus copy

  Outputs a copy of the bus connected to the block's input.

- Virtual bus

  Converts a nonvirtual bus to a virtual bus. This option enables you to combine an originally nonvirtual bus with a virtual bus.

- Nonvirtual bus

  Converts a virtual bus to a nonvirtual bus as in the following example.
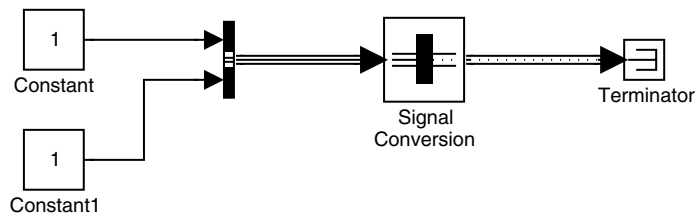
Note The virtual bus to be converted to a nonvirtual bus must be defined by a bus object, i.e., an instance of Simulink.Bus class. See the Bus Creator block for more information.

Override optimizations and always copy signal
> This option is enabled only for Contiguous copy conversion. Unless you select this option, Simulink eliminates the block from the compiled model as an optimization, if the elements of the input signal occupy contiguous areas of memory.

Characteristics

Sample Time	Inherited
Scalar Expansion	n/a

Dimensionalized	n/a
Zero Crossing	No

Signal Generator

Purpose   Generate various waveforms

Library   Sources

Description The Signal Generator block can produce one of three different waveforms: sine wave, square wave, and sawtooth wave. The signal parameters can be expressed in Hertz (the default) or radians per second. This figure shows each signal displayed on a Scope using default parameter values.
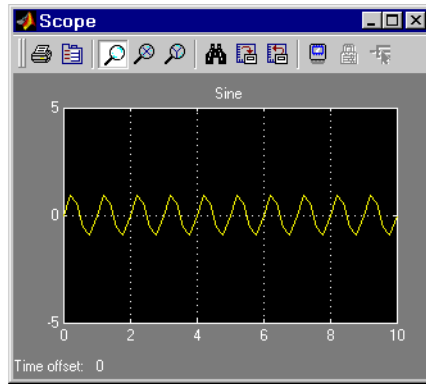
Sine Wave
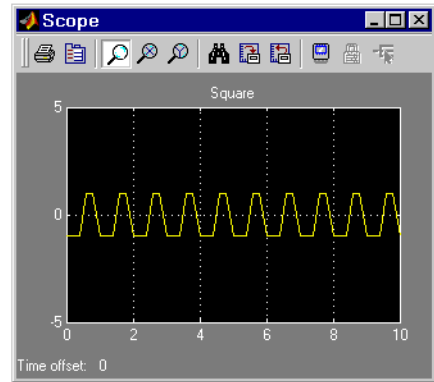
Square Wave
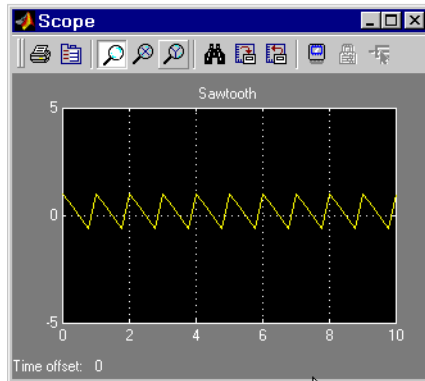
Sawtooth Wave

A negative **Amplitude** parameter value causes a 180-degree phase shift. You can generate a phase-shifted wave at other than 180 degrees in a variety of ways, including connecting a Clock block signal to a MATLAB Fcn block and writing the equation for the particular wave.

You can vary the output settings of the Signal Generator block while a simulation is in progress. This is useful to determine quickly the response of a system to different types of inputs.

The block's **Amplitude** and **Frequency** parameters determine the amplitude and frequency of the output signal. The parameters must be of the same dimensions after scalar expansion. If the **Interpret vector parameters as 1-D** option is off, the block outputs a signal of the same dimensions as the **Amplitude** and **Frequency** parameters (after scalar expansion). If the **Interpret vector parameters as 1-D** option is on, the block outputs a vector (1-D) signal if the **Amplitude** and **Frequency** parameters are row or column vectors, i.e. single row or column 2-D arrays. Otherwise, the block outputs a signal of the same dimensions as the parameters.

Data Type Support

The Signal Generator block outputs a scalar or array of real signals of type double.

Parameters and Dialog Box
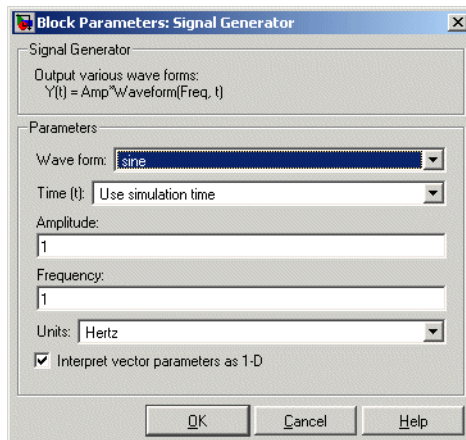
Signal Generator

Opening this dialog box causes a running simulation to pause.
See "Changing Source Block Parameters" in the online Simulink
documentation for details.

Wave form
> The wave form: a sine wave, square wave, or sawtooth wave. The
> default is a sine wave. This parameter cannot be changed while
> a simulation is running.

Time
> Specifies whether to use simulation time as the source of values
> for the waveform's time variable or an external signal. If you
> specify an external time source, the block displays an input port
> for the time source.

Amplitude
> The signal amplitude. The default is 1.

Frequency
> The signal frequency. The default is 1.

Units
> The signal units: Hertz or radians/sec. The default is Hertz.

Interpret vector parameters as 1-D

If selected, column or row matrix values for the **Amplitude** and
Frequency parameters result in a vector output signal. See
"Determining the Output Dimensions of Source Blocks" in the "Working
with Signals" chapter of the Using Simulink documentation.

Characteristics

Sample Time	Continuous
Scalar Expansion	Yes, of parameters
Dimensionalized	Yes
Zero Crossing	No

Purpose   Specify the desired dimensions, sample time, data type, numeric type, and other attributes of a signal.

Library   Signal Attributes
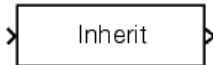
Description   The Signal Specification block allows you to specify the attributes of the signal connected to its input and output ports. If the specified attributes conflict with the attributes specified by the blocks connected to its ports, Simulink displays an error when it compiles the model, for example, at the beginning of a simulation. If no conflict exists, Simulink eliminates the Signal Specification block from the compiled model. In other words, the Signal Specification block is a virtual block. It exists only to specify the attributes of a signal and plays no role in the simulation of the model.

> Inherit

You can use the Signal Specification block to ensure that the actual attributes of a signal meet desired attributes. For example, suppose that you and a colleague are working on different parts of the same model and you use Signal Specification blocks to connect your part of the model with your colleague's. Now, if your colleague changes the attributes of a signal without informing you, the attributes entering the corresponding Signal Specification block do not match and Simulink reports an appropriate error.

The Signal Specification block can also be used to ensure correct propagation of signal attributes throughout a model. The capability of allowing many attributes to be propagated from block to block in Simulink is very powerful. However, because blocks may not specify some or all of the attributes of the signals they accept or output, it is possible to create models that don't have enough information to correctly propagate attributes around the model. For these cases, the Signal Specification block is a good way of providing the information Simulink needs. Using the Signal Specification block also helps speed up model compilation when blocks are missing signal attributes.

Data Type Support   The Signal Specification block accepts real or complex signals of any data type supported by Simulink, including fixed-point data types. The

Signal Specification

input data type must match the data type specified by the **Data type** parameter.

For a discussion on the data types supported by Simulink, see "Data Types Supported by Simulink" in the Simulink documentation.

Parameters and Dialog Box
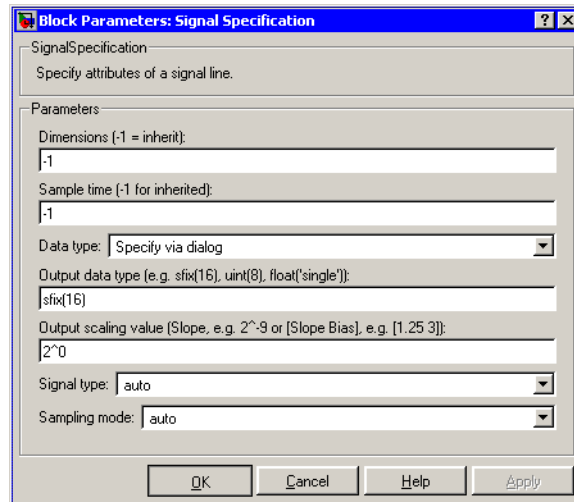
Dimensions

Specify the dimension's of the block's input and output signals. Valid values are

- -1–Inherited from the block to which it is connected

- n–Vector signal of width n

- [m n]–Matrix signal having m rows and n columns

Sample Time

Specify the sample time at which the block is updated. Valid values are

- -1–inherited from the block to which it is connected

- period >= 0
- [period, offset]
- [0, -1]
- [-1, -1]

where period is the sample rate and offset is the offset of the sample period from time zero. See "Specifying Sample Time" in the online documentation for more information.

Data type
Specify the data type of the input and output signals. To let Simulink determine the data type, set this parameter to auto.

Output data type
Specify any data type, including fixed-point data types. This parameter is only visible if you select Specify via dialog for the **Data type** parameter.

Output scaling value
Set the output scaling using binary point-only or [Slope Bias] scaling. This parameter is only visible if you select Specify via dialog for the **Data type** parameter.

Signal type
Specify the numeric type (real or complex) of the input and output signal. To let Simulink determine the numeric type, set this parameter to auto.

Sampling mode
Specify the sampling mode (sample-based or frame-based) of this block. To let Simulink determine the sampling mode, set this parameter to auto.

Signal Specification

Characteristics

Direct Feedthrough	Yes
Sample Time	Specified by the block's Sample Time parameter.
Scalar Expansion	No
Dimensionalized	Yes
Zero Crossing	No

Purpose   Implement a sine wave in fixed-point using a lookup table approach
              that exploits quarter wave symmetry

Library   Lookup Tables

Description   The Sine block is an implementation of the Sine and Cosine block. See
              `Sine and Cosine` for more information.

sin(2*pi*u)
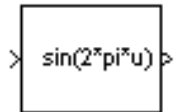
Sine and Cosine

Purpose
Implement a sine and/or cosine wave in fixed point using a lookup table approach that exploits quarter wave symmetry

Library
Lookup Tables (Sine block or Cosine block)

Description
The Sine and Cosine block implements a sine and/or cosine wave in fixed point using a lookup table method that exploits quarter wave symmetry.

The Sine and Cosine block can output the following functions of the input signal, depending upon what you select for the **Output formula** parameter:

- $\sin(2\pi u)$
- $\cos(2\pi u)$
- $\exp(i2\pi u)$
- $\sin(2\pi u)$ and $\cos(2\pi u)$

You define the number of lookup table points in the **Number of data points for lookup table** parameter. The block implementation is most efficient when you specify the lookup table data points to be `(2^n)+1`, where n is an integer.

Use the **Output word length** parameter to specify the word length of the fixed-point output data type. The fraction length of the output is the output word length minus 2.

Data Type Support
The Sine and Cosine block accepts signals of any data type supported by Simulink, including fixed-point data types. The output of the block is a fixed-point data type.

Parameters and Dialog Box
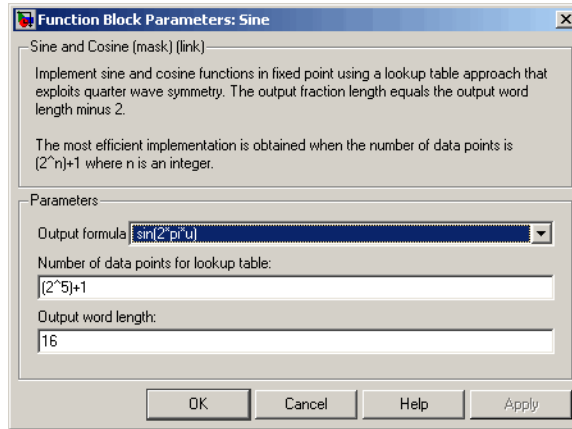
Output formula

Select the signal(s) to output.

Number of data points for lookup table

Specify the number of data points to retrieve from the lookup table. The implementation is most efficient when you specify the lookup table data points to be (2^n)+1, where n is an integer.

Output word length

Specify the word length for the fixed-point data type of the output signal. The fraction length of the output is the output word length minus 2.

Characteristics

Direct Feedthrough	Yes
Scalar Expansion	N/A

Sine Wave

Purpose   Generate a sine wave

Library   Sources

Description   The Sine Wave block provides a sinusoid. The block can operate in
                   either time-based or sample-based mode.

Time-Based Mode

The output of the Sine Wave block is determined by

$$y = Amplitude \times \sin(frequency \times time + phase) + bias$$

Time-based mode has two submodes: continuous mode or discrete mode.
The value of the **Sample time** parameter determines whether the block
operates in continuous mode or discrete mode:

- 0 (the default) causes the block to operate in continuous mode.

- >0 causes the block to operate in discrete mode.

See "Specifying Sample Time" in the online documentation for more
information.

Using the Sine Wave Block in Continuous Mode

A **Sample time** parameter value of 0 causes the block to operate in
continuous mode. When operating in continuous mode, the Sine Wave
block can become inaccurate due to loss of precision as time becomes
very large.

Using the Sine Wave Block in Discrete Mode

A **Sample time** parameter value greater than zero causes the block
to behave as if it were driving a Zero-Order Hold block whose sample
time is set to that value.

Using the Sine Wave block in this way allows you to build models with
sine wave sources that are purely discrete, rather than models that are
hybrid continuous/discrete systems. Hybrid systems are inherently
more complex and as a result take longer to simulate.

Sine Wave

The Sine Wave block in discrete mode uses an incremental algorithm rather than one based on absolute time. As a result, the block can be useful in models intended to run for an indefinite length of time, such as in vibration or fatigue testing.

The incremental algorithm computes the sine based on the value computed at the previous sample time. This method makes use of the following identities:

$$\sin(t + \Delta t) = \sin(t)\cos(\Delta t) + \sin(\Delta t)\cos(t)$$
$$\cos(t + \Delta t) = \cos(t)\cos(\Delta t) - \sin(t)\sin(\Delta t)$$

These identities can be written in matrix form:

$$\begin{bmatrix} \sin(t + \Delta t) \\ \cos(t + \Delta t) \end{bmatrix} = \begin{bmatrix} \cos(\Delta t) & \sin(\Delta t) \\ -\sin(\Delta t) & \cos(\Delta t) \end{bmatrix} \begin{bmatrix} \sin(t) \\ \cos(t) \end{bmatrix}$$

Since Δt is constant, the following expression is a constant:

$$\begin{bmatrix} \cos(\Delta t) & \sin(\Delta t) \\ -\sin(\Delta t) & \cos(\Delta t) \end{bmatrix}$$

Therefore the problem becomes one of a matrix multiplication of the value of $\sin(t)$ by a constant matrix to obtain $\sin(t+\Delta t)$.

Discrete mode reduces but does not eliminate accumulation of roundoff errors. This is because the computation of the block's output at each time step depends on the value of the output at the previous time step.

Sample-Based Mode

Sample-based mode uses the following formula to compute the output of the Sine Wave block.

$$y = A \times \sin(2 \times \pi \times (k + o)/p) + b$$

where

- A is the amplitude of the sine wave.

Sine Wave

- p is the number of time samples per sine wave period.

- k is a repeating integer value that ranges from 0 to p-1.

- o is the offset (phase shift) of the signal.

- b is the signal bias.

In this mode, Simulink sets k equal to 0 at the first time step and computes the block's output, using the preceding formula. At the next time step, Simulink increments k and recomputes the output of the block. When k reaches p, Simulink resets k to 0 before computing the block's output. This process continues until the end of the simulation.

The sample-based method of computing the block's output does not depend on the result of the previous time step to compute the result at the current time step. It therefore avoids roundoff error accumulation. However, it has one potential drawback. If the block is in a conditionally executed subsystem and the conditionally executed subsystem pauses and then resumes execution, the output of the Sine Wave block might no longer be in sync with the rest of the simulation. Thus, if the accuracy of your model requires that the output of conditionally executed Sine Wave blocks remain in sync with the rest of the model, you should use time-based mode for computing the output of the conditionally executed blocks.

Parameter Dimensions

The block's numeric parameters must be of the same dimensions after scalar expansion. If the **Interpret vector parameters as 1-D** option is off, the block outputs a signal of the same dimensions and dimensionality as the parameters. If the **Interpret vector parameters as 1-D** option is on and the numeric parameters are row or column vectors (i.e., single row or column 2-D arrays), the block outputs a vector (1-D array) signal; otherwise, the block outputs a signal of the same dimensionality and dimensions as the parameters.

Data Type Support

The Sine Wave block accepts and outputs real signals of type double.
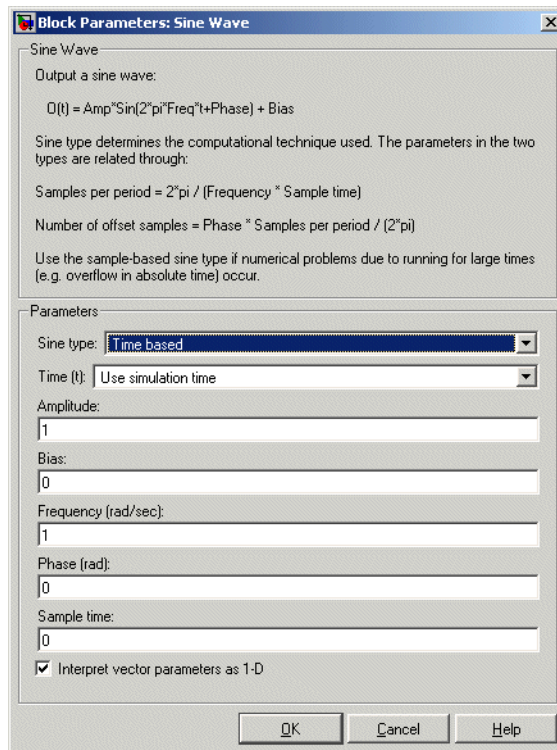
Sine Wave

Parameters and Dialog Box

Opening this dialog box causes a running simulation to pause. See "Changing Source Block Parameters" in the online Simulink documentation for details.

Sine type

Type of sine wave generated by this block, either time- or sample-based. Some of the other options presented by the Sine Wave dialog box depend on whether you select time-based or sample-based as the value of **Sine type** parameter.

Time

Specifies whether to use simulation time as the source of values for the sine wave's time variable or an external source. If you

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Sine Wave

specify an external time source, the block displays an input port for the time source.

Amplitude
The amplitude of the signal. The default is 1.

Bias
Constant value added to the sine to produce the output of this block.

Frequency
The frequency, in radians/second. The default is 1 rad/s. This parameter appears only if you choose time-based as the **Sine type** of the block.

Samples per period
Number of samples per period. This parameter appears only if you choose sample-based as the **Sine type** of the block.

Phase
The phase shift, in radians. The default is 0 radians. This parameter appears only if you choose time-based as the **Sine type** of the block.

Number of offset samples
The offset (discrete phase shift) in number of sample times. This parameter appears only if you choose sample-based as the **Sine type** of the block.

Sample time
The sample period. The default is 0. If the sine type is sample-based, the sample time must be greater than 0. See "Specifying Sample Time" in the online documentation for more information.

Interpret vector parameters as 1-D
If selected, column or row matrix values for the Sine Wave block's numeric parameters result in a vector output signal; otherwise, the block outputs a signal of the same dimensionality as the parameters. If this option is not selected, the block always outputs a signal of the same dimensionality as the block's numeric

parameters. See "Determining the Output Dimensions of Source Blocks" in the "Working with Signals" chapter of the Using Simulink documentation.

Characteristics

Sample Time	Specified in the **Sample time** parameter
Scalar Expansion	Yes, of parameters
Dimensionalized	Yes
Zero Crossing	No

Sine Wave Function

Purpose   Generate a sine wave, using an external signal as a time source.

Library   Math Operations

Description   This block is the same as the Sine Wave block with its **Time** parameter set to Use external source. See the documentation for the Sine Wave block for more information.
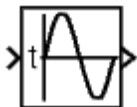
Purpose   Vary a scalar gain using a slider

Library   Math Operations

Description   The Slider Gain block allows you to vary a scalar gain during a
                   simulation using a slider. The block accepts one input and generates
                   one output.

Data Type   Data type support for the Slider Gain block is the same as that for the
Support   Gain block (see Gain).

**Parameters
and
Dialog
Box**
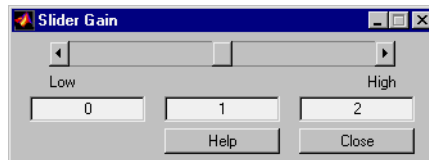
Low
    The lower limit of the slider range. The default is 0.

High
    The upper limit of the slider range. The default is 2.

The edit fields indicate (from left to right) the lower limit, the current
value, and the upper limit. You can change the gain in two ways: by
manipulating the slider, or by entering a new value in the current value
field. You can change the range of gain values by changing the lower
and upper limits. Close the dialog box by clicking the **Close** button.

If you click the slider's left or right arrow, the current value changes
by about 1% of the slider's range. If you click the rectangular area to
either side of the slider's indicator, the current value changes by about
10% of the slider's range.

To apply a vector or matrix gain to the block input, consider using the
Gain block.

Slider Gain

Characteristics

Direct Feedthrough	Yes
Sample Time	Inherited from driving block
Scalar Expansion	Yes, of the gain
States	0
Dimensionalized	Yes
Zero Crossing	No

Purpose   Implement a linear state-space system

Library   Continuous

Description   The State-Space block implements a system whose behavior is defined by

$$\dot{x} = Ax + Bu$$
$$y = Cx + Du$$

where x is the state vector, u is the input vector, and y is the output vector. The matrix coefficients must have these characteristics, as illustrated in the following diagram:

- **A** must be an n-by-n matrix, where n is the number of states.

- **B** must be an n-by-m matrix, where m is the number of inputs.

- **C** must be an r-by-n matrix, where r is the number of outputs.

- **D** must be an r-by-m matrix.
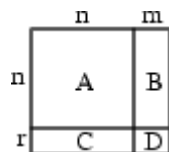
The block accepts one input and generates one output. The input vector width is determined by the number of columns in the B and D matrices. The output vector width is determined by the number of rows in the C and D matrices.

Simulink converts a matrix containing zeros to a sparse matrix for efficient multiplication.

Specifying the Absolute Tolerance for the Block's States

By default Simulink uses the absolute tolerance value specified in the **Configuration Parameters** dialog box (see "Solver Pane") to solve the

states of the State-Space block. If this value does not provide sufficient error control, specify a more appropriate value in the **Absolute tolerance** field of the State-Space block's dialog box. The value that you specify is used to solve all the block's states.

Data Type Support
A State-Space block accepts and outputs real signals of type double.

Parameters and Dialog Box

A, B, C, D
The matrix coefficients.

Initial conditions
The initial state vector. Simulink does not allow the initial conditions of this block to be inf or NaN.

Absolute tolerance
Absolute tolerance used to solve the block's states. You can enter auto or a numeric value. If you enter auto, Simulink determines the absolute tolerance (see "Solver Pane"). If you enter a numeric

value, Simulink uses the specified value to solve the block's states. Note that a numeric value overrides the setting for the absolute tolerance in the **Configuration Parameters** dialog box.

Characteristics

Direct Feedthrough	Only if $D \neq 0$
Sample Time	Continuous
Scalar Expansion	Yes, of the initial conditions
States	Depends on the size of A
Dimensionalized	Yes
Zero Crossing	No

Step

Purpose   Generate a step function

Library   Sources

Description   The Step block provides a step between two definable levels at a
                     specified time. If the simulation time is less than the **Step time**
                     parameter value, the block's output is the **Initial value** parameter
                     value. For simulation time greater than or equal to the **Step time**, the
                     output is the **Final value** parameter value.

                     The block's numeric parameters must be of the same dimensions
                     after scalar expansion. If the **Interpret vector parameters as
                     1-D** option is off, the block outputs a signal of the same dimensions
                     and dimensionality as the parameters. If the **Interpret vector
                     parameters as 1-D** option is on and the numeric parameters are row or
                     column vectors (i.e., single row or column 2-D arrays), the block outputs
                     a vector (1-D array) signal; otherwise, the block outputs a signal of the
                     same dimensionality and dimensions as the parameters.

Data Type   The Step block outputs real signals of type `double`.
Support
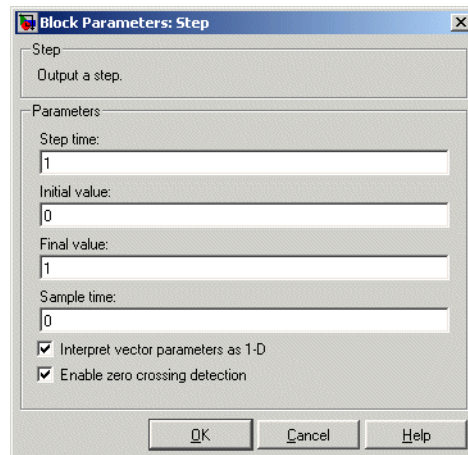
Parameters
and
Dialog
Box

Opening this dialog box causes a running simulation to pause. See "Changing Source Block Parameters" in the online Simulink documentation for details.

Step time

> The time, in seconds, when the output jumps from the **Initial value** parameter to the **Final value** parameter. The default is 1 second.

Initial value

> The block output until the simulation time reaches the **Step time** parameter. The default is 0.

Final value

> The block output when the simulation time reaches and exceeds the **Step time** parameter. The default is 1.

Sample time

> Sample rate of step. See "Specifying Sample Time" in the online documentation for more information.

Interpret vector parameters as 1-D

> If selected, column or row matrix values for the Step block's numeric parameters result in a vector output signal; otherwise, the block outputs a signal of the same dimensionality as the parameters. If this option is not selected, the block always outputs a signal of the same dimensionality as the block's numeric parameters. See "Determining the Output Dimensions of Source Blocks" in the "Working with Signals" chapter of the Using Simulink documentation.

Enable zero crossing detection

> Select to enable zero crossing detection to detect step times. For more information, see "Zero-Crossing Detection" in the "How Simulink Works" chapter of the Using Simulink documentation.

Step

Characteristics

Sample Time	Specified in the **Sample time** parameter
Scalar Expansion	Yes, of parameters
Dimensionalized	Yes
Zero Crossing	Yes, if enabled.

Purpose   Stop the simulation when the input is nonzero

Library   Sinks

Description   The Stop Simulation block stops the simulation when the input is nonzero.

The simulation completes the current time step before terminating. If the block input is a vector, any nonzero vector element causes the simulation to stop.

You can use this block in conjunction with the Relational Operator block to control when the simulation stops. For example, this model stops the simulation when the input signal reaches 10.
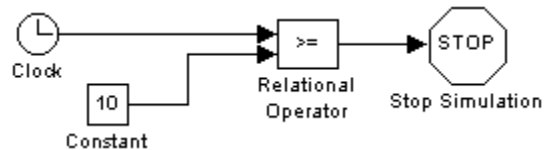
Data Type Support   The Stop Simulation block accepts real signals of type double or Boolean.

Parameters and Dialog Box
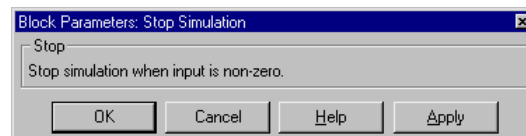
Characteristics

Sample Time	Inherited from driving block
Dimensionalized	Yes

Subsystem, Atomic Subsystem, CodeReuse Subsystem

Purpose   Represent a system within another system

Library   Ports & Subsystems

Description   A Subsystem block represents a subsystem of the system that contains
it. The Subsystem block can represent a virtual subsystem or a true
(atomic) subsystem, depending on the value of its **Treat as Atomic
Unit** parameter. An Atomic Subsystem block is a Subsystem block that
has its **Treat as Atomic Unit** parameter selected by default.

You create a subsystem in these ways:

- Copy the Subsystem (or Atomic Subsystem) block from the Ports
  & Subsystems library into your model. You can then add blocks to
  the subsystem by opening the Subsystem block and copying blocks
  into its window.

- Select the blocks and lines that are to make up the subsystem using a
  bounding box, then choose **Create Subsystem** from the **Edit** menu.
  Simulink replaces the blocks with a Subsystem block. When you
  open the block, the window displays the blocks you selected, adding
  Inport and Outport blocks to reflect signals entering and leaving
  the subsystem.

The number of input ports drawn on the Subsystem block's icon
corresponds to the number of Inport blocks in the subsystem. Similarly,
the number of output ports drawn on the block corresponds to the
number of Outport blocks in the subsystem.

See "Creating Subsystems" for more information about subsystems.

Data Type Support   For a discussion on the data types supported by Simulink, see "Data
Types Supported by Simulink" in the Simulink documentation.

See Inport for information on the data types accepted by a subsystem's
input ports. See Outport for information on the data types output by a
subsystem's output ports.

Subsystem, Atomic Subsystem, CodeReuse Subsystem

Parameters and Dialog Box
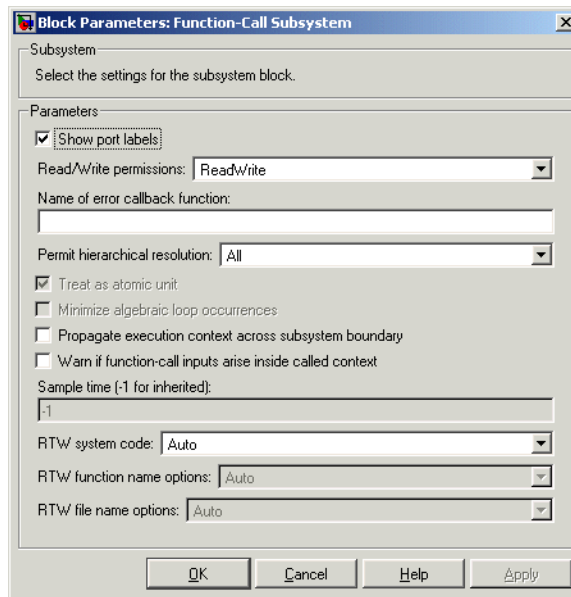
Show port labels

Causes Simulink to display the labels of the subsystem's ports in the subsystem's icon.

Read/Write permissions

Controls user access to the contents of the subsystem. You can select any of the following values.

Subsystem, Atomic Subsystem, CodeReuse Subsystem

Permissions	Description
ReadWrite	User can open and modify the contents of the subsystem.
ReadOnly	User can open but not modify the subsystem. If the subsystem resides in a block library, a user can create and open links to the subsystem and can make and modify local copies of the subsystem but cannot change the permissions or modify the contents of the original library instance.
NoReadOrWrite	User cannot open or modify the subsystem. If the subsystem resides in a library, a user can create links to the subsystem in a model but cannot open, modify, change permissions, or create local copies of the subsystem.

Name of error callback function

Name of a function to be called if an error occurs while Simulink is executing the subsystem. Simulink passes two arguments to the function: the handle of the subsystem and a string that specifies the error type. If no function is specified, Simulink displays a generic error message if executing the subsystem causes an error.

Permit hierarchical resolution

Specifies whether to resolve names of workspace variables referenced by this subsystem. The options are

- All

  Resolve all names of workspace variables used by this subsystem, including those used to specify block parameter values and Simulink data objects (for example, Simulink.Signal objects).

- ExplicitOnly

Resolve only names of workspace variables used to specify block parameter values, data store memory (where no block exists), signals, and states marked as "must resolve").

- None

  Do not resolve any workspace variable names.

Treat as atomic unit
Causes Simulink to treat the subsystem as a unit when determining the execution order of block methods. For example, when it needs to compute the output of the subsystem, Simulink invokes the output methods of all the blocks in the subsystem before invoking the output methods of other block at the same level as the subsystem block. If this option is not selected, Simulink treats all blocks in the subsystem as being at the same level in the model hierarchy as the subsystem when determining block method execution order. This can cause execution of methods of blocks in the subsystem to be interleaved with execution of methods of blocks outside the subsystem. See "Atomic Subsystems" for more information.

Minimize algebraic loop occurrences
Try to eliminate any algebraic loops that include this subsystem (see "Eliminating Algebraic Loops" in the online Simulink documentation for more information).

Propagate execution context across subsystem boundary
This option appears only if the subsystem is conditionally executed. If selected, this option enables execution context propagation across this subsystem's boundary (see "Propagating Execution Contexts" in the online Simulink documentation). Simulink disables this option by default.

Warn if function-call inputs arise inside called context
This option appears only if the subsystem is a function-call subsystem and is effective only if the **Context-dependent inputs** diagnostic on the **Configuration Parameters** dialog box is set to Use local settings. In this case, if this option is

checked, Simulink displays a warning if it has to compute any of this function-call subsystem's inputs directly or indirectly during execution of a function-call (see the "Function-call systems" examples in the Simulink "Subsystem Semantics" library for examples of such function-call subsystems.

Sample time

Specifies the sample time of this subsystem if it is atomic, i.e., its **Treat as atomic unit** option is selected. The sample time that you specify must be one of the following:

- Inherited Sample Time (`-1`), the default
- Constant Sample Time (`inf`)
- Periodic (`[Ts 0]`)

Use this parameter to specify whether all blocks in this subsystem must run at the same rate or can run at different rates. If the blocks in the subsystem can run at different rates, specify the subsystem's sample time as inherited (`-1`). If all blocks must run at the same rate, specify the sample time corresponding to this rate as the value of the subsystem's **Sample time** parameter. If any of the blocks in the subsystem specify a different sample time (other than `-1` or `inf`), Simulink displays an error message when you update or simulate the model. For example, suppose all the blocks in the subsystem must run 5 times a second. To ensure this, specify the sample time of the subsystem as `0.2`. In this example, if any of the blocks in the subsystem specify a sample time other than `0.2`, `-1`, or `inf`, Simulink displays an error when you update or simulate the model.

Real-Time Workshop system code (Real-Time Workshop license required)

Specifies the code format to be generated for an atomic (nonvirtual) subsystem.

If You Want Real-Time Workshop To...	Select...
Choose the optimal format for you based on the type and number of instances of the subsystem that exist in the model	Auto
Inline the subsystem unconditionally	Inline
Generate a separate, non-reentrant function with no arguments, and optionally place the subsystem code in a separate file	Function
Generates a function with arguments that allows the subsystem's code to be shared by other instances of it in the model	Reusable function

When this option is set to Function or Reusable function, two additional options appear — **Real-Time Workshop function name options** and **Real-Time Workshop file name options**.

For more information on using these options, see"Nonvirtual Subsystem Code Generation Options" in the Real-Time Workshop documentation.

Real-Time Workshop function name options (Real-Time Workshop license required)

Specifies how Real-Time Workshop is to name the function it generates for the subsystem.

Subsystem, Atomic Subsystem, CodeReuse Subsystem

If You Want Real-Time Workshop to...	Select...
Assign a unique function name using the default naming convention, *model_subsystem*(), where *model* is the name of the model and *subsystem* is the name of the subsystem (or that of an identical one when code is being reused)	`Auto`
Use the subsystem name as the function name	`Use subsystem name`
Assign a unique, valid C or C++ function name that you specify	`User specified`

If you specify `Use subsystem name` and the subsystem is a library block, Real-Time Workshop names the function (and filename) with the name of the library block, regardless of the names used for that subsystem in the model.

If you select `User specified`, a **Real-Time Workshop function name** option appears.

Real-Time Workshop function name (Real-Time Workshop license required)
Specifies a unique, valid C or C++ function name for subsystem code.

Real-Time Workshop file name options (Real-Time Workshop license required)
Specifies how Real-Time Workshop is to name the separate file for the function it generates for the subsystem.

If You Want Real-Time Workshop to...	Select...
Generate the function code within the module generated from the subsystem's parent system, or, if the subsystem's parent is the model itself, within the file `model.c` or `model.cpp`	`Auto`
Generate a separate file and name it with the name of the subsystem or library block	`Use subsystem name`
Generate a separate file and name it with the function name you specify for **Real-Time Workshop function name options**	`Use function name`
Assign a unique, valid C or C++ function name that you specify	`User specified`

If you specify `Use subsystem name`, the subsystem filename is mangled if the model contains Model blocks, or if a model reference target is being generated for the model. In these situations, the filename for the subsystem consists of the subsystem name prefixed by the model name.

If you select `User specified`, the option **Real-Time Workshop filename** option appears.

Real-Time Workshop file name (no extension) (Real-Time Workshop license required)

Specifies how Real-Time Workshop is to name the file for the function it generates for the subsystem. The filename that you specify does not have to be unique. However, avoid giving non-unique names that result in cyclic dependencies (for example, `sys_a.h` includes `sys_b.h`, `sys_b.h` includes `sys_c.h`, and `sys_c.h` includes `sys_a.h`).

Subsystem, Atomic Subsystem, CodeReuse Subsystem

Function with separate data (Real-Time Workshop Embedded Coder license required)

Appears if you select Function for the **Real-Time Workshop system code** option. If checked, Real-Time Workshop Embedded Coder generates subsystem function code in which the internal data for an atomic subsystem is separated from its parent model and is owned by the subsystem. As a result, the generated code for the atomic subsystem is easier to trace and test. The data separation also tends to reduce the size of data structures throughout the model.

When you select this option, three memory section options for data appear: **Memory section for constants**, **Memory section for internal data**, and **Memory section for parameters**.

For details on how to generate modular function code for an atomic subsystem, see "Nonvirtual Subsystem Modular Function Code Generation" in the Real-Time Workshop Embedded Coder documentation.

For details on how to apply memory sections to atomic subsystems, see "Applying Memory Sections to Atomic Subsystems" in the Real-Time Workshop Embedded Coder documentation.

Memory sections for initialize/terminate functions(Real-Time Workshop Embedded Coder license required)
Memory sections for execution functions

Appear if you select Function for the **Real-Time Workshop system code** option. The value you specify for each of these options indicates how the Real-Time Workshop Embedded coder is to apply memory sections to the subsystem's initialization, termination, and execution functions. These options can be useful for overriding the model's memory section settings for the given subsystem.

The list of possible values varies depending on if and what package of memory sections you have set for the model's

configuration (see"Memory Sections Pane" in the Real-Time Workshop Embedded Coder documentation). If you have not configured the model with a package, Inherit from model is the only value that appears. Otherwise, the list includes Default and all memory sections the model's package contains.

If You Want Real-Time Workshop Embedded Coder To...	Select...
Apply the root model's memory sections to the subsystem's function code	Inherit from model
Not apply memory sections to the subsystem's system code, overriding any model-level specification	Default
Apply one of the model's memory sections to the subsystem	The memory section of interest

For details on how to apply memory sections to atomic subsystems, see "Applying Memory Sections to Atomic Subsystems" in the Real-Time Workshop Embedded Coder documentation.

Memory sections for constants (Real-Time Workshop Embedded Coder license required)
Memory sections for internal data
Memory sections for parameters

Appear if you select Function for the **Real-Time Workshop system code** option. The value you specify for each of these options indicates how the Real-Time Workshop Embedded coder is to apply memory sections to the subsystem's data. These options can be useful for overriding the model's memory section settings for the given subsystem.

The list of possible values varies depending on if and what package of memory sections you have set for the model's configuration (see"Memory Sections Pane" in the Real-Time

Subsystem, Atomic Subsystem, CodeReuse Subsystem

Workshop Embedded Coder documentation). If you have not configured the model with a package, `Inherit from model` is the only value that appears. Otherwise, the list includes `Default` and all memory sections the model's package contains.

If You Want Real-Time Workshop Embedded Coder To...	Select...
Apply the root model's memory sections to the subsystem's data	`Inherit from model`
Not apply memory sections to the subsystem's data, overriding any model-level specification	`Default`
Apply one of the model's memory sections to the subsystem	The memory section of interest

For details on how to apply memory sections to atomic subsystems, see "Applying Memory Sections to Atomic Subsystems" in the Real-Time Workshop Embedded Coder documentation.

Characteristics

Sample Time	Depends on the blocks in the subsystem
Dimensionalized	Depends on the blocks in the subsystem
Zero Crossing	Yes, for enable and trigger ports if present

Purpose   Add or subtract inputs

Library   Math Operations
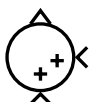
Description The Sum block performs addition or subtraction on its inputs. This
block can add or subtract scalar, vector, or matrix inputs. It can also
collapse the elements of a single input vector.

You specify the operations of the block with the **List of signs** parameter.
Plus (+), minus (-), and spacer (|) characters indicate the operations to
be performed on the inputs:

- If there are two or more inputs, then the number of + and - characters
  must equal the number of inputs. For example, "+-+" requires three
  inputs and configures the block to subtract the second (middle) input
  from the first (top) input, and then add the third (bottom) input.

  All nonscalar inputs must have the same dimensions. Scalar inputs
  will be expanded to have the same dimensions as the other inputs.

- A spacer character creates extra space between ports on the block's
  icon.

- If only addition of all inputs is required, then a numeric parameter
  value equal to the number of inputs can be supplied instead of
  "+"characters.

- If only one vector is input, then a single "+" or "-" will collapse the
  vector using the specified operation.

The Sum block first converts the input data type(s) to the output
data type using the specified rounding and overflow modes, and then
performs the specified operations.

**Data Type
Support**   The Sum block accepts real or complex signals of any data type
supported by Simulink, including fixed-point data types. The inputs
may be of different data types unless you select the **Require all inputs
to have same data type** parameter.

Sum, Add, Subtract, Sum of Elements

For a discussion on the data types supported by Simulink, see "Data Types Supported by Simulink" in the Simulink documentation.

Parameters and Dialog Box

The **Main** pane of the Sum block dialog appears as follows:
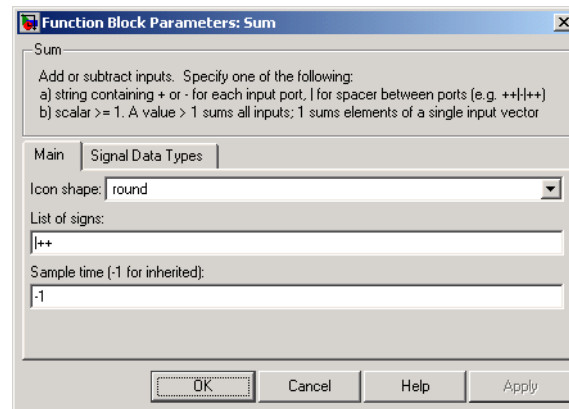
Icon shape

Designate the icon shape of the block.

List of signs

Enter as many plus (+) and minus (-) characters as there are inputs. Addition is the default operation, so if you only want to add the inputs, enter the number of input ports. For a single vector input, "+" or "-" will collapse the vector using the specified operation.

You can manipulate the positions of the input ports on the block by inserting spacers (|) between the signs in the **List of signs** parameter. For example, "++|--" creates an extra space between the second and third input ports.

Sample time (-1 for inherited)

Specify the time interval between samples. To inherit the sample time, set this parameter to -1. See Specifying Sample Time in the online documentation for more information.

The **Signal Data Types** pane of the Sum block dialog appears as follows:
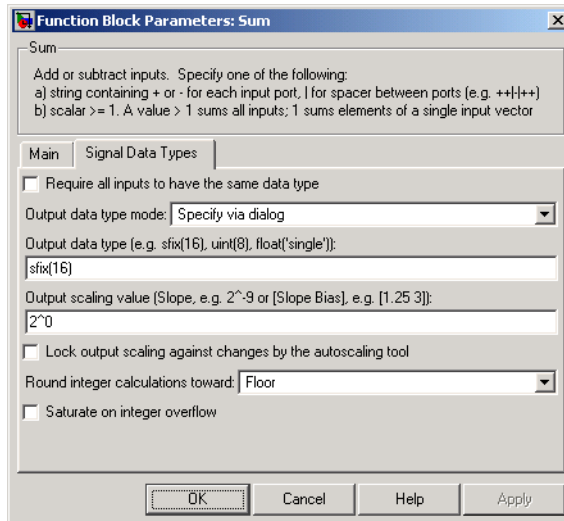
Require all inputs to have same data type

Select this parameter to require that all inputs must have the same data type.

Output data type mode

Specify the output data type and scaling to be the same as the first input, or inherit the data type and scaling from an internal rule or by backpropagation. You can also choose a built-in data type from the drop-down list. Lastly, if you choose `Specify via dialog`, the **Output data type**, **Output scaling value**, and **Lock output scaling against changes by the autoscaling tool** parameters become visible.

Output data type

Specify any data type, including fixed-point data types. This parameter is only visible if you select `Specify via dialog` for the **Output data type mode** parameter.

Sum, Add, Subtract, Sum of Elements

Output scaling value

Set the output scaling using binary point-only or [Slope Bias] scaling. This parameter is only visible if you select `Specify via dialog` for the **Output data type mode** parameter.

Lock output scaling against changes by the autoscaling tool

Select to lock scaling of outputs. This parameter is only visible if you select `Specify via dialog` for the **Output data type mode** parameter.

Round integer calculations toward

Select the rounding mode for fixed-point operations.

Saturate on integer overflow

Select to have overflows saturate.

Characteristics

Direct Feedthrough	Yes
Sample Time	Specified in the **Sample time** parameter
Scalar Expansion	Yes
States	0
Dimensionalized	Yes
Zero Crossing	No

Purpose   Switch output between the first input and the third input based on the value of the second input

Library   Signal Routing

Description   The Switch block passes through the first (top) input or the third (bottom) input based on the value of the second (middle) input. The first and third inputs are called *data inputs*. The second input is called the *control input*.

You select the conditions under which the first input is passed with the **Criteria for passing first input** parameter. You can make the block check whether the control input is greater than or equal to the threshold value, purely greater than the threshold value, or nonzero. If the control input meets the condition set in the **Criteria for passing first input parameter**, then the first input is passed. Otherwise, the third input is passed.

Note If the data inputs to the switch are buses, the element names of both buses must be the same to ensure that the output bus has the same element names no matter which input bus is selected. You can ensure that your model meets this requirement by using a bus object to define the buses with the model's **Element name mismatch** diagnostic set to error. See "Connectivity Diagnostics" for more information.

Data Type Support   The data and control inputs of a Switch block accept real or complex signals of any data type supported by Simulink, including fixed-point data types.

For a discussion on the data types supported by Simulink, see "Data Types Supported by Simulink" in the Simulink documentation.

Switch

Parameters and Dialog Box

The **Main** pane of the Switch block dialog appears as follows:
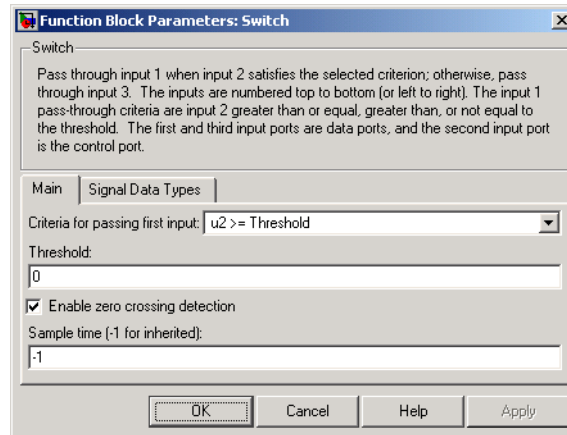
Criteria for passing first input

Select the conditions under which the first input is passed. You can make the block check whether the control input is greater than or equal to the threshold value, purely greater than the threshold value, or nonzero. If the control input meets the condition set in this parameter, then the first input is passed. Otherwise, the third input is passed.

Threshold

Assign the switch threshold that determines which input is passed to the output.

Enable zero crossing detection

Select to enable zero crossing detection. For more information, see Zero Crossing Detection in the "How Simulink Works" chapter of the Using Simulink documentation.

Sample time (-1 for inherited)

Specify the time interval between samples. To inherit the sample time, set this parameter to -1. See Specifying Sample Time in the online documentation for more information.

The **Signal Data Types** pane of the Switch block dialog appears as follows:
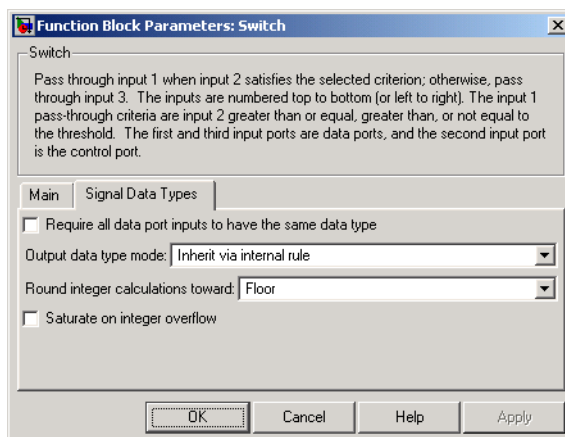
Require all data port inputs to have same data type
Select to require all data inputs to have the same data type.

Output data type mode
Choose to inherit the output data type and scaling by backpropagation or by an internal rule. The internal rule causes the output of the block to have the same data type and scaling as the input with the larger positive range.

Round integer calculations toward
Select the rounding mode for fixed-point operations.

Saturate on integer overflow
Select to have overflows saturate.

Characteristics

Direct Feedthrough	Yes
Sample Time	Specified in the **Sample time** parameter

Switch

Scalar Expansion	Yes
Dimensionalized	Yes
Zero Crossing	Yes, if enabled

See Also   Multiport Switch

Purpose   Implement a C-like `switch` control flow statement

Library   Ports & Subsystems

Description The following shows a completed Simulink C-like `switch` control flow statement in the subsystem of the Switch Case block.

Action signals

Action subsystems with
Action Port blocks inside
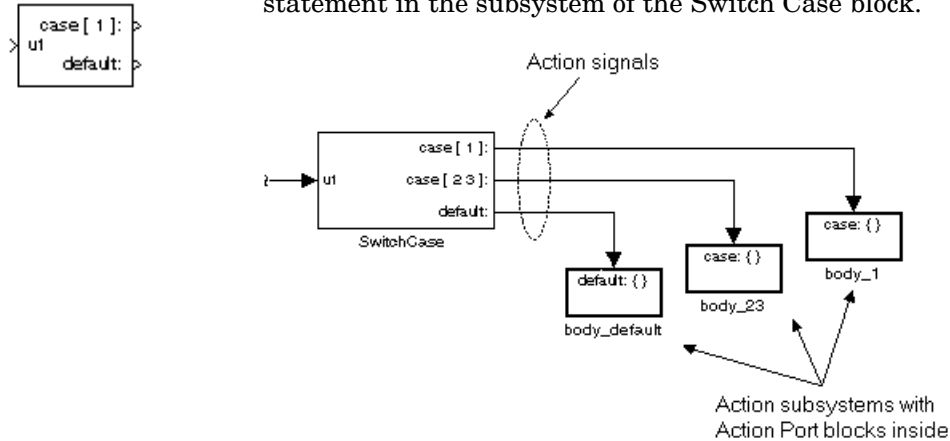
A Switch Case block receives a single input, which it uses to form case conditions that determine which subsystem to execute. Each output port case condition is attached to a Switch Case Action subsystem. The cases are evaluated top down starting with the top case. If a case value (in brackets) corresponds to the actual value of the input, its Switch Case Action subsystem is executed.

The preceding `switch` control flow statement can be represented by the following pseudocode:

```
switch (u1) {
 case [u1=1]:
  body_1;
  break;
 case [u1=2 or u1=3]:
  body_23;
  break;
```

```
 default:
  bodydefault;
}
```

You construct a Simulink `switch` control flow statement like the example shown as follows:

1 Place a Switch Case block in the current system and attach the input port labeled u1 to the source of the data you are evaluating.

2 Open the **Block Parameters** dialog of the Switch Case block and enter as follows:

   a Enter the **Case conditions** field with the individual cases.

   Each case can be an integer or set of integers specified with MATLAB cell notation. See the **Case conditions** field in the "Parameters and Dialog Box" section of this reference.

   b Select the **Show default case** check box to show a default case output port on the Switch Case block.

   If all other cases are false, the default case is taken.

3 Create a Switch Case Action subsystem for each case port you added to the Switch Case block.

   These consist of subsystems with Action Port blocks inside them. When you place the Action Port block inside a subsystem, the subsystem becomes an atomic subsystem with an input port labeled `Action`.

4 Connect each case output port and the default output port of the Switch Case block to the Action port of an Action subsystem.

   Each connected subsystem becomes a case body. This is indicated by the change in label for the Switch Case Action subsystem block and the Action Port block inside of it to the name case{}.

During simulation of a `switch` control flow statement, the Action signals from the Switch Case block to each Switch Case Action subsystem turn from solid to dashed.

5 In each Switch Case Action subsystem, enter the Simulink logic appropriate to the case it handles. All blocks in a Switch Case Action Subsystem must run at the same rate as the driving Switch Case block. You can achieve this by setting each block's sample time parameter to be either inherited (`-1`) or the same value as the Switch Case block's sample time.

Note As demonstrated in the preceding pseudocode example, cases for the Switch Case block contain an implied break after their Switch Case Action subsystems are executed. There is no fall-through behavior for the Simulink `switch` control flow statement as found in standard C `switch` statements.

Data Type Support

Input to the port labeled `u1` of a Switch Case block can be a scalar value of any data type supported by Simulink except `Boolean`. The input to `u1` can also be a fixed-point data type. Noninteger inputs are truncated. For a discussion on the data types supported by Simulink, see"Data Types Supported by Simulink" in the Simulink documentation.

Data outputs are action signals to Switch Case Action subsystems that are created with Action Port blocks and subsystems.

Switch Case

Parameters and Dialog Box

Block Parameters: Switch Case

SwitchCase Block

Perform a switch-case operation on the input. The input must be a scalar and its value will be truncated. The case conditions are specified using the MATLAB cell notation, where each case is a cell element. For example, entering {1,[2,3]} as the case condition implies that port 1 is run when the input is 1 and port 2 is run when the input is either 2 or 3. If the default case is shown, then port 3 is run for all other inputs.

Parameters

Case conditions (e.g. {1,[2,3]}):
{1}

☑ Show default case:

☑ Enable zero crossing detection

Sample time (-1 for inherited):
-1

[OK]   [Cancel]   [Help]   [Apply]

Case conditions

Case conditions are specified using MATLAB cell notation where each cell is a case condition consisting of integers or arrays of integers. In the preceding dialog example, entering {1,[7,9,4]} specifies that output port case[1] is run when the input value is 1, and output port case[7 9 4] is run when the input value is 7, 9, or 4.

You can use colon notation to specify a range of case conditions. For example, entering {[1:5]} specifies that output port case[1 2 3 4 5] is run when the input value is 1, 2, 3, 4, or 5.

Depending on block size, cases with long lists of conditions are displayed in shortened form in the Switch Case block, using a terminating ellipsis (...).

Show default case

If you select this check box, the default output port appears as the last case on the Switch Case block. This case is run when the input value does not match any of the case values specified in the **Case conditions** field.

Enable zero crossing detection
> Select to enable use of zero crossing detection. For more information, see "Zero Crossing Detection" in the "How Simulink Works" chapter of the Using Simulink documentation.

Sample time (-1 for inherited)
> Specify the time interval between samples. To inherit the sample time, set this parameter to -1. See "Specifying Sample Time" in the online documentation for more information.

Characteristics

Direct Feedthrough	Yes
Sample Time	Inherited from driving block
Scalar Expansion	No
Dimensionalized	No
Zero Crossing	Yes, if enabled

Switch Case Action Subsystem

Purpose   Represent a subsystem whose execution is triggered by a Switch Case block

Library   Ports & Subsystems

Description   This block is a Subsystem block that is preconfigured to serve as a starting point for creating a subsystem whose execution is triggered by a Switch Case block.
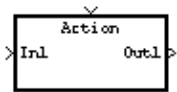
Note All blocks in a Switch Case Action Subsystem must run at the same rate as the driving Switch Case block. You can achieve this by setting each block's sample time parameter to be either inherited (-1) or the same value as the Switch Case block's sample time.

For more information, see the Switch Case block and "Modeling Control Flow Logic" in the "Creating a Model" chapter of the Using Simulink documentation.

Purpose   Delay a scalar signal multiple sample periods and output all the delayed versions

Library   Discrete

Description The Tapped Delay block delays its input by the specified number of sample periods, and outputs all the delayed versions.

This block provides a mechanism for discretizing a signal in time, or resampling the signal at a different rate. You specify the time between samples with the **Sample time** parameter. You specify the number of delays with the **Number of delays** parameter. A value of -1 instructs the block to inherit the number of delays by backpropagation. Each delay is equivalent to the z^{-1} discrete-time operator, which is represented by the Unit Delay block.

The block accepts one scalar input and generates an output for each delay. The input must be a scalar. You specify the order of the output vector with the **Order output vector starting with** parameter list. **Oldest** orders the output vector starting with the oldest delay version and ending with the newest delay version. **Newest** orders the output vector starting with the newest delay version and ending with the oldest delay version.

The block output for the first sampling period is specified by the **Initial condition** parameter. Careful selection of this parameter can minimize unwanted output behavior.

Data Type Support The Tapped Delay block accepts signals of any data type supported by Simulink, including fixed-point data types.

Tapped Delay

Parameters and Dialog Box
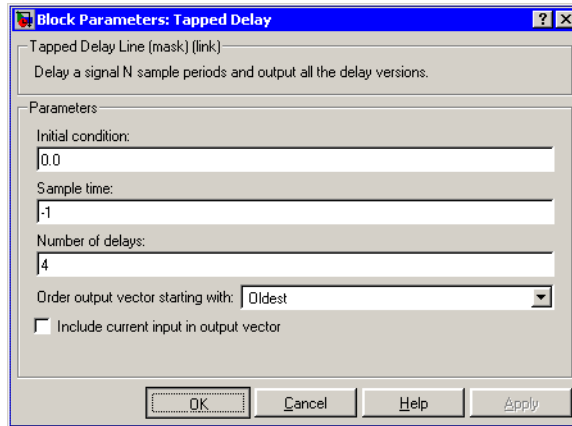
Initial condition

Specify the initial output of the simulation. The **Initial condition** parameter is converted from a double to the input data type offline using round-to-nearest and saturation. Simulink does not allow you to set the initial condition of this block to `inf` or `NaN`.

Sample time

Specify the time interval between samples. To inherit the sample time, set this parameter to `-1`. See "Specifying Sample Time" in the online documentation for more information.

Number of delays

Specify the number of discrete-time operators.

Order output vector starting with

Specify whether the oldest delay version is output first, or the newest delay version is output first.

Include current input in output vector

Select to include the current input in the output vector.

Characteristics

Direct Feedthrough	Yes, when **Include current input in output vector** parameter is checked. No otherwise.
Sample Time	Specified in the **Sample time** parameter
Scalar Expansion	Yes, of initial conditions

Terminator

Purpose   Terminate an unconnected output port

Library   Sinks

Description   The Terminator block can be used to cap blocks whose output ports
are not connected to other blocks. If you run a simulation with blocks
having unconnected output ports, Simulink issues warning messages.
Using Terminator blocks to cap those blocks avoids warning messages.

Data Type Support   The Terminator block accepts real or complex signals of any data type
supported by Simulink, including fixed-point data types.

For a discussion on the data types supported by Simulink, see"Data
Types Supported by Simulink" in the Simulink documentation.

Parameters and Dialog Box

Block Parameters: Terminator

Terminator
Used to "terminate" output signals. (Prevents warnings about
unconnected output ports.)

    OK   Cancel   Help   Apply
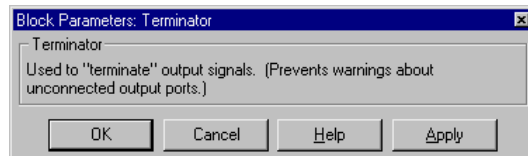
Characteristics

Sample Time	Inherited from driving block
Dimensionalized	Yes

Purpose   Generate linear models in the base workspace at specific times

Library   Model-Wide Utilities

Description This block calls `linmod` or `dlinmod` to create a linear model for the
system when the simulation clock reaches the time specified by the
Linearization time parameter. No trimming is performed. The
linear model is stored in the base workspace as a structure, along with
information about the operating point at which the snapshot was taken.
Multiple snapshots are appended to form an array of structures.

T=1

The name of the structure used to save the snapshots is the name of
the model appended by _Timed_Based_Linearization, for example,
vdp_Timed_Based_Linearization. The structure has the follow fields:

Field	Description
a	The A matrix of the linearization
b	The B matrix of the linearization
c	The C matrix of the linearization
d	The D matrix of the linearization
StateName	Names of the model's states
OutputName	Names of the model's output ports
InputName	Names of the model's input ports
OperPoint	A structure that specifies the operating point of the linearization. The structure specifies the operating point time (`OperPoint.t`). The states (`OperPoint.x`) and inputs (`OperPoint.u`) fields are not used.
Ts	The sample time of the linearization for a discrete linearization

Use the Trigger-Based Linearization block if you need to generate linear
models conditionally.

Time-Based Linearization

You can use state and simulation time logging to extract the model states and inputs at operating points. For example, suppose that you want to get the states of the f14 demo model at linearization times of 2 seconds and 5 seconds.

1 Open the model and drag an instance of this block from the Model-Wide Utilities library and drop the instance into the model.

2 Open the block's parameter dialog box and set the **Linearization time** to 2 and 5.

3 Open the model's **Configuration Parameters** dialog box.

4 Select the **Data Import/Export** pane.

5 Check **States** and **Time** on the **Save to Workspace** control panel

6 Select OK to confirm the selections and close the dialog box.

7 Simulate the model.

At the end of the simulation, the following variables appear in the MATLAB workspace: f14_Timed_Based_Linearization, tout, and xout.

8 Get the indices to the operating point times by entering the following at the MATLAB command line:

```
ind1 = find(f14_Timed_Based_Linearization(1).OperPoint.t==tout);
ind2 = find(f14_Timed_Based_Linearization(1).OperPoint.t==tout);
```

9 Get the state vectors at the operating points.

```
x1 = xout(ind1,:);
x2 = xout(ind2,:);
```

Data Type Support   Not applicable.

Parameters and Dialog Box
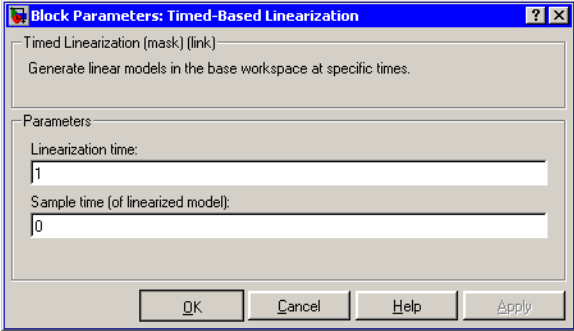
Linearization time

Time at which you want the block to generate a linear model. Enter a vector of times if you want the block to generate linear models at more than one time step.

Sample time (of linearized model)

Specify a sample time to create discrete-time linearizations of the model (see "Discrete-Time System Linearization" on page 3-6).

Characteristics

Sample Time	Specified in the **Sample time** parameter
Dimensionalized	No

To File

Purpose   Write data to a file

Library   Sinks

Description   The To File block writes its input to a matrix in a MAT-file. The block
writes one column for each time step: the first row is the simulation
time; the remainder of the column is the input data, one data point for
each element in the input vector. The matrix has this form.

untitled.mat

$$\begin{bmatrix} t_1 & t_2 & ...t_{final} \\ u1_1 & u1_2 & ...u1_{final} \\ ... & & \\ un_1 & un_2 & ...un_{final} \end{bmatrix}$$

The From File block can use data written by a To File block without
any modifications. However, the form of the matrix expected by the
From Workspace block is the transposition of the data written by the To
File block.

The block writes the data as well as the simulation time after the
simulation is completed. Its icon shows the name of the specified output
file.

The amount of data written and the time steps at which the data is
written are determined by block parameters:

- The **Decimation** parameter allows you to write data at every nth
  sample, where n is the decimation factor. The default decimation, 1,
  writes data at every time step.

- The **Sample time** parameter allows you to specify a sampling
  interval at which to collect points. This parameter is useful when
  you are using a variable-step solver where the interval between
  time steps might not be the same. The default value of -1 causes
  the block to inherit the sample time from the driving block when
  determining the points to write. See "Specifying Sample Time" in the
  online documentation for more information.

The To File block generates an uncompressed MAT-file. If you open and save this file, it will be smaller because MATLAB compresses the saved file. If the file exists at the time the simulation starts, the block overwrites its contents.

Data Type Support

The To File block accepts real signals of type `double`.

Parameters and Dialog Box
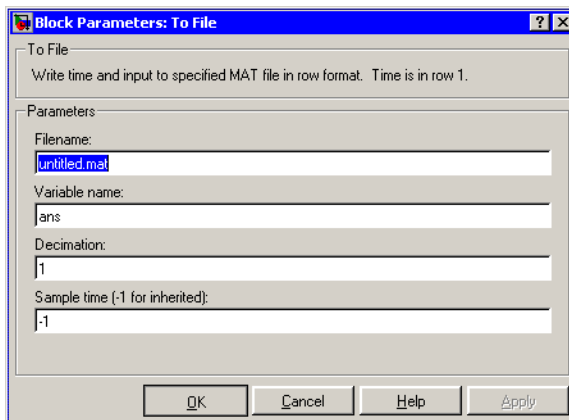
Filename

The fully qualified pathname or filename of the MAT-file in which to store the output. On UNIX, the pathname may start with a tilde (~) character signifying your home directory. The default filename is `untitled.mat`. If you specify an unqualified filename, Simulink stores the file in the MATLAB working directory. (To determine the working directory, type `pwd` at the MATLAB command line.)

Variable name

The name of the matrix contained in the named file.

Decimation

A decimation factor. The default value is `1`.

To File

Sample time

> The sample period and offset at which to collect points. See
> "Specifying Sample Time" in the online documentation for more
> information.

Characteristics

Sample Time	Specified in the **Sample time** parameter
Dimensionalized	Yes

Purpose   Write data to the workspace

Library   Sinks
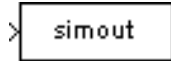
Description   The To Workspace block writes its input to the workspace. The block
                     writes its output to an array or structure that has the name specified by
                     the block's **Variable name** parameter. The **Save format** parameter
                     determines the output format.

simout

Array

Selecting this option causes the To Workspace block to save the
input as an N-dimensional array where N is one more than the
number of dimensions of the input signal. For example, if the input
signal is a 1-D array (i.e., a vector), the resulting workspace array is
two-dimensional. If the input signal is a 2-D array (i.e., a matrix), the
array is three-dimensional.

The way samples are stored in the array depends on whether the input
signal is a scalar or vector or a matrix. If the input is a scalar or a vector,
each input sample is output as a row of the array. For example, suppose
that the name of the output array is simout. Then, simout(1,:)
corresponds to the first sample, simout(2,:) corresponds to the second
sample, etc. If the input signal is a matrix, the third dimension of
the workspace array corresponds to the values of the input signal at
specified sampling point. For example, suppose again that simout is
the name of the resulting workspace array. Then, simout(:,:,1) is the
value of the input signal at the first sample point; simout(:,:,2) is the
value of the input signal at the second sample point; etc.

The amount of data written and the time steps at which the data is
written are determined by block parameters:

• The **Limit data points to last** parameter indicates how many
  sample points to save. If the simulation generates more data points
  than the specified maximum, the simulation saves only the most
  recently generated samples. To capture all the data, set this value
  to inf.

To Workspace

- The **Decimation** parameter allows you to write data at every `nth` sample, where `n` is the decimation factor. The default decimation, 1, writes data at every time step.

- The **Sample time** parameter allows you to specify a sampling interval at which to collect points. This parameter is useful when you are using a variable-step solver where the interval between time steps might not be the same. The default value of -1 causes the block to inherit the sample time from the driving block when determining the points to write. See "Specifying Sample Time" in the online documentation for more information.

During the simulation, the block writes data to an internal buffer. When the simulation is completed or paused, that data is written to the workspace. Its icon shows the name of the array to which the data is written.

Structure

This format consists of a structure with three fields: `time`, `signals`, and `blockName`. The `time` field is empty. The `blockName` field contains the name of the To Workspace block. The `signals` field contains a structure with three fields: `values`, `dimensions`, and `label`. The `values` field contains the array of signal values. The `dimensions` field specifies the dimensions of the values array. The `label` field contains the label of the input line.

Structure with Time

This format is the same as Structure except that the time field contains a vector of simulation time steps.

Using Saved Data with a From Workspace Block

If the data written using a To Workspace block is intended to be played back in another simulation using a From Workspace block, use the `Structure with Time` format to save the data.

Examples

In a simulation where the start time is 0, the **Limit data points to last** is 100, the **Decimation** is 1, and the **Sample time** is 0.5. The To Workspace block collects a maximum of 100 points, at time values of 0, 0.5, 1.0, 1.5, ..., seconds. Specifying a **Decimation** value of 1 directs the block to write data at each step.

In a similar example, the **Limit data points to last** is 100 and the **Sample time** is 0.5, but the **Decimation** is 5. In this example, the block collects up to 100 points, at time values of 0, 2.5, 5.0, 7.5, ..., seconds. Specifying a **Decimation** value of 5 directs the block to write data at every fifth sample. The sample time ensures that data is written at these points.

In another example, all parameters are as defined in the first example except that the **Limit data points to last** is 3. In this case, only the last three sample points collected are written to the workspace. If the simulation stop time is 100, data corresponds to times 99.0, 99.5, and 100.0 seconds (three points).

Data Type Support

The To Workspace block can save real or complex inputs of any data type supported by Simulink, including fixed-point data types, to the MATLAB workspace.

For a discussion on the data types supported by Simulink, see "Data Types Supported by Simulink" in the Simulink documentation.

To Workspace

**Parameters
and
Dialog
Box**

Block Parameters: To Workspace

To Workspace

Write input to specified array or structure in MATLAB's main workspace. Data is not available until the simulation is stopped or paused.

Parameters

Variable name:

simout

Limit data points to last:

inf

Decimation:

1

Sample time (-1 for inherited):

-1

Save format: Structure

☐ Log fixed-point data as a fi object

OK   Cancel   Help   Apply
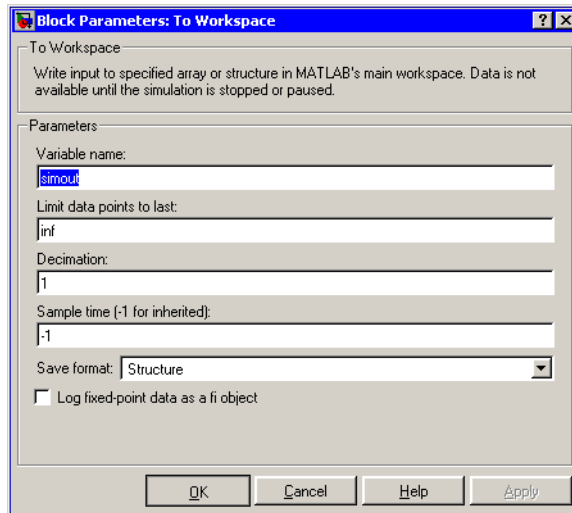
Variable name

The name of the array that holds the data.

Limit data points to last

The maximum number of input samples to be saved. The default is inf samples.

Decimation

A decimation factor. The default is 1.

Sample time

The sample time at which to collect points. See "Specifying Sample Time" in the online documentation for more information.

Save format

Format in which to save simulation output to the workspace. The default is structure.

Log fixed-point data as a fi object

Select to log fixed-point data to the MATLAB workspace as a Simulink Fixed-Point fi object. Otherwise, fixed-point data is logged to the workspace as double.

Characteristics

Sample Time	Specified in the **Sample time** parameter
Dimensionalized	Yes

Transfer Fcn

Purpose

Model a linear system by a transfer function

Library

Continuous

Description
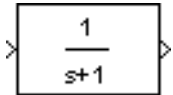
The Transfer Fcn block models a linear system by a transfer function of the Laplace-domain variable *s*. The block can model both single-input single-output (SISO) and single-input multiple output (SIMO) systems.

This block assumes that the transfer function has the following form

$$H(s) = \frac{y(s)}{u(s)} = \frac{num(s)}{den(s)} = \frac{num(1)s^{nn-1} + num(2)s^{nn-2} + \ldots + num(nn)}{den(1)s^{nd-1} + den(2)s^{nd-2} + \ldots + den(nd)}$$

where *u* and *y* are the system's input and outputs, respectively, *nn* and *nd* are the number of numerator and denominator coefficients, respectively. *num* and *den* contain the coefficients of the numerator and denominator in descending powers of *s*. The order of the denominator must be greater than or equal to the order of the numerator. This block also assumes that the transfer functions for the outputs of a multiple output system have the same denominator and that the numerators of the transfer functions have the same order.

To model a single-output system, enter a vector containing the system transfer function's numeric coefficients in the **Numerator coefficient** field in the block's parameter dialog box. Enter a vector containing the transfer function's denominator coefficients in the **Denominator coefficient** field. In this case, the input and output of the block are scalar time-domain signals.

To model a multiple-output system, enter a matrix in the **Numerator coefficient** field where each row of the matrix contains the numerator coefficients of a transfer function that determines one of the block's outputs. Enter a vector containing the denominator coefficients common to the system's transfer functions in the **Denominator coefficient** field. In this case, the block's input is a scalar and the block's output is a vector each of whose elements is an output of the system modeled by the block.
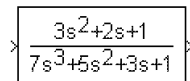
Initial conditions are preset to zero. If you need to specify initial conditions, convert to state-space form using `tf2ss` and use the State-Space block. The `tf2ss` utility provides the A, B, C, and D matrices for the system. For more information, type `help tf2ss` or consult the *Control System Toolbox documentation*.
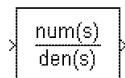
Transfer Fcn Display

The numerator and denominator are displayed on the Transfer Fcn block depending on how they are specified:

- If each is specified as an expression, a vector, or a variable enclosed in parentheses, the icon shows the transfer function with the specified coefficients and powers of *s*. If you specify a variable in parentheses, the variable is evaluated. For example, if you specify **Numerator** as `[3,2,1]` and **Denominator** as `(den)` where `den` is `[7,5,3,1]`, the block looks like this:

$$\frac{3s^2 + 2s + 1}{7s^3 + 5s^2 + 3s + 1}$$

- If each is specified as a variable, the block shows the variable name followed by `(s)`. For example, if you specify **Numerator** as `num` and **Denominator** as `den`, the block looks like this:

$$\frac{num(s)}{den(s)}$$

Specifying the Absolute Tolerance for the Block's States

By default Simulink uses the absolute tolerance value specified in the **Configuration Parameters** dialog box (see "Absolute tolerance") to solve the states of the Transfer Fcn block. If this value does not provide sufficient error control, specify a more appropriate value in the **Absolute tolerance** field of the Transfer Fcn block's dialog box. The value that you specify is used to solve all the block's states.

Transfer Fcn

Data Type Support

The Transfer Fcn block accepts and outputs signals of type `double`.
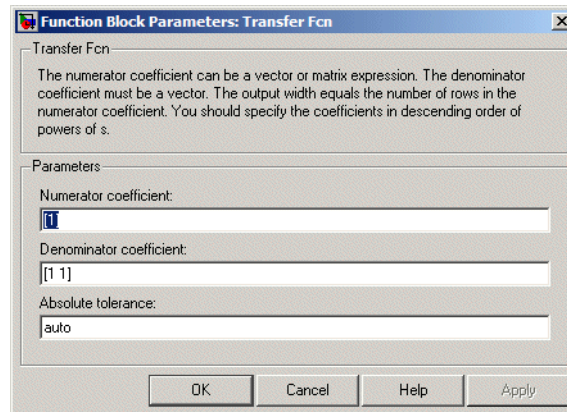
Parameters and Dialog Box

Numerator coefficient

The row vector of numerator coefficients. A matrix with multiple rows can be specified to generate multiple output. The default is [1].

Denominator coefficient

The row vector of denominator coefficients. The default is [1 1].

Absolute tolerance

Absolute tolerance used to solve the block's states. You can enter `auto` or a numeric value. If you enter `auto`, Simulink determines the absolute tolerance (see "Specifying Variable-Step Solver Error Tolerances"). If you enter a numeric value, Simulink uses the specified value to solve the block's states. Note that a numeric value overrides the setting for the absolute tolerance in the **Configuration Parameters** dialog box.

Characteristics

Direct Feedthrough	Only if the lengths of the **Numerator** and **Denominator** parameters are equal
Sample Time	Continuous
Scalar Expansion	No
States	Length of **Denominator** -1
Dimensionalized	Yes, in the sense that the block expands scalar input into vector output when the transfer function numerator is a matrix. See the preceding block description.
Zero Crossing	No
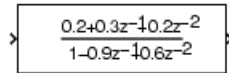
Transfer Fcn Direct Form II

Purpose   Implement a Direct Form II realization of a transfer function

Library   Additional Math & Discrete / Additional Discrete

Description

$$\frac{0.2+0.3z^{-1}0.2z^{-2}}{1-0.9z^{-1}0.6z^{-2}}$$

The Transfer Fcn Direct Form II block implements a Direct Form II realization of the transfer function specified by the **Numerator coefficients** and the **Denominator coefficients excluding lead** parameters. The block only supports single input-single output transfer functions.

The block automatically selects the data types and scalings of the output, the coefficients, and any temporary variables.

Data Type Support

The Transfer Fcn Direct Form II block accepts signals of any data type supported by Simulink, including fixed-point data types.

Parameters and Dialog Box
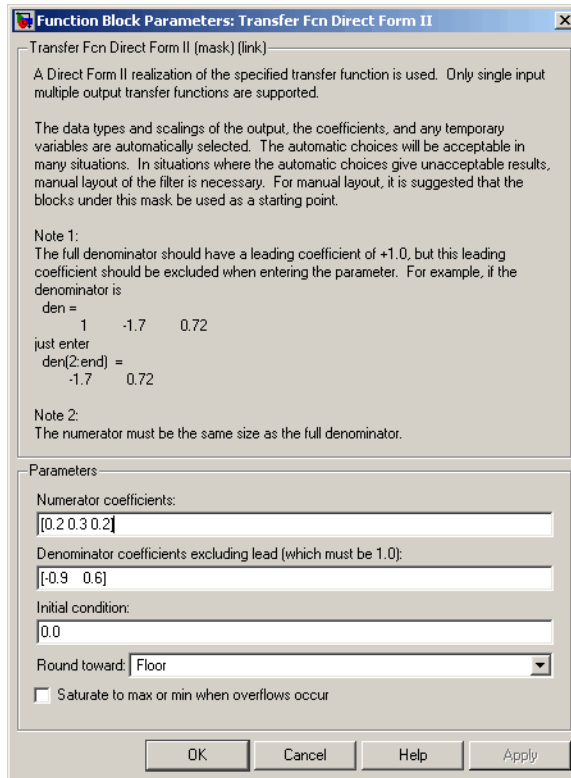
Numerator coefficients
Specify the numerator coefficients.

Denominator coefficients excluding lead
Specify the denominator coefficients, excluding the leading coefficient, which must be 1.0.

Initial condition
Set the initial condition.

Round toward
Rounding mode for the fixed-point output.

Saturate to max or min when overflows occur
If selected, fixed-point overflows saturate.

Characteristics

Direct Feedthrough	Yes
Scalar Expansion	Yes, of initial conditions

See Also   Transfer Fcn Direct Form II Time Varying

Purpose   Implement a time varying Direct Form II realization of a transfer function

Library   Additional Math & Discrete / Additional Discrete
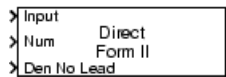
Description   The Transfer Fcn Direct Form II Time Varying block implements a Direct Form II realization of the specified transfer function. The block only supports single input-single output transfer functions.

The block automatically selects the data types and scalings of the output, the coefficients, and any temporary variables.

```
>│ Input   Direct
>│ Num     Form II       >
>│ Den No Lead
```

Data Type Support   The Transfer Fcn Direct Form II Time Varying block accepts signals of any data type supported by Simulink, including fixed-point data types.

Parameters and Dialog Box

Function Block Parameters: Transfer Fcn Direct Form II Time Varying

Transfer Fcn Direct Form II Time Varying (mask) (link)

A Direct Form II realization of the specified transfer function is used. Only single input single output transfer functions are supported.

The data types and scalings of the output, the coefficients, and any temporary variables are automatically selected. The automatic choices will be acceptable in many situations. In situations where the automatic choices give unacceptable results, manual layout of the filter is necessary. For manual layout, it is suggested that the blocks under this mask be used as a starting point.

Note 1:
The full denominator should have a leading coefficient of +1.0, but this leading coefficient should be excluded when entering the parameter. For example, if the denominator is
```
 den =
        1      -1.7      0.72
```
just enter
```
 den(2:end) =
        -1.7      0.72
```

Note 2:
The numerator must be the same size as the full denominator.

Parameters

Initial condition:
```
0.0
```

Round toward: Floor

☐ Saturate to max or min when overflows occur

[OK] [Cancel] [Help] [Apply]

Transfer Fcn Direct Form II Time Varying

Initial condition

Set the initial condition.

Round toward

Rounding mode for the fixed-point output.

Saturate to max or min when overflows occur

If selected, fixed-point overflows saturate.

Characteristics

Direct Feedthrough	Yes
Scalar Expansion	Yes, of initial conditions

See Also   Transfer Fcn Direct Form II

Purpose   Implement a discrete-time first order transfer function

Library   Discrete

Description   The Transfer Fcn First Order block implements a discrete-time first
order transfer function of the input. The transfer function has a unity
DC gain.

$$\frac{0.05z}{z-0.95}$$
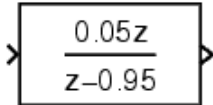
Data Type   The Transfer Fcn First Order block accepts signals of any data type
Support   supported by Simulink, including fixed-point data types.

**Parameters
and
Dialog
Box**
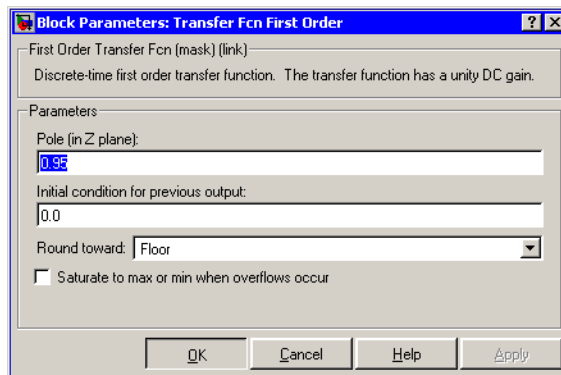
Pole (in Z plane)
    Set the pole.

Initial condition for previous output
    Set the initial condition for the previous output.

Round toward
    Rounding mode for the fixed-point output.

Saturate to max or min when overflows occur
    If selected, fixed-point overflows saturate.

Transfer Fcn First Order

Characteristics

Direct Feedthrough	Yes
Scalar Expansion	Yes, of initial conditions

Purpose   Implement a discrete-time lead or lag compensator

Library   Discrete

Description   The Transfer Fcn Lead or Lag block implements a discrete-time
lead or lag compensator of the input. The instantaneous gain of the
compensator is one, and the DC gain is equal to $(1-z)/(1-p)$, where z is
the zero and p is the pole of the compensator.

$$\frac{z-0.75}{z-0.95}$$
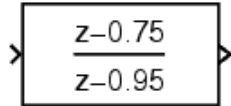
The block implements a lead compensator when $0 < z < p < 1$, and
implements a lag compensator when $0 < p < z < 1$.

Data Type Support   The Transfer Fcn Lead or Lag block accepts signals of any data type
supported by Simulink, including fixed-point data types.

Parameters and Dialog Box

Block Parameters: Transfer Fcn Lead or Lag

Lead or Lag Compensator (mask) (link)

Discrete-time lead or lag compensator. The compensator has a unity instantaneous gain, the DC gain equals (1-Zero)/(1-Pole).

Lead compensation is obtained when 0 < Pole < Zero < 1.
Lag compensation is obtained when 0 < Zero < Pole < 1.

Parameters

Pole of compensator (in Z plane):
0.95

Zero of compensator (in Z plane):
0.75

Initial condition for previous output:
0.0

Initial condition for previous input:
0.0

Round toward: Floor

☐ Saturate to max or min when overflows occur

[OK] [Cancel] [Help] [Apply]

Pole of compensator (in Z plane)
Set the pole.

Transfer Fcn Lead or Lag

Zero of compensator (in Z plane)
 Set the zero.

Initial condition for previous output
 Set the initial condition for the previous output.

Initial condition for previous input
 Set the initial condition for the previous input.

Round toward
 Rounding mode for the fixed-point output.

Saturate to max or min when overflows occur
 If selected, fixed-point overflows saturate.

Characteristics

Direct Feedthrough	Yes
Scalar Expansion	Yes, of initial conditions

Transfer Fcn Real Zero

Purpose   Implement a discrete-time transfer function that has a real zero and no pole

Library   Discrete

Description The Transfer Fcn Real Zero block implements a discrete-time transfer function that has a real zero and effectively has no pole.

$$\frac{z-0.75}{z}$$

Data Type Support The Transfer Fcn Real Zero block accepts signals of any data type supported by Simulink, including fixed-point data types.

Parameters and Dialog Box
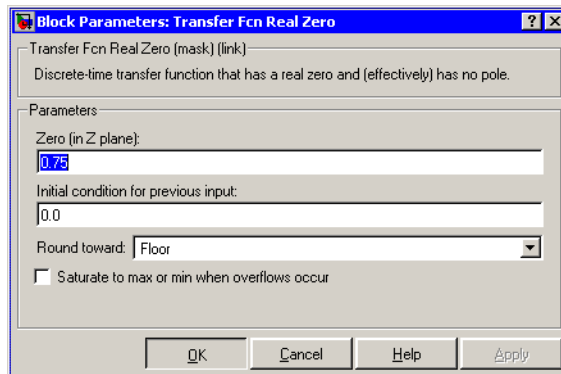
Zero (in Z plane)
Set the zero.

Initial condition for previous input
Set the initial condition for the previous input.

Round toward
Rounding mode for the fixed-point output.

Transfer Fcn Real Zero

Saturate to max or min when overflows occur
If selected, fixed-point overflows saturate.

Characteristics

Direct Feedthrough	Yes
Scalar Expansion	Yes, of initial conditions

Purpose   Delay the input by a given amount of time

Library   Continuous

Description   The Transport Delay block delays the input by a specified amount of time. It can be used to simulate a time delay.

At the start of the simulation, the block outputs the **Initial output** parameter until the simulation time exceeds the **Time delay** parameter, when the block begins generating the delayed input. The **Time delay** parameter must be nonnegative.

The block stores input points and simulation times during a simulation in a buffer whose initial size is defined by the **Initial buffer size** parameter. If the number of points exceeds the buffer size, the block allocates additional memory and Simulink displays a message after the simulation that indicates the total buffer size needed. Because allocating memory slows down the simulation, define this parameter value carefully if simulation speed is an issue. For long time delays, this block might use a large amount of memory, particularly for dimensionalized input.

When output is required at a time that does not correspond to the times of the stored input values, the block interpolates linearly between points. When the delay is smaller than the step size, the block extrapolates from the last output point, which can produce inaccurate results. Because the block does not have direct feedthrough, it cannot use the current input to calculate its output value. To illustrate this point, consider a fixed-step simulation with a step size of 1 and the current time at t = 5. If the delay is 0.5, the block needs to generate a point at t = 4.5. Because the most recent stored time value is at t = 4, the block performs forward extrapolation.

The Transport Delay block does not interpolate discrete signals. Instead, it returns the discrete value at the required time.

This block differs from the Unit Delay block, which delays and holds the output on sample hits only.

Transport Delay

Using linmod to linearize a model that contains a Transport Delay block can be troublesome. For more information about ways to avoid the problem, see "Linearizing Models" in the "Analyzing Simulation Results" chapter of the Using Simulink documentation.

Data Type Support

The Transport Delay block accepts and outputs real signals of type double.

Parameters and Dialog Box
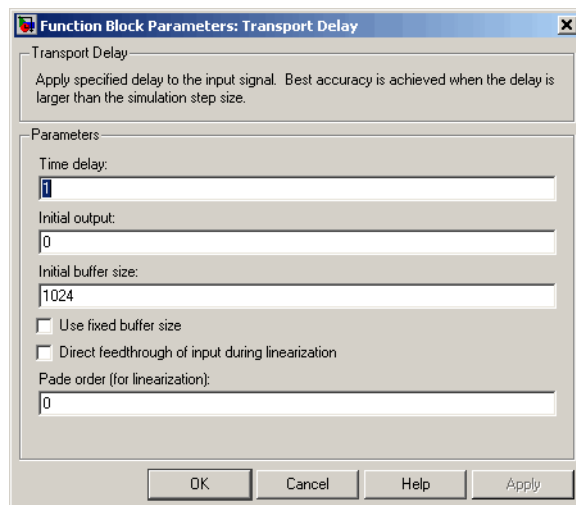
Time delay

The amount of simulation time that the input signal is delayed before being propagated to the output. The value must be nonnegative.

Initial output

Specifies the output of the block at simulation time 0.

Initial buffer size

The initial memory allocation for the number of points to store.

Use fixed buffer size

Specifies use of a fixed-size buffer to save input data from previous time steps. The **Initial buffer size** parameter specifies the buffer's size. If the buffer is full, new data replaces data already in the buffer. Simulink uses linear extrapolation to estimate the output value if it is not in the buffer. This option can save memory if the input data is linear. If the input is not linear, this option may yield inaccurate results.

> **Note** ERT or GRT code generation uses a fixed-size buffer even if you do not select this check box.

Direct feedthrough of input during linearization

Causes the block to output its input during linearization and trim. This sets the block's mode to direct feedthrough.

Enabling this check box can cause a change in the ordering of states in the model when using the functions linmod, dlinmod, or trim. To extract this new state ordering, use the following commands.

First compile the model using the following command, where model is the name of the Simulink model.

```
[sizes, x0, x_str] = model([],[],[],'lincompile');
```

Next, terminate the compilation with the following command.

```
model([],[],[],'term');
```

The output argument, x_str, which is a cell array of the states in the Simulink model, contains the new state ordering. When passing a vector of states as input to the linmod, dlinmod, or trim functions, the state vector must use this new state ordering.

Pade order (for linearization)
> The order of the Pade approximation for linearization routines. The default value is 0, which results in a unity gain with no dynamic states. Setting the order to a positive integer n adds n states to your model, but results in a more accurate linear model of the transport delay.

Characteristics

Direct Feedthrough	No
Sample Time	Continuous
Scalar Expansion	Yes, of input and all parameters except **Initial buffer size**
Dimensionalized	Yes
Zero Crossing	No

Trigger

Purpose   Add a trigger port to a subsystem or function-call model

Library   Ports & Subsystems

Description   Adding a Trigger block to a subsystem or a model allows its execution to be triggered by an external signal. You can configure the Trigger block to enable a change in the value of the external signal (described below) to trigger execution of a subsystem once on each integration step when the value of the signal that passes through the trigger port changes in a specifiable way (see"Triggered Subsystems"). You can also configure the Trigger block to accept a function-call trigger. This allows a Function-Call Generator block or S-function to trigger execution of a subsystem or model multiple times during a time step. A subsystem or model can contain only one Trigger block. For more information, see "Function-Call Models" and "Function-Call Subsystems".

The **Trigger type** parameter allows you to choose the type of event that triggers execution of the subsystem:

- `rising` triggers execution of the subsystem when the control signal rises from a negative or zero value to a positive value (or zero if the initial value is negative).

- `falling` triggers execution of the subsystem when the control signal falls from a positive or a zero value to a negative value (or zero if the initial value is positive).

- `either` triggers execution of the subsystem when the signal is either rising or falling.

- `function-call` allows a Function-Call Generator or S-function to control execution of the subsystem or model.

Note The **Trigger type** must be `function-call` for Trigger ports at the root-level of a model. In other words, only function-call signals can trigger execution of a model.

Trigger

You can output the trigger signal by selecting the **Show output port** check box. Selecting this option allows the system to determine what caused the trigger. The width of the signal is the width of the triggering signal. The signal value is

- 1 for a signal that causes a rising trigger
- -1 for a signal that causes a falling trigger
- 2 for a function-call trigger
- 0 otherwise

Data Type Support

The Trigger block accepts signals of any data type supported by Simulink, including fixed-point data types.

For a discussion on the data types supported by Simulink, see "Data Types Supported by Simulink" in the Simulink documentation.

Parameters and Dialog Box
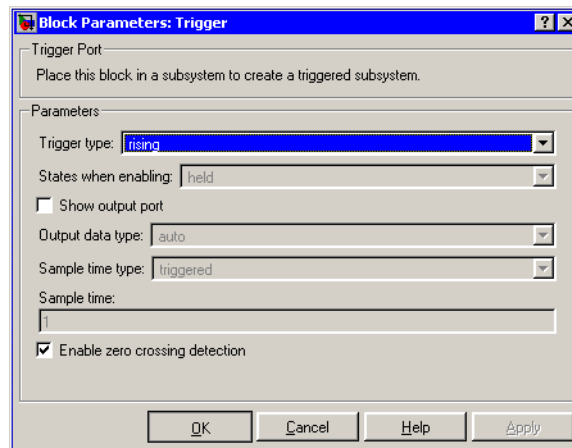
Trigger type

The type of event that triggers execution of the subsystem.

States when enabling

This option is enabled only if you select function-call as the block's trigger type. It specifies whether a function-call enable trigger causes Simulink to reset the states of the subsystem containing this Trigger block to their initial values.
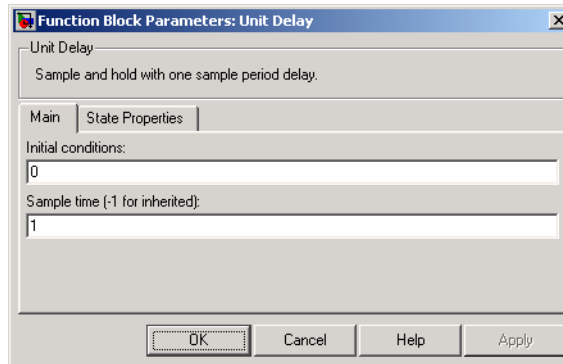
Selecting held (the default) causes Simulink to leave the states at their current values.

Selecting reset for this option causes Simulink to reset the states.

Selecting inherit causes the trigger's held/reset setting to be the same as that of the function-call initiator's parent subsystem, for example, an enabled subsystem, or the model's root system if the function-call initiator is at the model's root level. If the parent of the initiator is the model root, the inherited setting is held. If the trigger has multiple initiators and its **States when enabling** setting is inherit, the parents of all initiators must have the same held/reset setting, i.e., either all held or all reset. For more information about the **States when enabling** setting, see "Function-Call Subsystems" in the "Implementing Block Features" section of *Writing S-Functions*.

Show output port

If selected and this block is in a subsystem, Simulink displays the Trigger block output port and outputs the trigger signal. Simulink does not allow you to log the output of this port if the block's **Trigger type** is function-call.

Note This option is disabled for function-call Trigger blocks residing at the root-level of a model.

Output data type

Specifies the data type (double or int8) of the trigger output. If you select auto, Simulink sets the data type to be the same as

that of the port to which the output is connected. If the port's data type is not `double` or `int8`, Simulink signals an error.

Note The Trigger block ignores the **Data Type Override** setting of the Fixed-Point Settings interface.

Enable zero crossing detection

Select to enable zero crossing detection. For more information, see "Zero Crossing Detection" in the "How Simulink Works" chapter of the Using Simulink documentation.

Sample time type

This parameter is active only when **Trigger type** is set to `function-call`. Its value may be `triggered` or `periodic`. Select `periodic` if the caller of the parent function-call subsystem, for example, a Stateflow chart, calls the subsystem once per time step when the subsystem is active (enabled). Otherwise, select `triggered`. See "Using Bind Actions to Control Function-Call Subsystems" in *Using Stateflow* and the "Function-Call Subsystems" section of *Writing S-functions* for more information.

Sample time

This parameter is active only when the **Trigger type** is `function-call` and the **Sample time type** is `periodic`. Set this parameter to the sample time at which you expect the function-call subsystem that contains this block to be called. See "Specifying Sample Time" in the online documentation for information on how to the value of this parameter. Simulink displays an error if the actual rate at which the subsystem is called differs from the rate that this parameter specifies.

Characteristics

Sample Time	Determined by the sample time parameter if the trigger type is function-call and the sample time type is periodic; otherwise, by the signal at the trigger port.
Dimensionalized	Yes
Zero Crossing	Yes, if enabled

Trigger-Based Linearization

Purpose   Generate linear models in the base workspace when triggered

Library   Model-Wide Utilities
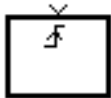
Description   When triggered, this block calls `linmod` or `dlinmod` to create a linear model for the system at the current operating point. No trimming is performed. The linear model is stored in the base workspace as a structure, along with information about the operating point at which the snapshot was taken. Multiple snapshots are appended to form an array of structures.

The name of the structure used to save the snapshots is the name of the model appended by `_Trigger_Based_Linearization`, for example, `vdp_Trigger_Based_Linearization`. The structure has the follow fields:

Field	Description
a	The A matrix of the linearization
b	The B matrix of the linearization
c	The C matrix of the linearization
d	The D matrix of the linearization
StateName	Names of the model's states
OutputName	Names of the model's output ports
InputName	Names of the model's input ports
OperPoint	A structure that specifies the operating point of the linearization. The structure specifies the value of the model's states (`OperPoint.x`) and inputs (`OperPoint.u`) at the operating point time (`OperPoint.t`).
Ts	The sample time of the linearization for a discrete linearization

Use the Time-Based Linearization block to generate linear models at predetermined times.

Data Type Support

The trigger port accepts signals of any data type supported by Simulink.

Parameters and Dialog Box

Block Parameters: Trigger-Based Linearization
Triggered Linearization (mask) (link)
Generates linear models in the base workspace when triggered.
Parameters
Trigger type: rising
Sample time (of linearized model):
0
OK Cancel Help Apply
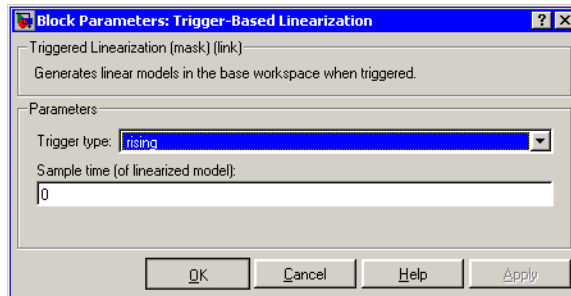
Trigger type

Type of event on the trigger input signal that triggers generation of a linear model. See the **Trigger type** parameter of the Trigger block for an explanation of the various trigger types that you can select.

Sample time (of linearized model)

Specify a sample time to create a discrete-time linearization of the model (see "Discrete-Time System Linearization" on page 3-6).

Characteristics

Sample Time	Specified in the **Sample time** parameter
Dimensionalized	No

Triggered Subsystem

Purpose   Represent a subsystem whose execution is triggered by external input

Library   Ports & Subsystems

Description   This block is a Subsystem block that is preconfigured to serve as
the starting point for creating a triggered subsystem (see "Triggered
Subsystems").
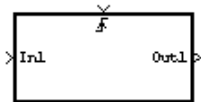
Purpose   Perform a trigonometric function

Library   Math Operations

Description   The Trigonometric Function block performs numerous common
                     trigonometric functions.

                     You can select one of these functions from the **Function** list: sin, cos,
                     tan, asin, acos, atan, atan2, sinh, cosh, tanh, asinh, acosh, and
                     atanh. The block output is the result of the operation of the function on
                     the input or inputs.

                     The name of the function appears on the block. If you select the atan2
                     function, the block displays two inputs. The first (upper) input is the
                     y-axis or complex part of the function argument. The second (lower)
                     input is the x-axis or real part of the function argument.

                     Use the Trigonometric Function block instead of the Fcn block when
                     you want dimensionalized output, because the Fcn block can produce
                     only scalar output.

**Data Type   The Trigonometric Function block accepts and outputs real or complex
Support**   signals of type double.

**Parameters
and
Dialog
Box**
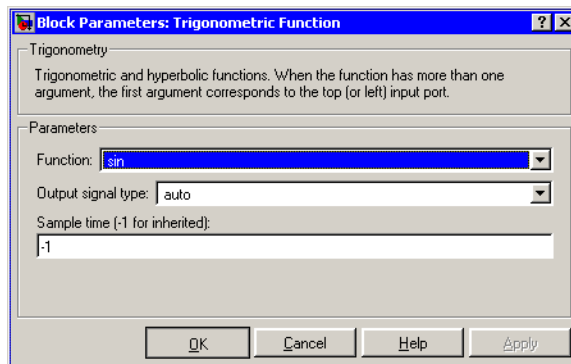
Trigonometric Function

Function
>   The trigonometric function.

Output signal type
>   Type of signal (complex or real) to output.

Sample time (-1 for inherited)
>   Specify the time interval between samples. To inherit the sample time, set this parameter to -1. See "Specifying Sample Time" in the online documentation for more information.

Characteristics

Direct Feedthrough	Yes
Sample Time	Inherited from driving block
Scalar Expansion	Yes, of the input when the function requires two inputs
Dimensionalized	Yes
Zero Crossing	No

Unary Minus

Purpose   Negate the input

Library   Math Operations

Description   The Unary Minus block negates the input. The block accepts only signed data types.
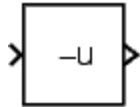
For signed data types, you cannot accurately negate the most negative value since the result is not representable by the data type. In this case, the behavior of the block is controlled by the **Saturate to max or min when overflows occur** check box. If selected, the most negative value of the data type wraps to the most positive value. If not selected, the operation has no effect. If an overflow occurs, then a warning is returned to the MATLAB command line.

For example, suppose the block input is an 8-bit signed integer. The range of this data type is from -128 to 127, and the negation of -128 is not representable. If you select the **Saturate to max or min when overflows occur** check box, then the negation of -128 is 127. If it is not selected, then the negation of -128 remains at -128.

Data Type Support   The Unary Minus block accepts signals of any data type supported by Simulink except unsigned integers, including fixed-point data types.

Parameters and Dialog Box

![Block Parameters: Unary Minus dialog box]
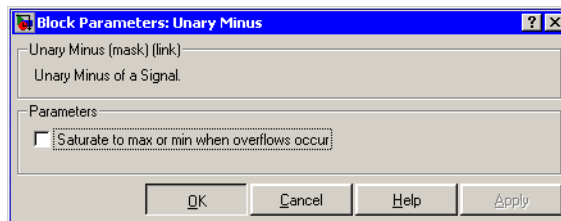
Saturate to max or min when overflows occur
    If selected, fixed-point overflows saturate.

Unary Minus

Characteristics

Direct Feedthrough	No
Scalar Expansion	Yes, of input or initial conditions

Uniform Random Number

Purpose Generate uniformly distributed random numbers

Library Sources

Description The Uniform Random Number block generates uniformly distributed random numbers over a specifiable interval with a specifiable starting seed. The seed is reset each time a simulation starts. The generated sequence is repeatable and can be produced by any Uniform Random Number block with the same seed and parameters. To generate normally distributed random numbers, use the `Random Number` block.

Avoid integrating a random signal, because solvers are meant to integrate relatively smooth signals. Instead, use the Band-Limited White Noise block.

The block's numeric parameters must be of the same dimensions after scalar expansion. If the **Interpret vector parameters as 1-D** option is off, the block outputs a signal of the same dimensions and dimensionality as the parameters. If the **Interpret vector parameters as 1-D** option is on and the numeric parameters are row or column vectors (i.e., single row or column 2-D arrays), the block outputs a vector (1-D array) signal; otherwise, the block outputs a signal of the same dimensions as the parameters.

Data Type Support The Uniform Random Number block outputs a real signal of type `double`.

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Uniform Random Number

Parameters and Dialog Box
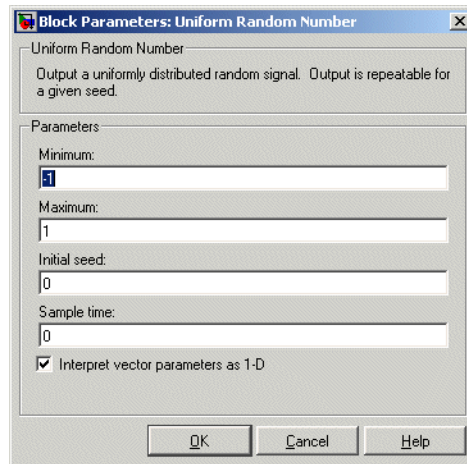
Opening this dialog box causes a running simulation to pause. See "Changing Source Block Parameters" in the online Simulink documentation for details.

Minimum

    The minimum of the interval. The default is `-1`.

Maximum

    The maximum of the interval. The default is `1`.

Initial seed

    The starting seed for the random number generator. The default is `0`.

Sample time

    The sample period. The default is `0`. See "Specifying Sample Time" in the online documentation for more information.

Interpret vector parameters as 1-D

    If selected, column or row matrix values for the Step block's numeric parameters result in a vector output signal; otherwise, the block outputs a signal of the same dimensionality as the parameters. If this option is not selected, the block always outputs a signal of the same dimensionality as the block's numeric

parameters. See "Determining the Output Dimensions of Source Blocks" in the "Working with Signals" chapter of the Using Simulink documentation.

Characteristics

Sample Time	Specified in the **Sample time** parameter
Scalar Expansion	No
Dimensionalized	Yes
Zero Crossing	No

Unit Delay

Purpose   Delay a signal one sample period

Library   Discrete
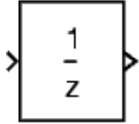
Description   The Unit Delay block delays its input by the specified sample period.
                     This block is equivalent to the z^{-1} discrete-time operator. The block
                     accepts one input and generates one output, which can be either both
                     scalar or both vector. If the input is a vector, all elements of the vector
                     are delayed by the same sample period.

                     You specify the block output for the first sampling period with the
                     Initial conditions parameter. Careful selection of this parameter can
                     minimize unwanted output behavior. The time between samples is
                     specified with the **Sample time** parameter. A setting of -1 means the
                     sample time is inherited.

Note The Unit Delay block accepts continuous signals. When it has
a continuous sample time, the block is equivalent to the Simulink
Memory block.

The Unit Delay block provides a mechanism for discretizing one or more
signals in time.

Note Do not use the Unit Delay block to create a slow-to-fast transition
between blocks operating at different sample rates. Instead, use the
Rate Transition block.

Data Type Support   The Unit Delay block accepts real or complex signals of any data type
                            supported by Simulink, including fixed-point data types. If the data type
                            of the input signal is user-defined, the initial condition must be zero.

                            For a discussion on the data types supported by Simulink, see "Data
                            Types Supported by Simulink" in the Simulink documentation.

Unit Delay

Dimensionalized	Yes
Zero Crossing	No

Purpose   Delay a signal one sample period, if the external enable signal is on

Library   Additional Math & Discrete / Additional Discrete
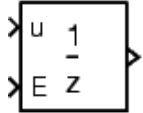
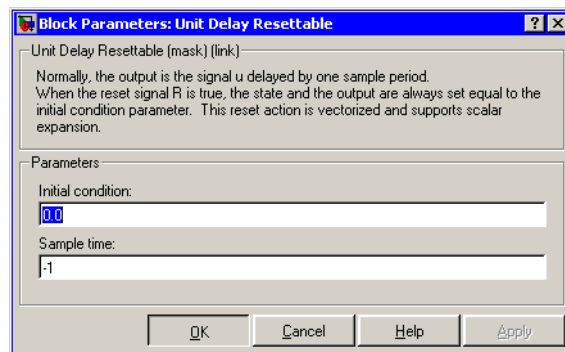**Description**   The Unit Delay Enabled block delays a signal by one sample period when the external enable signal E is on. While the enable is off, the block is disabled. It holds the current state at the same value and outputs that value. The enable signal is on when E is not 0, and off when E is 0.

You specify the block output for the first sampling period with the value of the **Initial condition** parameter.

The output data type is the same as the input u data type. The data type of the input u and the enable E can be any data type.

You input the sample time with the **Sample time** parameter. A setting of -1 means the **Sample time** is inherited.

Data Type Support   The Unit Delay Enabled block accepts signals of any data type supported by Simulink, including fixed-point data types.

Parameters and Dialog Box

Block Parameters: Unit Delay Enabled

Unit Delay Enabled (mask) (link)

Normally, the output is the signal u delayed by one sample period.
When the enable signal is false, the block is disabled, and the state and output values do not change except for resets. The enable action is vectorized and supports scalar expansion.

Parameters

Initial condition:
0.0

Sample time:
-1

OK   Cancel   Help   Apply
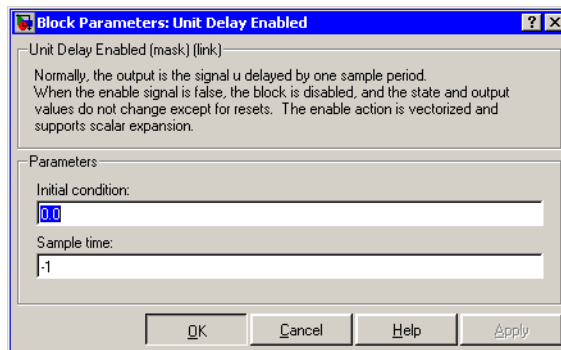
Initial condition
    Initial condition.

Unit Delay Enabled

Sample time

Specify the time interval between samples. To inherit the sample time, set this parameter to -1. See "Specifying Sample Time" in the online documentation for more information.

Characteristics

Direct Feedthrough	No
Sample Time	Specified in the **Sample time** parameter
Scalar Expansion	Yes

See Also   Unit Delay, Unit Delay Enabled External IC, Unit Delay Enabled Resettable, Unit Delay Enabled Resettable External IC, Unit Delay External IC, Unit Delay Resettable, Unit Delay Resettable External IC, Unit Delay With Preview Enabled, Unit Delay With Preview Enabled Resettable, Unit Delay With Preview Enabled Resettable External RV, Unit Delay With Preview Resettable, Unit Delay With Preview Resettable External RV

Purpose   Delay a signal one sample period, if the external enable signal is on, with an external initial condition

Library   Additional Math & Discrete / Additional Discrete

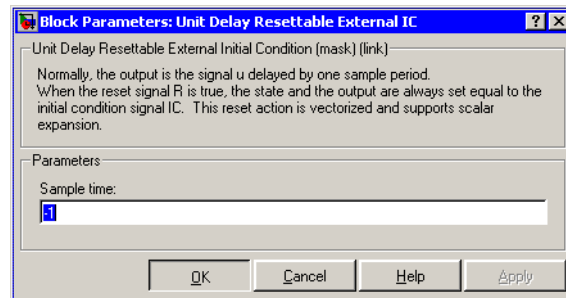**Description** The Unit Delay Enabled External IC block delays a signal by one sample period when the enable signal E is on. While the enable is off, the block holds the current state at the same value and outputs that value. The enable E is on when E is not 0, and off when E is 0.

The initial condition of this block is given by the signal IC.

The input u and IC data types must be the same, and are any data type. The output data type is the same as u and IC. The enable E is any data type.

You specify the time between samples with the **Sample time** parameter. A setting of -1 means the **Sample time** is inherited.

Data Type Support   The Unit Delay Enabled External IC block accepts signals of any data type supported by Simulink, including fixed-point data types.

Parameters and Dialog Box
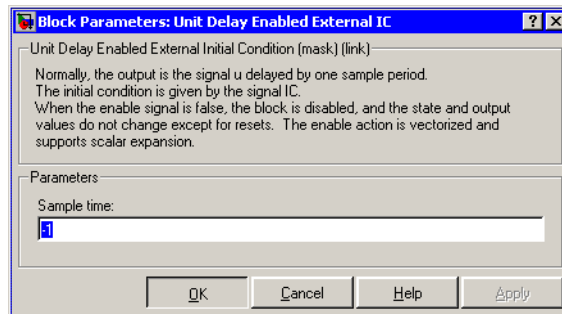
Sample time

Specify the time interval between samples. To inherit the sample time, set this parameter to -1. See "Specifying Sample Time" in the online documentation for more information.

Unit Delay Enabled External IC

Characteristics

Direct Feedthrough	Yes, of the reset input port
	No, of the enable input port
	Yes, of the external IC port
Sample Time	Specified in the **Sample time** parameter
Scalar Expansion	Yes

See Also   Unit Delay, Unit Delay Enabled, Unit Delay Enabled Resettable, Unit Delay Enabled Resettable External IC, Unit Delay External IC, Unit Delay Resettable, Unit Delay Resettable External IC, Unit Delay With Preview Enabled, Unit Delay With Preview Enabled Resettable, Unit Delay With Preview Enabled Resettable External RV, Unit Delay With Preview Resettable, Unit Delay With Preview Resettable External RV

Unit Delay Enabled Resettable

Parameters and Dialog Box

Initial condition

The initial output of the simulation.

Sample time

Specify the time interval between samples. To inherit the sample time, set this parameter to -1. See "Specifying Sample Time" in the online documentation for more information.

Characteristics

Direct Feedthrough	No, of the input port
	No, of the enable port
	Yes, of the reset port
Sample Time	Specified in the **Sample time** parameter
Scalar Expansion	Yes

See Also

Unit Delay, Unit Delay Enabled, Unit Delay Enabled External IC, Unit Delay Enabled Resettable External IC, Unit Delay External IC, Unit Delay Resettable, Unit Delay Resettable External IC, Unit Delay With Preview Enabled, Unit Delay With Preview Enabled Resettable, Unit

Delay With Preview Enabled Resettable External RV, Unit Delay With Preview Resettable, Unit Delay With Preview Resettable External RV

Unit Delay Enabled Resettable External IC
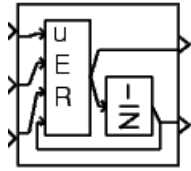
Purpose   Delay a signal one sample period, if the external enable signal is on, with an external Boolean reset and initial condition

Library   Additional Math & Discrete / Additional Discrete

Description   The Unit Delay Enabled Resettable External IC block combines the features of the Unit Delay Enabled, Unit Delay External IC, and Unit Delay Resettable blocks.

The block can reset its state based on an external reset signal R. When the enable signal E is on and the reset signal R is false, the block outputs the input signal delayed by one sample period.

When the enable signal E is on and the reset signal R is true, the block resets the current state to the initial condition given by the signal IC, and outputs that state delayed by one sample period.

When the enable signal is off, the block is disabled, and the state and output do not change except for resets. The enable signal is on when E is not 0, and off when E is 0.

The output data type is the same as the input u and the initial condition IC data type, which can be any data type, but must be the same. The enable E and reset R can be any data type.

You specify the time between samples with the **Sample time** parameter. A setting of -1 means the **Sample time** is inherited.

Data Type Support   The Unit Delay Enabled Resettable External IC block accepts signals of any data type supported by Simulink, including fixed-point data types.

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Unit Delay Enabled Resettable External IC

Purpose   Delay a signal one sample period, if the external enable signal is on, with an external Boolean reset and initial condition

Library   Additional Math & Discrete / Additional Discrete

Description   The Unit Delay Enabled Resettable External IC block combines the features of the Unit Delay Enabled, Unit Delay External IC, and Unit Delay Resettable blocks.

The block can reset its state based on an external reset signal R. When the enable signal E is on and the reset signal R is false, the block outputs the input signal delayed by one sample period.

When the enable signal E is on and the reset signal R is true, the block resets the current state to the initial condition given by the signal IC, and outputs that state delayed by one sample period.

When the enable signal is off, the block is disabled, and the state and output do not change except for resets. The enable signal is on when E is not 0, and off when E is 0.

The output data type is the same as the input u and the initial condition IC data type, which can be any data type, but must be the same. The enable E and reset R can be any data type.
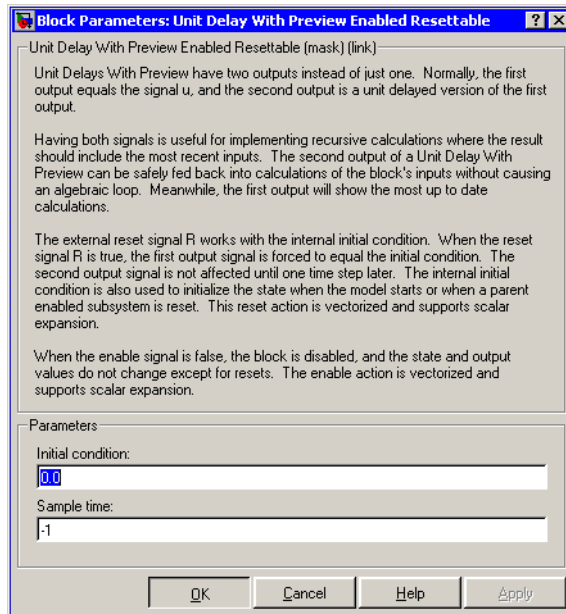
You specify the time between samples with the **Sample time** parameter. A setting of -1 means the **Sample time** is inherited.

Data Type Support   The Unit Delay Enabled Resettable External IC block accepts signals of any data type supported by Simulink, including fixed-point data types.

Parameters and Dialog Box

Block Parameters: Unit Delay Enabled Resettable External IC

Unit Delay Enabled Resettable External Initial Condition (mask) (link)

Normally, the output is the signal u delayed by one sample period.
When the reset signal R is true, the state and the output are always set equal to the initial condition signal IC. This reset action is vectorized and supports scalar expansion.
When the enable signal is false, the block is disabled, and the state and output values do not change except for resets. The enable action is vectorized and supports scalar expansion.

Parameters

Sample time:

-1

OK   Cancel   Help   Apply

Sample time

Specify the time interval between samples. To inherit the sample time, set this parameter to -1. See "Specifying Sample Time" in the online documentation for more information.

Characteristics

Direct Feedthrough	No, of the input port
	No, of the enable port
	Yes, of the enable port
	Yes, of the external IC port
Sample Time	Specified in the **Sample time** parameter
Scalar Expansion	Yes

See Also   Unit Delay, Unit Delay Enabled, Unit Delay Enabled External IC, Unit Delay Enabled Resettable, Unit Delay External IC, Unit Delay Resettable, Unit Delay Resettable External IC, Unit Delay With Preview Enabled, Unit Delay With Preview Enabled Resettable, Unit Delay With Preview Enabled Resettable External RV, Unit Delay With Preview Resettable, Unit Delay With Preview Resettable External RV

Unit Delay External IC

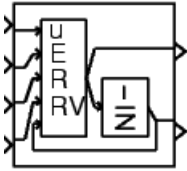**Purpose**   Delay a signal one sample period, with an external initial condition

Library   Additional Math & Discrete / Additional Discrete

Description   The Unit Delay External IC block delays its input by one sample period. This block is equivalent to the z^{-1} discrete-time operator. The block accepts one input and generates one output, both of which can be scalar or vector. If the input is a vector, all elements of the vector are delayed by the same sample period.
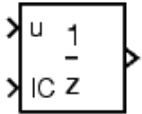
The block's output for the first sample period is equal to the signal IC.

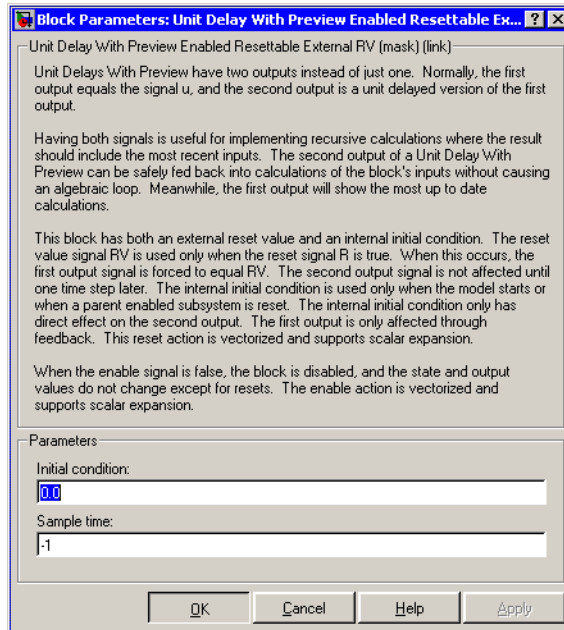The input u and initial condition IC data types must be the same, and are any data type.

You specify the time between samples with the **Sample time** parameter. A setting of -1 means the **Sample time** is inherited.

Data Type Support   The Unit Delay External IC block accepts signals of any data type supported by Simulink, including fixed-point data types.

Parameters and Dialog Box

Sample time

    Specify the time interval between samples. To inherit the sample time, set this parameter to -1. See "Specifying Sample Time" in the online documentation for more information.

Characteristics

Direct Feedthrough	No, of the input port
	Yes, of the external IC port
Sample Time	Specified in the **Sample time** parameter
Scalar Expansion	Yes

See Also   Unit Delay, Unit Delay Enabled, Unit Delay Enabled External IC, Unit Delay Enabled Resettable, Unit Delay Enabled Resettable External IC, Unit Delay Resettable, Unit Delay Resettable External IC, Unit Delay With Preview Enabled, Unit Delay With Preview Enabled Resettable, Unit Delay With Preview Enabled Resettable External RV, Unit Delay With Preview Resettable, Unit Delay With Preview Resettable External RV
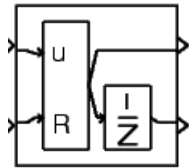
Unit Delay Resettable

Purpose   Delay a signal one sample period, with an external Boolean reset

Library   Additional Math & Discrete / Additional Discrete

Description   The Unit Delay Resettable block delays a signal one sample period.
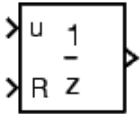
The block can reset its state based on an external reset signal R. The block has two input ports, one for the input signal u and the other for the external reset signal R. When the reset signal is false, the block outputs the input signal delayed by one time step. When the reset signal is true, the block resets the current state to the initial condition, specified by the **Initial condition** parameter, and outputs that state delayed by one time step.
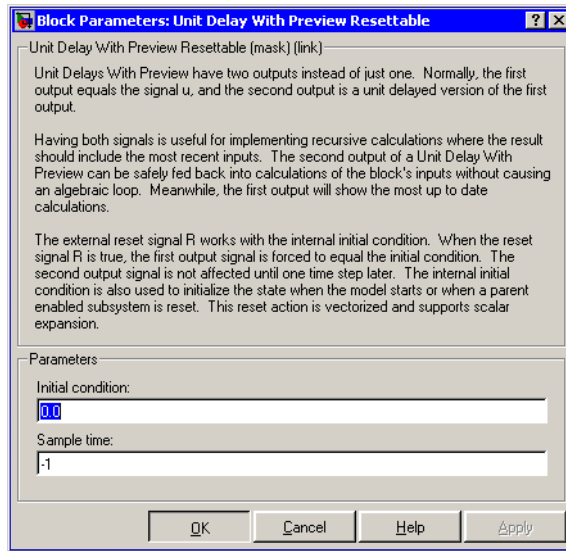
You specify the time between samples with the **Sample time** parameter. A setting of -1 means the **Sample time** is inherited.

Data Type Support   The Unit Delay Resettable block accepts signals of any data type supported by Simulink, including fixed-point data types.

Parameters and Dialog Box

Initial condition

    Specify the initial output of the simulation.

Sample time

Specify the time interval between samples. To inherit the sample time, set this parameter to -1. See "Specifying Sample Time" in the online documentation for more information.

Characteristics

Direct Feedthrough	No, of the input port
	Yes, of the reset port
Sample Time	Specified in the **Sample time** parameter
Scalar Expansion	Yes

See Also   Unit Delay, Unit Delay Enabled, Unit Delay Enabled External IC, Unit Delay Enabled Resettable, Unit Delay Enabled Resettable External IC, Unit Delay External IC, Unit Delay Resettable External IC, Unit Delay With Preview Enabled, Unit Delay With Preview Enabled Resettable, Unit Delay With Preview Enabled Resettable External RV, Unit Delay With Preview Resettable, Unit Delay With Preview Resettable External RV
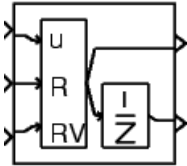
Unit Delay Resettable External IC

Purpose Delay a signal one sample period, with an external Boolean reset and initial condition

Library Additional Math & Discrete / Additional Discrete

Description The Unit Delay Resettable External IC block delays a signal one sample period.

The block can reset its state based on an external reset signal R. The block has two input ports, one for the input signal u and the other for the reset signal R. When the reset signal is false, the block outputs the input signal delayed by one time step. When the reset signal is true, the block resets the current state to the initial condition given by the signal IC and outputs that state delayed by one time step.

The input u and initial condition IC must be the same data type, but can be any data type. The output is the same data type as the inputs u and IC. The reset R can be any data type.

You specify the time between samples with the **Sample time** parameter. A setting of -1 means the **Sample time** is inherited.
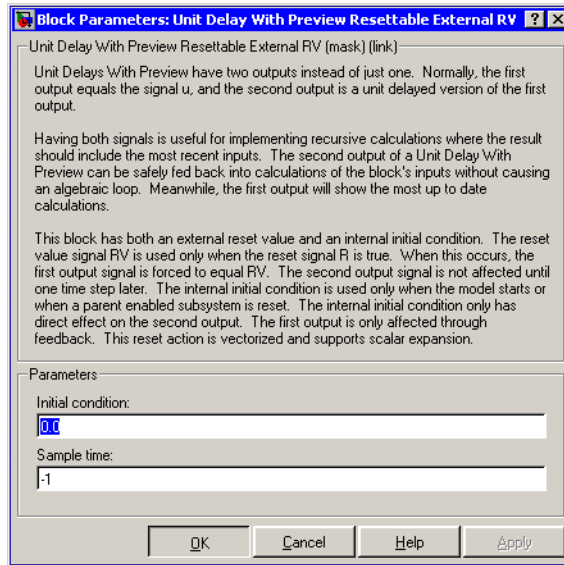
Data Type Support The Unit Delay Resettable External IC block accepts signals of any data type supported by Simulink, including fixed-point data types.

Parameters and Dialog Box

Block Parameters: Unit Delay Resettable External IC

Unit Delay Resettable External Initial Condition (mask) (link)

Normally, the output is the signal u delayed by one sample period. When the reset signal R is true, the state and the output are always set equal to the initial condition signal IC. This reset action is vectorized and supports scalar expansion.

Parameters

Sample time:

-1

OK   Cancel   Help   Apply

Sample time

Specify the time interval between samples. To inherit the sample time, set this parameter to -1. See "Specifying Sample Time" in the online documentation for more information.

Characteristics

Direct Feedthrough	No, of the input port
	Yes, of the reset port
	Yes, of the external IC port
Sample Time	Specified in the **Sample time** parameter
Scalar Expansion	Yes

See Also Unit Delay, Unit Delay Enabled, Unit Delay Enabled External IC, Unit Delay Enabled Resettable, Unit Delay Enabled Resettable External IC, Unit Delay External IC, Unit Delay Resettable, Unit Delay With Preview Enabled, Unit Delay With Preview Enabled Resettable, Unit Delay With Preview Enabled Resettable External RV, Unit Delay With Preview Resettable, Unit Delay With Preview Resettable External RV

Unit Delay With Preview Enabled

Purpose   Output the signal and the signal delayed by one sample period, if the external enable signal is on

Library   Additional Math & Discrete / Additional Discrete
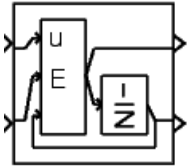
Description   The Unit Delay With Preview Enabled block supports calculations that have feedback and depend on the current input.

The block has two output ports. When the external enable signal E is on, the upper port outputs the signal and the lower port outputs the signal delayed by one sample period. The block has two input ports, one for the input signal u and the other for the enable signal E.

When the enable signal E is off, the block is disabled, and the state and output values do not change, except for resets. The enable signal is on when E is not 0, and off when E is 0.

You specify the block output for the first sampling period with the value of the **Initial condition** parameter.

The input u can be any data type. The output is the same data type as the input u.

You specify the time between samples with the **Sample time** parameter. A setting of -1 means the **Sample time** is inherited.

Data Type Support   The Unit Delay With Preview Enabled block accepts signals of any data type supported by Simulink, including fixed-point data types.

**Parameters
and
Dialog
Box**

Initial condition
> Specify the initial condition.

Sample time
> Specify the time interval between samples. To inherit the sample
> time, set this parameter to -1. See "Specifying Sample Time" in
> the online documentation for more information.

Characteristics

Direct Feedthrough	Yes, to upper output port
	No, to lower output port
Sample Time	Specified in the **Sample time** parameter
Scalar Expansion	Yes

See Also   Unit Delay, Unit Delay Enabled, Unit Delay Enabled External IC, Unit
Delay Enabled Resettable, Unit Delay Enabled Resettable External IC,
Unit Delay External IC, Unit Delay Resettable, Unit Delay Resettable
External IC, Unit Delay With Preview Enabled Resettable, Unit Delay

Unit Delay With Preview Enabled

With Preview Enabled Resettable External RV, Unit Delay With Preview Resettable, Unit Delay With Preview Resettable External RV

Purpose   Output the signal and the signal delayed by one sample period, if the
                  external enable signal is on, with an external Boolean reset

Library   Additional Math & Discrete / Additional Discrete

Description   The Unit Delay With Preview Enabled Resettable block supports
                  calculations that have feedback and depend on the current input.

The block can reset its state based on an external reset signal R. The
block has two output ports. When the external enable signal E is on and
the reset R is false, the upper port outputs the signal and the lower port
outputs the signal delayed by one sample period. The block has three
input ports, one for the input signal u, one for the enable signal E, and
one for the reset signal R.

When the enable signal E is on and the reset R is true, the block resets
the current state to the initial condition given by the **Initial condition**
parameter. The block outputs that state delayed by one sample time
through the lower output port, and outputs the state without a delay
through the upper output port.

When the Enable signal is off, the block is disabled, and the state and
output values do not change, except for resets. The enable signal is on
when E is not 0, and off when E is 0.

The input u can be any data type. The output is the same data type as
the input u. The reset R can be any data type.

You specify the time between samples with the **Sample time**
parameter. A setting of -1 means the **Sample time** is inherited.

Data Type   The Unit Delay With Preview Enabled Resettable block accepts signals
Support   of any data type supported by Simulink, including fixed-point data
                  types.

Unit Delay With Preview Enabled Resettable

Parameters and Dialog Box

Unit Delay With Preview Enabled Resettable (mask) (link)

Unit Delays With Preview have two outputs instead of just one. Normally, the first output equals the signal u, and the second output is a unit delayed version of the first output.

Having both signals is useful for implementing recursive calculations where the result should include the most recent inputs. The second output of a Unit Delay With Preview can be safely fed back into calculations of the block's inputs without causing an algebraic loop. Meanwhile, the first output will show the most up to date calculations.

The external reset signal R works with the internal initial condition. When the reset signal R is true, the first output signal is forced to equal the initial condition. The second output signal is not affected until one time step later. The internal initial condition is also used to initialize the state when the model starts or when a parent enabled subsystem is reset. This reset action is vectorized and supports scalar expansion.

When the enable signal is false, the block is disabled, and the state and output values do not change except for resets. The enable action is vectorized and supports scalar expansion.

Parameters

Initial condition:
0.0

Sample time:
-1

OK   Cancel   Help   Apply

Initial condition
Specify the initial condition.

Sample time
Specify the time interval between samples. To inherit the sample time, set this parameter to -1. See "Specifying Sample Time" in the online documentation for more information.

Characteristics

Direct Feedthrough	Yes, to upper output port
	No, to lower output port
Sample Time	Specified in the **Sample time** parameter
Scalar Expansion	Yes

See Also   Unit Delay, Unit Delay Enabled, Unit Delay Enabled External IC, Unit Delay Enabled Resettable, Unit Delay Enabled Resettable External IC, Unit Delay External IC, Unit Delay Resettable, Unit Delay Resettable External IC, Unit Delay With Preview Enabled, Unit Delay With Preview Enabled Resettable External RV, Unit Delay With Preview Resettable, Unit Delay With Preview Resettable External RV

Unit Delay With Preview Enabled Resettable External RV

Purpose Output the signal and the signal delayed by one sample period, if the external enable signal is on, with an external RV reset

Library Additional Math & Discrete / Additional Discrete

Description The Unit Delay With Preview Enabled Resettable External RV block supports calculations that have feedback and depend on the current input.

The block can reset its state based on an external reset signal R. The block has two output ports. When the external enable signal E is on and the reset R is false, the upper port outputs the signal and the lower port outputs the signal delayed by one sample period. The block has four input ports, one for the input signal u, one for the enable signal E, one for the reset signal R, and one for the external reset signal, RV.

When the enable signal E is on and the reset R is true, the upper output signal is forced to equal the external reset signal RV. The lower output signal is not affected until one time step later, at which time it is equal to the external reset signal RV at the previous time step. The block uses the internal **Initial condition** only when the model starts or when a parent enabled subsystem is used. The internal **Initial condition** only affects the lower output signal. The first output is only affected through feedback.

When the Enable signal is off, the block is disabled, and the state and output values do not change, except for resets. The enable signal is on when E is not 0, and off when E is 0.

The input u can be any data type. The output is the same data type as the input u. The reset R can be any data type.

You specify the time between samples with the **Sample time** parameter. A setting of -1 means the **Sample time** is inherited.

Data Type Support The Unit Delay With Preview Enabled Resettable External RV block accepts signals of any data type supported by Simulink, including fixed-point data types.

Unit Delay With Preview Enabled Resettable External RV

Parameters and Dialog Box

Initial condition
Specify the initial condition.

Sample time
Specify the time interval between samples. To inherit the sample time, set this parameter to -1. See "Specifying Sample Time" in the online documentation for more information.

Characteristics

Direct Feedthrough	Yes, to upper output port
	No, to lower output port
Sample Time	Specified in the **Sample time** parameter
Scalar Expansion	Yes

Unit Delay With Preview Enabled Resettable External RV

See Also   Unit Delay, Unit Delay Enabled, Unit Delay Enabled External IC, Unit Delay Enabled Resettable, Unit Delay Enabled Resettable External IC, Unit Delay External IC, Unit Delay Resettable, Unit Delay Resettable External IC, Unit Delay With Preview Enabled, Unit Delay With Preview Enabled Resettable, Unit Delay With Preview Resettable, Unit Delay With Preview Resettable External RV

Purpose   Output the signal and the signal delayed by one sample period, with an external Boolean reset

Library   Additional Math & Discrete / Additional Discrete

Description   The Unit Delay With Preview Resettable block supports calculations that have feedback and depend on the current input.

The block can reset its state based on an external reset signal R. The block has two output ports. When the reset R is false, the upper port outputs the signal and the lower port outputs the signal delayed by one sample period.

When the reset R is true, the block resets the current state to the initial condition given by the **Initial condition** parameter. The block outputs that state delayed by one sample time through the lower output port, and outputs the state without a delay through the upper output port.

The input u can be any data type. The output is the same data type as the input u. The reset R can be any data type.

You specify the time between samples with the **Sample time** parameter. A setting of -1 means the **Sample time** is inherited.

Data Type Support   The Unit Delay With Preview Resettable block accepts signals of any data type supported by Simulink, including fixed-point data types.

Unit Delay With Preview Resettable

Parameters and Dialog Box

Initial condition

Specify the initial condition.

Sample time

Specify the time interval between samples. To inherit the sample time, set this parameter to -1. See "Specifying Sample Time" in the online documentation for more information.

Characteristics

Direct Feedthrough	Yes, to upper output port
	No, to lower output port
Sample Time	Specified in the **Sample time** parameter
Scalar Expansion	Yes

See Also   Unit Delay, Unit Delay Enabled, Unit Delay Enabled External IC, Unit Delay Enabled Resettable, Unit Delay Enabled Resettable

External IC, Unit Delay External IC, Unit Delay Resettable, Unit Delay Resettable External IC, Unit Delay With Preview Enabled, Unit Delay With Preview Enabled Resettable, Unit Delay With Preview Enabled Resettable External RV, Unit Delay With Preview Resettable External RV

Unit Delay With Preview Resettable External RV

Purpose   Output the signal and the signal delayed by one sample period, with an external RV reset

Library   Additional Math & Discrete / Additional Discrete

Description   The Unit Delay With Preview Resettable External RV block supports calculations that have feedback and depend on the current input.

The block can reset its state based on an external reset signal R. The block has two output ports. When the external reset R is false, the upper port outputs the signal and the lower port outputs the signal delayed by one sample period.

When the external reset R is true, the upper output signal is forced to equal the external reset signal RV. The lower output signal is not affected until one time step later, at which time it is equal to the external reset signal RV at the previous time step. The block uses the internal **Initial condition** only when the model starts or when a parent enabled subsystem is used. The internal **Initial condition** only affects the lower output signal. The first output is only affected through feedback.

The input u can be any data type. The output is the same data type as the input u. The reset R can be any data type.

You specify the time between samples with the **Sample time** parameter**.** A setting of -1 means the **Sample time** is inherited.

Data Type Support   The Unit Delay With Preview Resettable External RV block accepts signals of any data type supported by Simulink, including fixed-point data types.

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Unit Delay With Preview Resettable External RV

**Parameters
and
Dialog
Box**

Initial condition
Specify the initial condition.

Sample time
Specify the time interval between samples. To inherit the sample time, set this parameter to -1. See "Specifying Sample Time" in the online documentation for more information.

Characteristics

Direct Feedthrough	Yes, to upper output port
	No, to lower output port
Sample Time	Specified in the **Sample time** parameter
Scalar Expansion	Yes

See Also   Unit Delay, Unit Delay Enabled, Unit Delay Enabled External IC, Unit Delay Enabled Resettable, Unit Delay Enabled Resettable

Unit Delay With Preview Resettable External RV

External IC, Unit Delay External IC, Unit Delay Resettable, Unit Delay Resettable External IC, Unit Delay With Preview Enabled, Unit Delay With Preview Enabled Resettable, Unit Delay With Preview Enabled Resettable External RV, Unit Delay With Preview Resettable

Variable Time Delay, Variable Transport Delay

Purpose   Delay the input by a variable amount of time

Library   Continuous

Description   The Variable Transport Delay and Variable Time Delay appear as two blocks in the Simulink block library. However, they are actually the same built-in Simulink block with different settings of a **Select delay type** parameter. This parameter allows you to specify that the block operate in either of the following modes.

Variable Time Delay

In this mode, the block has a data input, a time delay input, and a data output. The block's output at the current time step equals the value of its data input at a previous time equal to the current simulation time minus a delay time specified by the block's time delay input.

$$y(t) = u(t - t_0) = u(t - \tau(t))$$
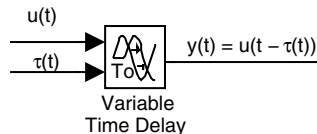
The block's **Maximum delay** parameter defines the largest value the time delay input can have. The block clips values of the delay that exceed this value. The **Maximum delay** must be greater than or equal to zero. If the time delay becomes negative, the block clips it to zero and issues a warning message.

During the simulation, the block stores time and input value pairs in an internal buffer. At the start of the simulation, the block outputs the value of the **Initial output** parameter until the simulation time exceeds the time delay input. Then, at each simulation step, the block outputs the signal at the time that corresponds to the current simulation time minus the delay time.

Variable Time Delay, Variable Transport Delay

When output is required at a time that does not correspond to the times of the stored input values and the solver is a continuous solver, the block interpolates linearly between points. If the time delay is smaller than the step size, the block extrapolates an output point from a previous point. For example, consider a fixed-step simulation with a step size of 1 and the current time at t = 5. If the delay is 0.5, the block needs to generate a point at t = 4.5. Because the most recent stored time value is at t = 4, the block extrapolates the input at 4.5 from the input at 4 and uses the extrapolated value as its output at t = 5.

Extrapolating forward from the previous time step can produce a less accurate result than extrapolating back from the current time step. However, the block cannot use the current input to calculate its output value because the input port does not have direct feedthrough.

If the model specifies a discrete solver, the block does not interpolate between time steps. Instead, it returns the nearest stored value that precedes the required value.

Variable Transport Delay

In this mode, the block's output at the current time step is equal to the value of its data input at an earlier time equal to the current time minus a transportation delay

$$y(t) = u(t - t_d(t))$$

Simulink finds the transportation delay, $t_d(t)$, by solving the following equation

$$\int_{t-t_d(t)}^{t} \frac{1}{t_i(\tau)} d\tau = 1$$

This equation involves an instantaneous time delay, $t_i(t)$, given by the block's time delay input.

Variable
Transport Delay
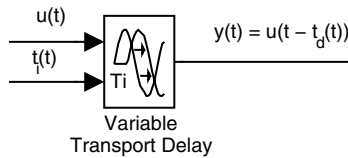
For example, suppose you want to use this block to model the flow of a fluid through a pipe where the speed of the flow varies with time. In this case, the time delay input to the block would be

$$t_i(t) = \frac{L}{v_i(t)}$$

where L is the length of the pipe and $v_i(t)$ is the speed of the fluid.

Data Type Support

The Variable Time Delay and Variable Transport Delay blocks accept and output real signals of type `double`.

Parameters and Dialog Box

The block's parameters and dialog box differ, depending on whether it is operating in variable time or variable transport delay mode. Most parameters exist in both modes. The following sections note parameters that exist only in one mode.

Variable Time Delay Parameters and Dialog Box

The dialog box for the Variable Time Delay block appears as follows.

Variable Time Delay, Variable Transport Delay
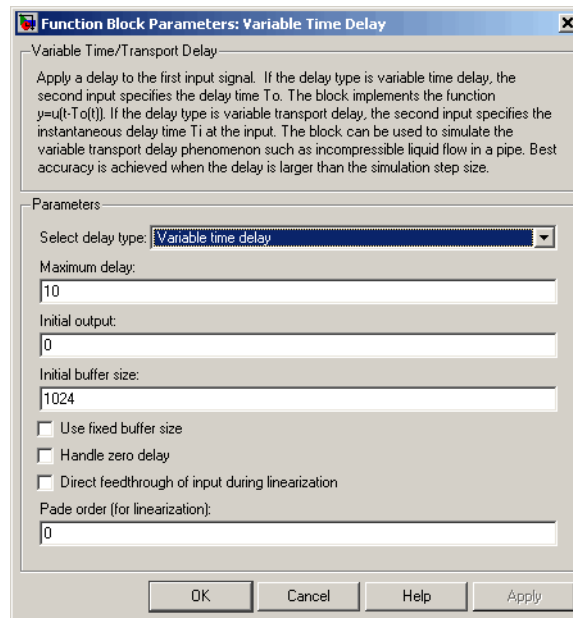
Select delay type

> The delay type of the block. The Variable Time Delay block in the Simulink library has a preset value of `Variable time delay`. The Variable Transport Delay block has a preset value of `Variable transport delay`.

Maximum delay

> The maximum value of the time delay input. The value cannot be negative. The default is `10`.

Initial output

> The output generated by the block until the simulation time first exceeds the time delay input. The default is `0`. Simulink does not allow the initial output of this block to be `inf` or `NaN`.

Initial buffer size

> Initial size of the buffer used to store previous input values. The default is `1024`.

Use fixed buffer size

Specifies use of a fixed-size buffer to save input data from previous time steps. The **Initial buffer size** parameter specifies the buffer's size. If the buffer is full, new data replaces data already in the buffer. Simulink uses linear extrapolation to estimate the output value if it is not in the buffer. This option can save memory if the input data is linear. If the input is not linear, this option may yield inaccurate results.

Note ERT or GRT code generation uses a fixed-size buffer even if you do not select this check box.

Handle zero delay

For Variable time delay mode. Turns this block into a direct feedthrough block.

Direct feedthrough of input during linearization

Causes the block to output its input during linearization and trim. This sets the block's mode to direct feedthrough.

Enabling this check box can cause a change in the ordering of states in the model when using the functions linmod, dlinmod, or trim. To extract this new state ordering, use the following commands.

First compile the model using the following command, where model is the name of the Simulink model.

```
[sizes, xO, x_str] = model([],[],[],'lincompile');
```

Next, terminate the compilation with the following command.

```
model([],[],[],'term');
```

The output argument, x_str, which is a cell array of the states in the Simulink model, contains the new state ordering. When

passing a vector of states as input to the `linmod`, `dlinmod`, or `trim` functions, the state vector must use this new state ordering.

Pade order (for linearization)

The order of the Pade approximation for linearization routines. The default value is `0`, which results in a unity gain with no dynamic states. Setting the order to a positive integer `n` adds `n` states to your model, but results in a more accurate linear model of the transport delay.

Variable Transport Delay Parameters and Dialog Box

The block's dialog box in Variable Transport Delay mode appears as follows.
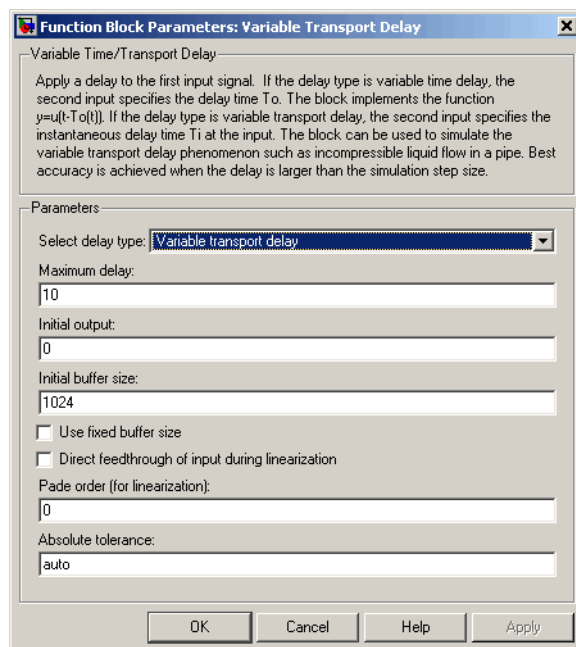
This mode adds the following parameter.

Absolute tolerance

Absolute tolerance used to solve the block's states. You can enter `auto` or a numeric value. If you enter `auto`, Simulink determines the absolute tolerance (see "Absolute tolerance"). If you enter a numeric value, Simulink uses the specified value to solve the block's states. Note that a numeric value overrides the setting for the absolute tolerance in the **Configuration Parameters** dialog box.

Characteristics

Direct Feedthrough	Yes, of the time delay (second) input
Sample Time	Continuous
Scalar Expansion	Yes, of input and all parameters except **Initial buffer size**
Dimensionalized	Yes
Zero Crossing	No

Weighted Moving Average

Purpose   Implement a weighted moving average

Library   Discrete

Description
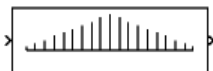
The Weighted Moving Average block samples and holds the N most recent inputs, multiplies each input by a specified value (given by the **Weights** parameter), and stacks them in a vector. This block supports both single-input/single-output (SISO) and single-input/multi-output (SIMO) modes.

For the SISO mode, the **Weights** parameter is specified as a row vector. For the SIMO mode, the weights are specified as a matrix where each row corresponds to a separate output.

The **Initial condition** parameter provides the initial values for all times preceding the start time. You specify the time interval between samples with the **Sample time** parameter.

You can choose whether or not to specify the data type and scaling of the weights in the dialog with the **Gain data type and scaling** parameter. If you select Specify via dialog for this parameter, the **Parameter data type**, **Parameter scaling**, and **Parameter scaling mode** parameters become visible.

You can specify the scaling for the weights with the **Parameter scaling** and **Parameter scaling mode** parameters. If **Parameter data type** is a generalized fixed-point number such as sfix(16), the **Parameter scaling mode** list provides you with these scaling modes:

- Use Specified Scaling–This mode uses the [Slope Bias] or binary point-only scaling specified by the **Parameter scaling** parameter (for example, 2^-10).

- Best Precision: Element-wise–This mode produces binary points such that the precision is maximized for each element of the **Weights** parameter.

- Best Precision: Row-wise–This mode produces a common binary point for each element of the **Weights** row based on the best precision for the largest value of that row.

- `Best Precision: Column-wise`—This mode produces a common binary point for each element of the **Weights** column based on the best precision for the largest value of that column.

- `Best Precision: Matrix-wise`—This mode produces a common binary point for each element of the **Weights** matrix based on the best precision for the largest value of the matrix.

If the weights are specified as a row vector, then scaling element-wise and column-wise produce the same result, while scaling matrix-wise and row-wise produce the same result.

The Weighted Moving Average block first multiplies its inputs by the **Weights** parameter, converts those results to the output data type using the specified rounding and overflow modes, and then carries out the summation.

Data Type Support

The Weighted Moving Average block supports all data types supported by Simulink, including fixed-point data types.

Parameters and Dialog Box

The **Main** pane of the Weighted Moving Average block dialog appears as follows:
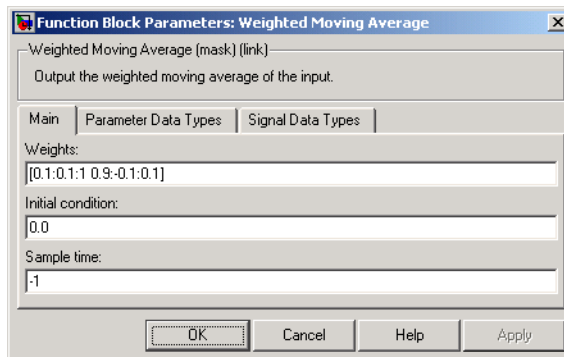
Weighted Moving Average

Weights

Specify the weights of the moving average; one row per output. The **Weights** parameter is converted from doubles to the specified data type offline using round-to-nearest and saturation.

Initial condition

Specify the initial values for all times preceding the start time. The **Initial condition** parameter is converted from doubles to the input data type offline using round-to-nearest and saturation.

Sample time

Specify the time interval between samples. To inherit the sample time, set this parameter to -1. See Specifying Sample Time in the online documentation for more information.

The **Parameter Data Types** pane of the Weighted Moving Average block dialog appears as follows:
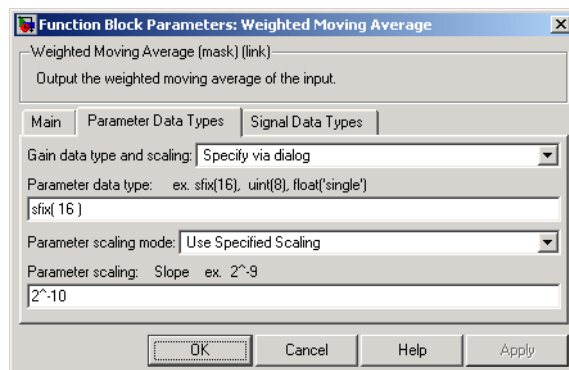
Gain data type and scaling

Choose whether to specify the data type of the weights in the block dialog or via an internal rule. If you select Specify via dialog, the **Parameter data type**, **Parameter scaling**, and **Parameter scaling mode** parameters become visible.

Parameter data type

Specify the data type of the weights. This parameter is only visible if you select `Specify via dialog` for the **Gain data type and scaling** parameter.

Parameter scaling mode

This drop-down list enables you to specify the parameter scaling in the dialog or by an inherited rule. This parameter is only visible if you select `Specify via dialog` for the **Gain data type and scaling** parameter.

Parameter scaling

Set the scaling of the weights using binary point-only or [Slope Bias] scaling. Additionally, the **Weights** vector or matrix can be scaled using the constant vector or constant matrix scaling modes for maximizing precision. These scaling modes are available only for generalized fixed-point data types. This parameter is only visible if you select `Specify via dialog` for the **Gain data type and scaling** parameter.

The **Signal Data Types** pane of the Weighted Moving Average block dialog appears as follows:
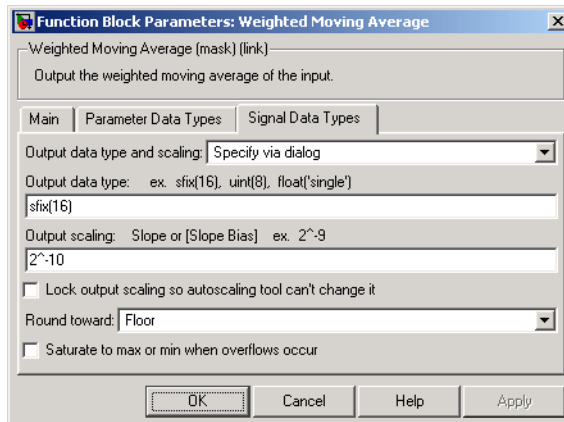
Weighted Moving Average

Output data type and scaling
> Specify the output data type and scaling via the dialog box, or inherit the data type and scaling from the driving block or by backpropagation.

Output data type
> Specify the output data type.

Output scaling
> Set the output scaling using binary point-only or [Slope Bias] scaling. These scaling modes are available only for generalized fixed-point data types.

Lock output scaling so autoscaling tool can't change it
> If selected, **Output scaling** is locked. This feature is available only for generalized fixed-point output.

Round toward
> Rounding mode for the fixed-point output.

Saturate to max or min when overflows occur
> If selected, fixed-point overflows saturate.

Examples   Suppose you want to configure this block for two outputs (SIMO mode) where the first output is given by

$$y_1(k) = a_1 \cdot u(k) + b_1 \cdot u(k-1) + c_1 \cdot u(k-2)$$

the second output is given by

$$y_2(k) = a_2 \cdot u(k) + b_2 \cdot u(k-1)$$

and the initial values of $u(k - 1)$ and $u(k - 2)$ are given by ic1 and ic2, respectively. To configure the Weighted Moving Average block for this situation, you must specify the **Weights** parameter as [a1 b1 c1; a2 b2 c2] where c2 = 0, and the **Initial condition** parameter as [ic1 ic2].

Characteristics

Direct Feedthrough	Yes
Scalar Expansion	Yes, of initial conditions

Weighted Sample Time

Purpose   Support calculations involving sample time

Library   Signal Attributes

Description   The Weighted Sample Time block is an implementation of the Weighted
                     Sample Time Math block. See `Weighted Sample Time Math` for more
                     information.

> Ts >
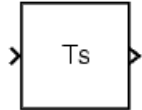
Purpose   Support calculations involving sample time

Library   Math Operations

Description   The Weighted Sample Time Math block adds, subtracts, multiplies, or divides the input signal, u, by a weighted sample time Ts.

You specify the math operation with the **Operation** parameter. Additionally, you can specify to use only the weight with either the sample time or its inverse.

Enter the weighting factor in the **Weight value** parameter. If the weight is 1, w is removed from the equation.

Data Type Support   The Weighted Sample Time Math block accepts signals of any data type supported by Simulink, including fixed-point data types.

Parameters and Dialog Box   The **Main** pane of the Weighted Sample Time Math block dialog appears as follows:
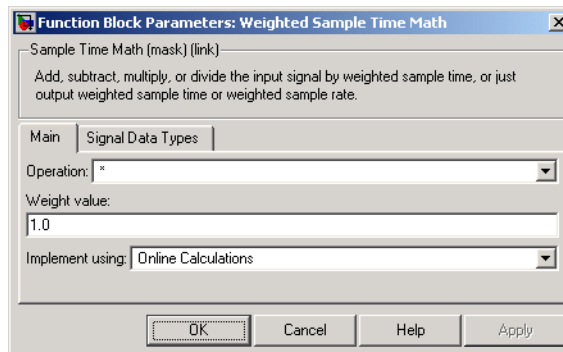
Operation
Specify operation to use: +, -, *, /, Ts only, 1/Ts only.

Weight value
Enter weight of sample time.

Weighted Sample Time Math

Implement using

Specify online calculations or offline scaling adjustment. This parameter is only visible for some **Operation** parameter settings.

The **Signal Data Types** pane of the Weighted Sample Time Math block dialog appears as follows:
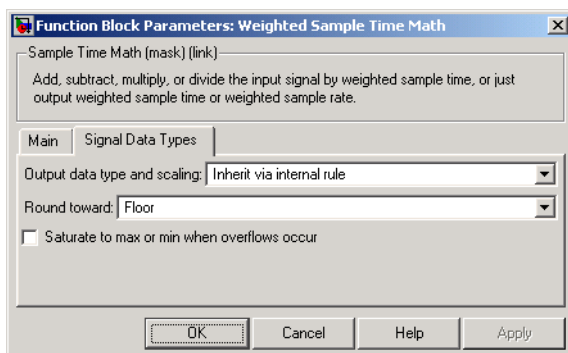
Output data type and scaling

Specify whether the output data type and scaling are inherited by an internal rule or by backpropagation.

Round toward

Select the rounding mode for fixed-point operations. This parameter is only visible if you select Online Calculations for the **Implement using** parameter.

Saturate to max or min when overflows occur

If selected, fixed-point overflows saturate. This parameter is only visible if you select Online Calculations for the **Implement using** parameter.

Characteristics

Direct Feedthrough	For all math operations options except Ts and 1/Ts
Scalar Expansion	No, the weight is always a scalar

Purpose   Repeatedly execute the contents of a subsystem at the current time
                step while a condition is satisfied.

Library   Ports & Subsystems / While Iterator Subsystem
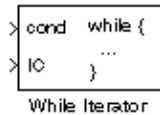
Description The While Iterator block, when placed in a subsystem, repeatedly
                 executes the contents of the subsystem at the current time step while a
                 specified condition is true.

```
> cond   while {
          ...
> IC      }
```
While Iterator

Note Placing a While Iterator block in a subsystem makes it an atomic
subsystem if it is not already an atomic subsystem.

You can use this block to implement the block-diagram equivalent of
a C program `while` or `do-while` loop. In particular, the block's **While
loop style** parameter allows you to choose either of the following while
loop modes:

• `do-while`

  In this mode, the While Iterator block has one input, the while
  condition input, whose source must reside in the subsystem. At each
  time step, the block runs all the blocks in the subsystem once and
  then checks whether the while condition input is true. If the input is
  true, the iterator block runs the blocks in the subsystem again. This
  process continues as long as the while condition input is true and
  the number of iterations is less than or equal to the iterator block's
  Maximum number of iterations parameter.

• `while`

  In this mode, the iterator block has two inputs: a while condition
  input and an initial condition (IC) input. The source of the initial
  condition signal must be external to the while subsystem. At the
  beginning of the time step, if the IC input is true, the iterator block
  executes the contents of the subsystem and then checks the while
  condition input. If the while condition input is true, the iterator

While Iterator

executes the subsystem again. This process continues as long as the while condition input is true and the number of iterations is less than or equal to the iterator block's **Maximum number of iterations** parameter. If the IC input is false at the beginning of a time step, the iterator does not execute the contents of the subsystem during the time step.

Note Unless you are certain that the while condition will become false at some point in the simulation, you should specify a maximum number of iterations to avoid endless loops, which can be broken only by terminating MATLAB.

The While Iterator block can optionally output the current iteration number, starting at 1. The following example uses this capability to compute N, where N is the first N integers whose sum is less than 100.
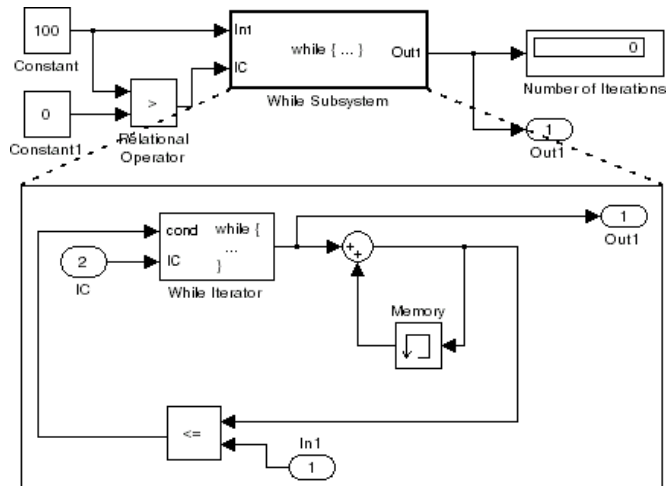
This example is the diagrammatic equivalent to the following pseudocode.

```
max_sum = 100;
sum = 0;
iteration_number = 0;
cond = (max_sum > 0);
while (cond != 0) {
 iteration_number = iteration_number + 1;
 sum = sum + iteration_number;
 if (sum > max_sum OR iteration_number > max_iterations)
  cond = 0;
}
```

Data Type Support

Acceptable data inputs for the condition ports are any type supported by Simulink, as well as any fixed-point type, that includes a 0 value. For a discussion on the data types supported by Simulink, see "Data Types Supported by Simulink" in the Simulink documentation.

The While Iterator block's optional output port can output any of the following data types: double, int32, int16, or int8.

Parameters and Dialog Box
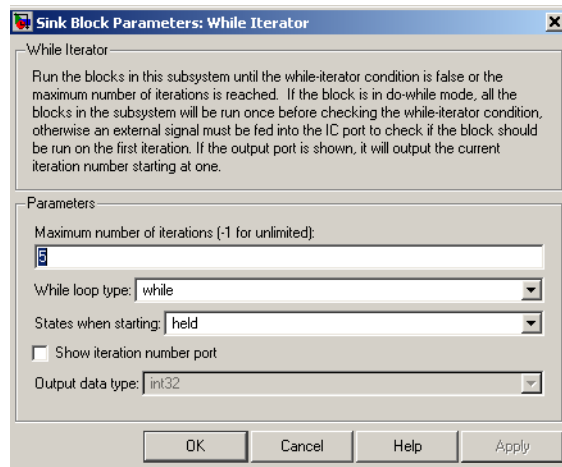
While Iterator

Maximum number of iterations

> The maximum number of iterations allowed. A value of -1 allows any number of iterations as long as the while condition input is true. Note that if you specify -1 and the while condition never becomes false, the simulation will run forever. In this case, the only way to stop the simulation is to terminate the MATLAB process. Therefore, you should not specify -1 as the value of this parameter unless you are certain that the while condition will become false at some point in the simulation.

While loop style

> Specifies the type of while loop implemented by this block. See the preceding block description for more information.

States when starting

> Set this field to `reset` if you want the iterator block to reset the states of the blocks in the while subsystem to their initial values at the beginning of each time step (i.e., before executing the first loop iteration in the current time step). To cause the states of blocks in the subsystem to persist across time steps, set this field to `held` (the default).

Show iteration number port

> If you select this check box, the While Iterator block outputs its iteration value. This value starts at `1` and is incremented by `1` for each succeeding iteration. By default, this check box is not selected.

Output data type

> If you select the **Show iteration number port** check box (the default), this field is enabled. Use it to set the data type of the iteration number output to `int32`, `int16`, `int8`, or `double`.

Characteristics

Direct Feedthrough	No
Sample Time	Inherited from driving block
Scalar Expansion	No

Dimensionalized	No
Zero Crossing	No

While Iterator Subsystem

Purpose   Represent a subsystem that executes repeatedly while a condition is satisfied during a simulation time step

Library   Ports & Subsystems

Description   The While Iterator Subsystem block is a Subsystem block that is preconfigured to serve as a starting point for creating a subsystem that executes repeatedly while a condition is satisfied during a simulation time step. See the `While Iterator` block and "Modeling Control Flow Logic" for more information.

Purpose   Output the width of the input vector

Library   Signal Attributes

Description   The Width block generates as output the width of its input vector.

Data Type Support   The Width block accepts real or complex signals of any data type supported by Simulink, including fixed-point data types. The Width block supports mixed-type signal vectors.

For a discussion on the data types supported by Simulink, see "Data Types Supported by Simulink" in the Simulink documentation.

Parameters and Dialog Box
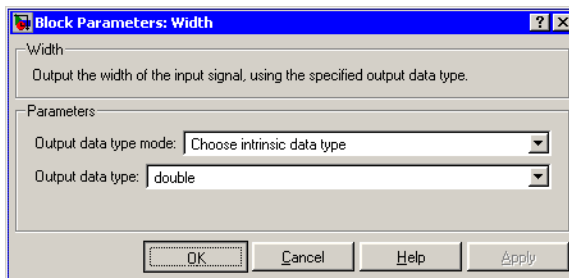
Note The Width block ignores the **Data Type Override** setting of the Fixed-Point Settings interface.

Output data type mode

Specify the output data type to be the same as the input, or inherit the data type by backpropagation. You can also choose to specify a built-in data type from the drop-down list in the **Output data type** parameter.

Width

Output data type

This parameter is visible when `Choose intrinsic data type` is selected for the **Output data type mode** parameter. Choose a built-in data type from the drop-down list.

Characteristics

Sample Time	Constant
Dimensionalized	Yes

Purpose   Set output to zero if input is above threshold

Library   Discontinuities

Description   The Wrap To Zero block sets the output to zero if the input is above the value set by the **Threshold** parameter, and outputs the input if the input is less than or equal to the **Threshold**.

Data Type Support   The Wrap To Zero block accepts signals of any data type supported by Simulink, including fixed-point data types.

Parameters and Dialog Box

Block Parameters: Wrap To Zero

Wrap To Zero (mask) (link)

If the input is above the threshold, the output is zero, otherwise the output equals the input.

Parameters

Threshold:

255

OK   Cancel   Help   Apply
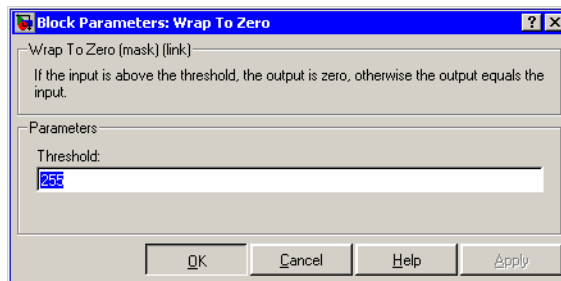
Threshold
     When the input exceeds the threshold, the output is set to zero.

Characteristics

Direct Feedthrough	Yes
Scalar Expansion	Yes

XY Graph

Purpose   Display an X-Y plot of signals using a MATLAB figure window

Library   Sinks

Description   The XY Graph block displays an X-Y plot of its inputs in a MATLAB figure window.

The block has two scalar inputs. The block plots data in the first input (the *x* direction) against data in the second input (the *y* direction). This block is useful for examining limit cycles and other two-state data. Data outside the specified range is not displayed.

Simulink opens a figure window for each XY Graph block in the model at the start of the simulation.

For a demo that illustrates the use of the XY Graph block, enter lorenz in the command window.

Data Type Support   The XY Graph block accepts real signals of type double.

Dialog box
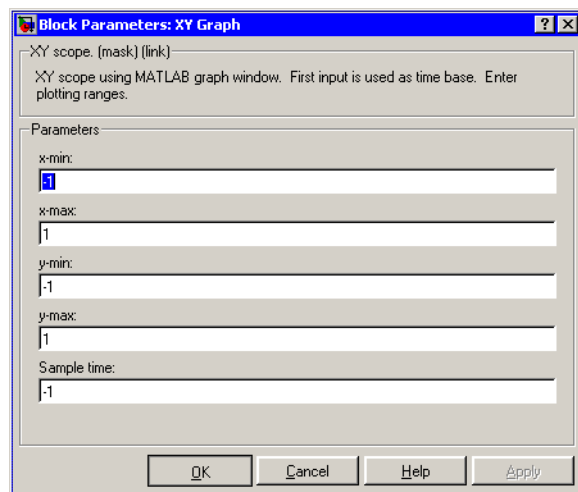
x-min

> The minimum *x*-axis value. The default is -1.

x-max

> The maximum *x*-axis value. The default is 1.

y-min

> The minimum *y*-axis value. The default is -1.

y-max

> The maximum *y*-axis value. The default is 1.

Sample time

> Specify the time interval between samples. To inherit the sample time, set this parameter to -1. See "Specifying Sample Time" in the online documentation for more information.

Characteristics

Sample Time	Specified in the **Sample time** parameter
States	0

Zero-Order Hold

Purpose   Implement a zero-order hold of one sample period

Library   Discrete
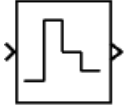
Description   The Zero-Order Hold block samples and holds its input for the specified sample period. The block accepts one input and generates one output, both of which can be scalar or vector. If the input is a vector, all elements of the vector are held for the same sample period.

You specify the time between samples with the **Sample time** parameter. A setting of -1 means the **Sample time** is inherited.

This block provides a mechanism for discretizing one or more signals in time.

Note Do not use the Zero-Order Hold block to create a fast-to-slow transition between blocks operating at different sample rates. Instead, use the Rate Transition block.

Data Type Support   The Zero-Order Hold block accepts real or complex signals of any data type supported by Simulink, including fixed-point data types.

For a discussion on the data types supported by Simulink, see "Data Types Supported by Simulink" in the Simulink documentation.

Parameters and Dialog Box

Sample time (-1 for inherited)

Specify the time interval between samples. To inherit the sample time, set this parameter to -1. See "Specifying Sample Time" in the online documentation for more information.

Characteristics

Direct Feedthrough	Yes
Sample Time	Specified in the **Sample time** parameter
Scalar Expansion	No
Dimensionalized	Yes
Zero Crossing	No

Zero-Pole

Purpose   Model a system by a zero-pole-gain transfer function

Library   Continuous
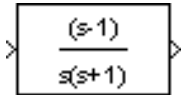
Description The Zero-Pole block models a system specified by the zeros, poles, and gain of a Laplace-domain transfer function that defines the relationship between the system's input and its outputs. You can use this block to model either a single-input-single output (SISO) or a single-input-multiple-output (SIMO) system.

Use the **Zeros**, **Poles**, and **Gain** parameters on the block's parameter dialog box to enter the values of the transfer function's zeros, poles, and gain, respectively. The dialog box assumes the following form for the transfer function that models the system

$$H(s) = K\frac{Z(s)}{P(x)} = K\frac{(s - Z(1))(s - Z(2))\ldots(s - Z(m))}{(s - P(1))(s - P(2))\ldots(s - P(n))}$$

where Z represents the zeros, P the poles, and K the gain of the transfer function. The number of poles must be greater than or equal to the number of zeros. If the poles and zeros are complex, they must be complex conjugate pairs.

For a single-output system, Z and P are vectors and K is a scalar. The input and the output of the block are time-domain scalar signals. For a multiple output system, Z is a matrix each of whose columns represents the zeros of a transfer function relating the system's input to one of its outputs. All of the system's transfer functions are assumed to have the same poles represented by the vector P. K is a vector each of whose elements represents a gain of the corresponding transfer function defined by Z. In this case, the output of the block is a vector each of whose elements represents the output of the transfer function defined by the corresponding column of Z, i.e., the block's output is a vector whose width is equal to the number of columns in Z

> **Note** You cannot use a single Zero-Pole block to model multiple-output systems whose transfer functions have a differing number of zeros or a single zero each. Use multiple Zero-Pole blocks to model such systems.

Transfer Function Display on Block

The Zero-Pole block displays the transfer function depending on how the parameters are specified:

- If each is specified as an expression or a vector, the icon shows the transfer function with the specified zeros, poles, and gain. If you specify a variable in parentheses, the variable is evaluated.

  For example, if you specify **Zeros** as [3,2,1], **Poles** as (poles), where poles is defined in the workspace as [7,5,3,1], and **Gain** as gain, the icon looks like this:

- If each is specified as a variable, the icon shows the variable name followed by (s) if appropriate. For example, if you specify **Zeros** as zeros, **Poles** as poles, and **Gain** as gain, the icon looks like this.

Specifying the Absolute Tolerance for the Block's States

By default, Simulink uses the absolute tolerance value specified in the **Configuration Parameters** dialog box (see "Specifying Variable-Step Solver Error Tolerances") to solve the states of the Zero-Pole block. If this value does not provide sufficient error control, specify a more appropriate value in the **Absolute tolerance** field of the Zero-Pole

Zero-Pole

block's dialog box. The value that you specify is used to solve all the block's states.

Data Type Support   The Zero-Pole block accepts real signals of type double.

Parameters and Dialog Box
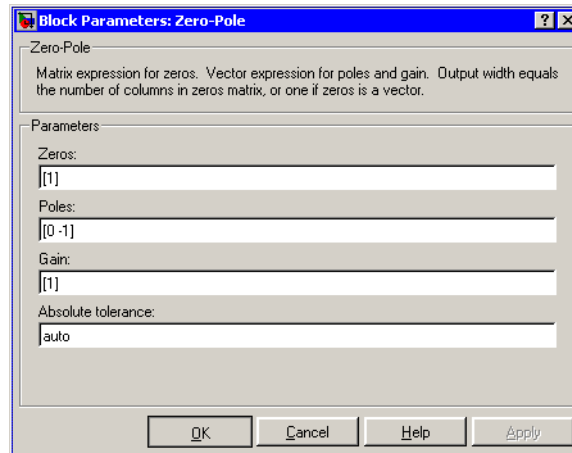
Zeros

The matrix of zeros. The default is [1].

Poles

The vector of poles. The default is [0 -1].

Gain

The vector of gains. The default is [1].

Absolute tolerance

Absolute tolerance used to solve the block's states. You can enter auto or a numeric value. If you enter auto, Simulink determines the absolute tolerance (see "Specifying Variable-Step Solver Error Tolerances"). If you enter a numeric value, Simulink uses the specified value to solve the block's states. Note that a numeric

value overrides the setting for the absolute tolerance in the **Configuration Parameters** dialog box.

Characteristics

Direct Feedthrough	Only if the lengths of the **Poles** and **Zeros** parameters are equal
Sample Time	Continuous
Scalar Expansion	No
States	Length of **Poles** vector
Dimensionalized	No
Zero Crossing	No

Linearization and Trimming Commands

This section describes commands that you can use to linearize or trim a Simulink model. See "Analyzing Simulation Results" in "Using Simulink" for more information on these commands.

Linearization and Trimming Commands — Alphabetical List

linmod, dlinmod, linmod2
trim

Purpose   Extract the continuous- or discrete-time linear state-space model of a
                   system around an operating point

Syntax   *argout* = linmod('sys');
                   argout = linmod('sys',x,u);
                   argout = linmod('sys', x, u, para);
                   argout = linmod('sys', x, u, para, 'v5');
                   argout = linmod('sys', x, u, para, xpert, upert, 'v5');

                   argout = dlinmod('sys', Ts, x, u);
                   argout = dlinmod('sys',Ts, x, u, para, 'v5');
                   argout = dlinmod('sys',Ts, x, u, para, xpert, upert, 'v5');

                   argout = linmod2('sys', x, u, para);

Arguments

sys	The name of the Simulink system from which the linear model is to be extracted.
x and u	The state and the input vectors. If specified, they set the operating point at which the linear model is to be extracted. You can also specify x using the Simulink structure format. To extract the x structure from the model, use the following command: x = sl('getInitialState','sys'); You can then change the operating point values within this structure by editing x.signals.values.
Ts	Sample time of the discrete-time linearized model

linmod, dlinmod, linmod2

`'v5'`	An optional argument that invokes the perturbation algorithm created prior to MATLAB 5.3. This perturbation algorithm is the only linearization algorithm that supports the linearization of models containing references to other models using the Model block. When a model has model references using the Model block, you must use the Simulink structure format to specify x, and xpert when not using the default perturbation values. To extract the x structure, use the following command:

```
x = sl('getInitialState','sys');
```

You can then change the operating point values within this structure by editing `x.signals.values`.

`para`	A three-element vector of optional arguments:

- `para(1)` — Perturbation value of delta, the value used to perform the perturbation of the states and the inputs of the model. This is valid for linearizations using the `'v5'` flag. The default value is 1e-05.

- `para(2)` — Linearization time. For blocks that are functions of time, this parameter can be set with a nonnegative value of t giving the time at which Simulink evaluates the blocks when linearizing a model. The default value is 0.

- `para(3)` — Set `para(3)=1` to remove extra states associated with blocks that have no path from input to output. The default value is 0.

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xpert and upert	The perturbation values used to perform the perturbation of all the states and inputs of the model. The default values are

```
xpert = para(1) + 1e-3*para(1)*abs(x)
upert = para(1) + 1e-3*para(1)*abs(u)
```

When a model has model references using the Model block, you must use the Simulink structure format to specify xpert. To extract the xpert structure, use the following command:

```
xpert = sl('getInitialState','sys');
```

You can then change the perturbation values within this structure by editing xpert.signals.values.

argout   linmod, dlinmod, and linmod2 all return state-space, transfer function, and MATLAB data structure representations of the linearized system, depending on how you specify the output (left-hand) side of the equation. Using linmod as an example:

- [A,B,C,D] = linmod('sys', x, u) obtains the linearized model of sys around an operating point with the specified state variables x and the input u. If you omit x and u, the default values are zero.

- [num, den] = linmod('sys', x, u) returns the linearized model in transfer function form.

- sys_struc = linmod('sys', x, u) returns a structure that contains the linearized model, including state names, input and output names, and information about the operating point.

linmod, dlinmod, linmod2

Description   `linmod` and `dlinmod` compute a linear state space model by linearizing each block in a model individually. `linmod2` computes a linear state-space model by perturbing the model inputs and model states, and uses an advanced algorithm to reduce truncation error.

`linmod` obtains linear models from systems of ordinary differential equations described as Simulink models. Inputs and outputs are denoted in Simulink block diagrams using Inport and Outport blocks.

The default algorithm uses preprogrammed analytic block Jacobians for most blocks which should result in more accurate linearization than numerical perturbation of block inputs and states. A list of blocks that have preprogrammed analytic Jacobians is available in the Simulink Control Design documentation along with a discussion of the block-by-block analytic algorithm for linearization. If you do not have Simulink Control Design installed, you can access the documentation on the MathWorks Web site at http://www.mathworks.com/access/helpdesk/help/toolbox/slcontrol/.

The default algorithm also allows for special treatment of problematic blocks such as the Transport Delay and the Quantizer. See the mask dialog of these blocks for more information and options.

Discrete-Time System Linearization

The function `dlinmod` can linearize discrete, multirate, and hybrid continuous and discrete systems at any given sampling time. Use the same calling syntax for `dlinmod` as for `linmod`, but insert the sample time at which to perform the linearization as the second argument. For example,

```
[Ad,Bd,Cd,Dd] = dlinmod('sys', Ts, x, u);
```

produces a discrete state-space model at the sampling time `Ts` and the operating point given by the state vector `x` and input vector `u`. To obtain a continuous model approximation of a discrete system, set `Ts` to `0`.

For systems composed of linear, multirate, discrete, and continuous blocks, `dlinmod` produces linear models having identical frequency and

time responses (for constant inputs) at the converted sampling time Ts, provided that

- Ts is an integer multiple of all the sampling times in the system.
- The system is stable.

For systems that do not meet the first condition, in general the linearization is a time-varying system, which cannot be represented with the [*A*,*B*,*C*,*D*] state-space model that dlinmod returns.

Computing the eigenvalues of the linearized matrix Ad provides an indication of the stability of the system. The system is stable if Ts>0 and the eigenvalues are within the unit circle, as determined by this statement:

```
all(abs(eig(Ad))) < 1
```

Likewise, the system is stable if Ts = 0 and the eigenvalues are in the left half plane, as determined by this statement:

```
all(real(eig(Ad))) < 0
```

When the system is unstable and the sample time is not an integer multiple of the other sampling times, dlinmod produces Ad and Bd matrices, which can be complex. The eigenvalues of the Ad matrix in this case still, however, provide a good indication of stability.

You can use dlinmod to convert the sample times of a system to other values or to convert a linear discrete system to a continuous system or vice versa.

You can find the frequency response of a continuous or discrete system by using the bode command.

Notes   By default, the system time is set to zero. For systems that are dependent on time, you can set the variable para to a two-element vector, where the second element is used to set the value of t at which to obtain the linear model.

linmod, dlinmod, linmod2

The ordering of the states from the nonlinear model to the linear model is maintained. For Simulink systems, a string variable that contains the block name associated with each state can be obtained using

```
[sizes,x0,xstring] = sys
```

where `xstring` is a vector of strings whose ith row is the block name associated with the `ith` state. Inputs and outputs are numbered sequentially on the diagram.

For single-input multi-output systems, you can convert to transfer function form using the routine `ss2tf` or to zero-pole form using `ss2zp`. You can also convert the linearized models to LTI objects using `ss`. This function produces an LTI object in state-space form that can be further converted to transfer function or zero-pole-gain form using `tf` or `zpk`.

The default algorithms in `linmod` and `dlinmod` handle Transport Delay blocks by replacing the linearization of the blocks with a Pade approximation. For the `'v5'` algorithm, linearization of a model that contains Derivative or Transport Delay blocks can be troublesome. For more information, see "Linearizing Models" in "Using Simulink".

trim

Purpose   Find a trim point of a dynamic system

Syntax
```
[x,u,y,dx] = trim('sys')
[x,u,y,dx] = trim('sys',x0,u0,y0)
[x,u,y,dx] = trim('sys',x0,u0,y0,ix,iu,iy)
[x,u,y,dx] = trim('sys',x0,u0,y0,ix,iu,iy,dx0,idx)
[x,u,y,dx] = trim('sys',x0,u0,y0,ix,iu,iy,dx0,idx,options)
[x,u,y,dx] = trim('sys',x0,u0,y0,ix,iu,iy,dx0,idx,options,t)
[x,u,y,dx,options] = trim('sys',...)
```

Description A trim point, also known as an equilibrium point, is a point in the
parameter space of a dynamic system at which the system is in a steady
state. For example, a trim point of an aircraft is a setting of its controls
that causes the aircraft to fly straight and level. Mathematically, a trim
point is a point where the system's state derivatives equal zero. trim
starts from an initial point and searches, using a sequential quadratic
programming algorithm, until it finds the nearest trim point. You must
supply the initial point implicitly or explicitly. If trim cannot find a
trim point, it returns the point encountered in its search where the
state derivatives are closest to zero in a min-max sense; that is, it
returns the point that minimizes the maximum deviation from zero
of the derivatives. trim can find trim points that meet specific input,
output, or state conditions, and it can find points where a system is
changing in a specified manner, that is, points where the system's state
derivatives equal specific nonzero values.

[x,u,y] = trim('sys') finds the equilibrium point nearest to the
system's initial state, x0. Specifically, trim finds the equilibrium
point that minimizes the maximum absolute value of [x-x0,u,y]. If
trim cannot find an equilibrium point near the system's initial state,
it returns the point at which the system is nearest to equilibrium.
Specifically, it returns the point that minimizes abs(dx-0). You can
obtain x0 using this command.

```
[sizes,x0,xstr] = sys([],[],[],0)
```

trim

[x,u,y] = trim('sys',x0,u0,y0) finds the trim point nearest to x0, u0, y0, that is, the point that minimizes the maximum value of

```
abs([x-x0; u-u0; y-y0])
```

The command

```
trim('sys', x0, u0, y0, ix, iu, iy)
```

finds the trim point closest to x0, u0, y0 that satisfies a specified set of state, input, and/or output conditions. The integer vectors ix, iu, and iy select the values in x0, u0, and y0 that must be satisfied. If trim cannot find an equilibrium point that satisfies the specified set of conditions exactly, it returns the nearest point that satisfies the conditions, namely

```
abs([x(ix)-x0(ix); u(iu)-u0(iu); y(iy)-y0(iy)])
```

Use the syntax

```
[x,u,y,dx] = trim('sys', x0, u0, y0, ix, iu, iy, dx0, idx)
```

to find specific nonequilibrium points, that is, points at which the system's state derivatives have some specified nonzero value. Here, dx0 specifies the state derivative values at the search's starting point and idx selects the values in dx0 that the search must satisfy exactly.

The optional options argument is an array of optimization parameters that trim passes to the optimization function that it uses to find trim points. The optimization function, in turn, uses this array to control the optimization process and to return information about the process. trim returns the options array at the end of the search process. By exposing the underlying optimization process in this way, trim allows you to monitor and fine-tune the search for trim points.

Five of the optimization array elements are particularly useful for finding trim points. The following table describes how each element affects the search for a trim point.

No.	Default	Description
1	0	Specifies display options. 0 specifies no display; 1 specifies tabular output; -1 suppresses warning messages.
2	0.0001	Precision the computed trim point must attain to terminate the search.
3	0.0001	Precision the trim search goal function must attain to terminate the search.
4	0.0001	Precision the state derivatives must attain to terminate the search.
10	N/A	Returns the number of iterations used to find a trim point.

See the "Optimization Toolbox User's Guide" for a detailed description of the options array.

Examples   Consider a linear state-space model

$$\dot{x} = Ax + Bu$$

$$y = Cx + Du$$

The *A*, *B*, *C*, and *D* matrices are as follows in a system called sys.

```
A = [-0.09 -0.01;  1   0];
B = [ 0    -7;     0  -2];
C = [ 0     2;     1  -5];
D = [-3     0;     1   0];
```

Example 1

To find an equilibrium point, use

```
[x,u,y,dx,options] = trim('sys')
x =
   0
```

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trim

```
      0
u  =
      0
y  =
      0
      0
dx =
      0
      0
```

The number of iterations taken is

```
options(10)
ans =
       7
```

Example 2

To find an equilibrium point near x = [1;1], u = [1;1], enter

```
x0 = [1;1];
u0 = [1;1];
[x,u,y,dx,options] = trim('sys', x0, u0);
x =
    1.0e-11 *
   -0.1167
   -0.1167
u =
    0.3333
    0.0000
y =
   -1.0000
    0.3333
dx =
    1.0e-11 *
    0.4214
    0.0003
```

The number of iterations taken is

```
options(10)
ans =
      25
```

Example 3

To find an equilibrium point with the outputs fixed to 1, use

```
y = [1;1];
iy = [1;2];
[x,u,y,dx] = trim('sys', [], [], y, [], [], iy)
x =
    0.0009
   -0.3075
u =
   -0.5383
    0.0004
y =
    1.0000
    1.0000
dx =
    1.0e-16 *
   -0.0173
    0.2396
```

Example 4

To find an equilibrium point with the outputs fixed to 1 and the derivatives set to 0 and 1, use

```
y = [1;1];
iy = [1;2];
dx = [0;1];
idx = [1;2];
[x,u,y,dx,options] = trim('sys',[],[],y,[],[],iy,dx,idx)
x =
    0.9752
```

```
         -0.0827
    u =
         -0.3884
         -0.0124
    y =
          1.0000
          1.0000
    dx =
          0.0000
          1.0000
```

The number of iterations taken is

```
    options(10)
    ans =
          13
```

Limitations   The trim point found by `trim` starting from any given initial point is only a local value. Other, more suitable trim points may exist. Thus, if you want to find the most suitable trim point for a particular application, it is important to try a number of initial guesses for `x`, `u`, and `y`.

Algorithm   `trim` uses a sequential quadratic programming algorithm to find trim points. See the "Optimization Toolbox User's Guide" for a description of this algorithm.

4

Model Construction Commands

The following sections describe commands that you can use in programs that create or modify models.

Task-Oriented Command List

This table lists the tasks performed by commands described in this section. An alphabetical list follows.

Task	Command
Create a new Simulink system.	`new_system`
Open an existing system.	`open_system`
Invisibly load a model into memory.	`load_system`
Open or close the Simulink Library Browser.	`simulink`
Change MATLAB character encoding to be compatible with model character encoding.	`slCharacterEncoding`
Close a system window.	`close_system`, `bdclose`
Save a system.	`save_system`
Find a system, block, line, or annotation.	`find_system`
Find model references.	`find_mdlrefs`
Get information about the library links in a model.	`libinfo`
Add a new block to a system.	`add_block`
Delete a block from a system.	`delete_block`
Replace a block in a system.	`replace_block`
Replace Mux blocks used as Bus Creator blocks with Bus Creator blocks.	`slreplace_mux`
Update obsolete versions of blocks.	`slupdate`
Terminate unconnected ports in a system.	`addterms`
Add a line to a system.	`add_line`
Delete a line from a system.	`delete_line`
Add a parameter to a system.	`add_param`

Task	Command
Get a parameter value.	get_param
Set parameter values.	set_param
Delete a system parameter.	delete_param
Attach a configuration set to a model.	attachConfigSet
Get a model's active configuration set.	getActiveConfigSet
Get one of a model's configuration sets.	getConfigSet
Get the names of a model's configuration sets.	getConfigSets
Set a model's active configuration set.	setActiveConfigSet
Dissociates a configuration set from a model.	detachConfigSet
Get the pathname of the current block.	gcb
Get the pathname of the current system.	gcs
Get the handle of the current block.	gcbh
Get the name of the root-level system.	bdroot
Display a graph of model reference dependencies.	view_mdlrefs
Discretize a model.	sldiscmdl
Configure a model for efficient simulation and code generation.	modeladvisor
Open the Model Discretizer GUI.	slmdldiscui
Save bus objects in an M-file.	Simulink.Bus.save
Create bus objects for blocks in a model.	Simulink.Bus.createObject

Task	Command
Restore bus objects saved in cell format to the MATLAB workspace.	`Simulink.Bus.cellToObject`
Convert an atomic subsystem to a model reference.	`Simulink.SubSystem.convertToModelReference`

Model Construction Commands — Alphabetical List

addterms
add_block
add_line
add_param
attachConfigSet
bdclose
bdroot
close_system
delete_block
delete_line
delete_param
detachConfigSet
find_mdlrefs
find_system
gcb
gcbh
gcs
getActiveConfigSet
getCallbackAnnotation
getConfigSet
getConfigSets
get_param
libinfo
load_system
modeladvisor
new_system
open_system
replace_block
save_system
setActiveConfigSet
set_param
signalbuilder
simulink
Simulink.Bus.cellToObject
Simulink.Bus.createObject

Simulink.Bus.save
Simulink.SubSystem.convertToModelReference
slCharacterEncoding
sldiscmdl
slmdldiscui
slreplace_mux
slupdate
view_mdlrefs

add_block

Purpose	Add a block to a Simulink system
Syntax	add_block(*'src'*, *'dest'*)

add_block(*'src'*, *'dest'*, *'param1'*, *value1*, ...)
add_block(*'src'*, *'dest'*, 'MakeNameUnique', 'on', *'param1'*, *value1*, ...)
add_block(*'src_inport'*, *'dest_inport'*, 'copyoption', 'duplicate', *'param1'*, *value1*,...)

Description   add_block(*'src'*, *'dest'*) copies the block with the full pathname *'src'* to a new block with the full pathname *'dest'*. The block parameters of the new block are identical to those of the original. You can use 'built-in*blocktype*' as a source block path for Simulink built-in blocks (blocks available in Simulink block libraries that are not masked blocks), where *blocktype* is the built-in block's type, i.e., the value of its BlockType parameter (see "Common Block Parameters" on page 10-55).

add_block(*'src'*, *'dest'*, *'param1'*, *value1*, ...) creates a copy as above, in which the named parameters have the specified values. Any additional arguments must occur in parameter/value pairs.

add_block(*'src'*, *'dest'*, 'MakeNameUnique', 'on', *'parameter1'*, *value1*,...) creates a copy of src. If a block having the full pathname *'dest'* already exists, the command creates a unique name for the new block based on *'dest'*.

add_block(*'src_inport'*, *'dest_inport'*, 'copyoption', 'duplicate', *'param1'*, *value1*,...) applies only to Inport blocks. It creates a copy with the same port number as the *'src_inport'* block.

Before you add a block, you need to first open the library that contains the block with the load_system (library opens invisibly) or open_system (library opens visibly) command.

Examples   This command copies the Scope block from the Sinks subsystem of the simulink system to a block named Scope1 in the timing subsystem of the engine system.

```
add_block('simulink/Sinks/Scope', 'engine/timing/Scope1')
```

add_block

This command creates a new subsystem named `controller` in the `F14` system.

```
add_block('built-in/SubSystem', 'F14/controller')
```

This command copies the built-in Gain block to a block named `Volume` in the `mymodel` system and assigns the `Gain` parameter a value of 4.

```
add_block('built-in/Gain', 'mymodel/Volume', 'Gain', '4')
```

The following command

```
block = add_block('vdp/Mu', 'vdp/Mu', 'MakeNameUnique', 'on')
```

copies the block named `Mu` in `vdp` and create a copy. Since `Mu` already exists, the command names the new block `Mu1`.

See Also   delete_block, set_param

Purpose   Add a line to a Simulink system

Syntax
```
h = add_line('sys','oport','iport')
h = add_line('sys','oport','iport', 'autorouting','on')
h = add_line('sys', points)
```

Description   The add_line command adds a line to the specified system and returns a handle to the new line. You can define the line in two ways:

- By naming the block ports that are to be connected by the line

- By specifying the location of the points that define the line segments

add_line('sys', 'oport', 'iport') adds a straight line to a system from the specified block output port 'oport' to the specified block input port 'iport'. 'oport' and 'iport' are strings consisting of a block name and a port identifier in the form 'block/port'. Most block ports are identified by numbering the ports from top to bottom or from left to right, such as 'Gain/1' or 'Sum/2'. Enable, Trigger, State, and Action ports are identified by name, such as 'subsystem_name/Enable', 'subsystem_name/Trigger', 'Integrator/State', or if_action_subsystem_name/Ifaction'.

add_line('sys','oport','iport', 'autorouting','on') works like add_line('sys','oport','iport') except that it routes the line around intervening blocks. The default value for autorouting is 'off'.

add_line(system, points) adds a segmented line to a system. Each row of the points array specifies the *x* and *y* coordinates of a point on a line segment. The origin is the top-left corner of the window. The signal flows from the point defined in the first row to the point defined in the last row. If the start of the new line is close to the output of an existing block or line, a connection is made. Likewise, if the end of the line is close to an existing input, a connection is made.

add_line

Examples   This command adds a line to the `mymodel` system connecting the output of the Sine Wave block to the first input of the Mux block.

```
add_line('mymodel','Sine Wave/1','Mux/1')
```

This command adds a line to the `mymodel` system extending from (20,55) to (40,10) to (60,60).

```
add_line('mymodel',[20 55; 40 10; 60 60])
```

See Also   delete_line

add_param

Purpose   Add a parameter to a Simulink system

Syntax   add_param('sys','parameter1',value1,'parameter2',value2,...)

Description The add_param command adds the specified parameters to the specified system and initializes the parameters to the specified values. Case is ignored for parameter names. Value strings are case sensitive. The value of the parameter must be a string. Once the parameter is added to a system, set_param and get_param can be used on the new parameters as if they were standard Simulink parameters.

Examples   This command

```
add_param('vdp','Param1','Value1','Param2','Value2')
```

adds the parameters Param1 and Param2 with values 'Value1' and 'Value2' to the vdp system.

See Also   delete_param, get_param, set_param

addterms

Purpose   Add terminators to unconnected ports in a model

Syntax   addterms('sys')

Description addterms('sys') adds Terminator and Ground blocks to the
                unconnected ports in the Simulink block diagram sys.

See Also   slupdate

Purpose   Associates a configuration set with a model

Syntax   attachConfigSet('model', configSet)

Description   attachConfigSet('model', configSet) associates the
Simulink.ConfigSet object specified by configSet with 'model',
where 'model' is the name of an open model.

> **Note** You cannot attach a configuration set to a model if the
> configuration set is already attached to another model or has the same
> name as another configuration set attached to the same model.

Examples   The following example creates a copy of the current model's active
configuration set and attaches it to the model as an alternate
configuration geared to model development.

```
activeConfig = getActiveConfigSet(gcs);
develConfig = activeConfig.copy;
develConfig.Name = 'develConfig';
attachConfigSet(gcs, develConfig);
```

See Also   getActiveConfigSet, getConfigSet, detachConfigSet

bdclose

Purpose   Close any or all Simulink system windows unconditionally

Syntax   bdclose
                bdclose('sys')
                bdclose('all')

Description bdclose with no arguments closes the current system window
                unconditionally and without confirmation. Any changes made to the
                system since it was last saved are lost.

                bdclose('sys') closes the specified system window.

                bdclose('all') closes all system windows.

Examples   This command closes the vdp system.

                   bdclose('vdp')

See Also   close_system, new_system, open_system, save_system

Purpose   Return the name of the top-level Simulink system

Syntax   bdroot
                   bdroot('obj')

Description   bdroot with no arguments returns the top-level system name.

                   bdroot('obj'), where 'obj' is a system or block pathname, returns
                   the name of the top-level system containing the specified object name.

Examples   This command returns the name of the top-level system that contains
                   the current block.

                       bdroot(gcb)

See Also   find_system, gcb

close_system

Purpose   Close a Simulink system window or a block dialog box

Syntax
```
close_system
close_system('sys')
close_system('sys', saveflag)
close_system('sys', 'newname')
close_system('sys', 'newname','ErrorIfShadowed')
close_system('blk')
```

Description   `close_system` with no arguments closes the current system or subsystem window. If the current system is the top-level system and it has been modified, `close_system` asks if the changed system should be saved to a file before removing the system from memory. The current system is defined in the description of the `gcs` command.

`close_system('sys')` closes the specified system or subsystem window. This command displays an error if '*sys*' is a MATLAB keyword, `'simulink'`, or more than 63 characters long.

`close_system('sys', saveflag)` closes the specified top-level system window and removes it from memory. If *saveflag* is 0, the system is not saved.

`close_system('sys', 'newname')` saves the specified top-level system to a file with the specified new name, then closes the system.

`close_system('sys','newname','ErrorIfShadowed')` saves the specified top-level system to a file with the specified new name. This command generates an error if the specified model name already exists on the MATLAB path or workspace.

`close_system('blk')`, where `'blk'` is a full block pathname, closes the dialog box associated with the specified block or calls the block's `CloseFcn` callback parameter if one is defined. Any additional arguments are ignored.

Examples   This command closes the current system.

    close_system

This command closes the vdp system.

    close_system('vdp')

This command saves the engine system with its current name, then closes it.

    close_system('engine', 1)

This command saves the mymdl12 system under the new name testsys, then closes it.

    close_system('mymdl12', 'testsys')

This command tries to save the vdp system to a file with the name 'max', but returns an error because 'max' is the name of an existing MATLAB function.

    close_system('vdp','max','ErrorIfShadowed')

This command closes the dialog box of the Unit Delay block in the Combustion subsystem of the engine system.

    close_system('engine/Combustion/Unit Delay')

See Also   bdclose, gcs, new_system, open_system, save_system

delete_block

Purpose	Delete a block from a Simulink system
Syntax	delete_block('blk')
Description	delete_block('blk'), where 'blk' is a full block pathname, deletes the specified block from a system.
Examples	This command removes the Out1 block from the vdp system. delete_block('vdp/Out1')
See Also	add_block

Purpose   Delete a line from a Simulink system

Syntax
```
delete_line('sys', 'oport', 'iport')
delete_line('system', [x y])
delete_line('handle')
```

Description   delete_line('sys', 'oport', 'iport') deletes the line extending
from the specified block output port 'oport' to the specified block
input port 'iport'. 'oport' and 'iport' are strings consisting
of a block name and a port identifier in the form 'block/port'.
Most block ports are identified by numbering the ports from top
to bottom or from left to right, such as 'Gain/1' or 'Sum/2'.
Enable, Trigger, and State ports are identified by name, such
as 'subsystem_name/Enable', 'subsystem_name/Trigger',
'Integrator/State', or if_action_subsystem_name/Ifaction'.

delete_line('sys', [x y]) deletes one of the lines in the system that
contains the specified point (x,y), if any such line exists.

delete_line('system', [x y]) deletes all of the lines in the system
that contain the specified point, including any branches.

delete_line('handle') deletes the line specified by the handle,
'handle'.

Examples   This command removes the line from the mymodel system connecting
the Sum block to the second input of the Mux block.

```
delete_line('mymodel','Sum/1','Mux/2')
```

See Also   add_line

delete_param

Purpose   Delete a system parameter added via the add_param command

Syntax   delete_param('sys','parameter1','parameter2',...)

Description This command deletes parameters that were added to the system using
the add_param command. The command displays an error message if a
specified parameter was not added with the add_param command.

Examples   The following example

```
add_param('vdp','Param1','Value1','Param2','Value2')
delete_param('vdp','Param1')
```

adds the parameters Param1 and Param2 to the vdp system, then deletes
Param1 from the system.

See Also   add_param

Purpose   Dissociates a configuration set from a model

Syntax   detachConfigSet('model', 'configSetName')

detachConfigSet('model', 'configSetName') disassociates the
Simulink.ConfigSet object specified by 'configSetName', where
ConfigSetName is the name of a configuration set, from 'model', where
model is the name of an open model.

Examples   The following example creates a copy of the vdp model's active
configuration set, attaches it to the model, then detaches it.

```
vdp
x=Simulink.ConfigSet;
x.Name='new config';
attachConfigSet('vdp',x);
detachConfigSet('vdp','new config');
```

See Also   attachConfigSet

find_mdlrefs

Purpose	Find the Model blocks in a model and the models that the Model blocks reference
Syntax	[refMdls, mdlBlks] = find_mdlrefs('modelName') [refMdls, mdlBlks] = find_mdlrefs('modelName', true) [refMdls, mdlBlks] = find_mdlrefs('modelName', false)

Description [refMdls, mdlBlks] = find_mdlrefs('modelName') or
find_mdlrefs('modelName', true) finds all Model blocks contained
by and models referenced by 'modelName' directly or indirectly (i.e., via
models referenced by 'modelName'. The commands output arguments
are

- refMdls

  List of models. The last element in the list is 'modelName'. The other
  elements are the names of models referenced by 'modelName'.

- mdlBlks

  Names of Model blocks contained by 'modelName' and the models
  that it references directly or indirectly.

[refMdls, mdlBlks] = find_mdlrefs(modelName, false) finds only
the Model blocks and models directly referenced by 'modelName'.

Examples Open the sldemo_mdlref_basic demo. Then execute

```
>> [r, b] = find_mdlrefs('sldemo_mdlref_basic')

r =
    'sldemo_mdlref_counter'
    'sldemo_mdlref_basic'

b =
    'sldemo_mdlref_basic/CounterA'
    'sldemo_mdlref_basic/CounterB'
```

```
'sldemo_mdlref_basic/CounterC'
```

See Also   view_mdlrefs

find_system

Purpose   Find systems, blocks, lines, ports, and annotations

Syntax   find_system(*sys*, *'c1'*, *cv1*, *'c2'*, *cv2*,...*'p1'*, *v1*, *'p2'*, *v2*,...)

Description   find_system(*sys*, *'c1'*, *cv1*, *'c2'*, *cv2*,...*'p1'*, *v1*, *'p2'*, *v2*,...) searches the systems or subsystems specified by *sys*, using the constraints specified by *c1*, *c2*, etc., and returns handles or paths to the objects whose parameters, *p1*, *p2*, etc., have the values, *v1*, *v2*, etc. *sys* can be a pathname (or cell array of pathnames), a handle (or vector of handles), or omitted. If you specify 'BlockDialogParams' as the parameter name , find_system searches for all blocks that have a parameter that has the specified value and appears in the block's dialog box.

Note All the search constraints must precede all the property-value pairs in the argument list.

If sys is a pathname or cell array of pathnames, find_system returns a cell array of pathnames of the objects it finds. If sys is a handle or a vector of handles, find_system returns a vector of handles to the objects that it finds. If sys is omitted, find_system searches all open systems and returns a cell array of pathnames.

Case is ignored for parameter names. Value strings are case sensitive by default (see the 'CaseSensitive' search constraint for more information). Any parameters that correspond to dialog box entries have string values. See Chapter 10, "Model and Block Parameters" for a list of model and block parameters.

You can specify any of the following search constraints.

Name	Value Type	Description
'SearchDepth'	scalar	Restricts the search depth to the specified level (0 for open systems only, 1 for blocks and subsystems of the top-level system, 2 for the top-level system and its children, etc.). The default is all levels.
'LookUnderMasks'	'none'	Search skips masked blocks.
	{'graphical'}	Search includes masked blocks that have no workspaces and no dialogs. This is the default.
	'functional'	Search includes masked blocks that do not have dialogs.
	'all'	Search includes all masked blocks.
'FollowLinks'	'on'| {'off'}	If 'on', search follows links into library blocks. The default is 'off'.
'FindAll'	'on'| {'off'}	If 'on', search extends to lines, ports, and annotations within systems. The default is 'off'. Note that find_system returns a vector of handles when this option is 'on', regardless of the array type of sys.
'CaseSensitive'	{'on'}| 'off'	If 'on', search considers case when matching search strings. The default is 'on'.
'RegExp'	'on'| {'off'}	If 'on', search treats search expressions as regular expressions. The default is 'off'.

find_system

The table encloses default constraint values in brackets. If a `'constraint'` is omitted, find_system uses the default constraint value.

By default, find_system attempts to load any partially loaded models. When a PreLoadFcn callback invokes find_system, find_system tries to load the calling model, causing recursive load warnings. To prevent this warning, disable the model loading property of find_system. Turn off the LoadFullyIfNeeded property, as follows:

```
find_system(gcs,'LoadFullyIfNeeded','off','PropertyName','PropertyValue')
```

Examples This command returns a cell array containing the names of all open systems and blocks.

```
find_system
```

This command returns the names of all open block diagrams.

```
open_bd = find_system('type', 'block_diagram')
```

This command returns the names of all Goto blocks that are children of the Unlocked subsystem in the clutch system.

```
find_system('clutch/
Unlocked','SearchDepth',1,'BlockType','Goto')
```

These commands return the names of all Gain blocks in the vdp system having a Gain parameter value of 1.

```
gb = find_system('vdp', 'BlockType', 'Gain')
find_system(gb, 'Gain', '1')
```

The preceding commands are equivalent to this command:

```
find_system('vdp', 'BlockType', 'Gain', 'Gain', '1')
```

These commands obtain the handles of all lines and annotations in the vdp system.

```
sys = get_param('vdp', 'Handle');
l = find_system(sys, 'FindAll', 'on', 'type', 'line');
a = find_system(sys, 'FindAll', 'on', 'type',
'annotation');
```

Searching with Regular Expressions

If you specify the 'RegExp' constraint as 'on', find_system treats search value strings as regular expressions. A regular expression is a string of characters in which some characters have special pattern-matching significance. For example, a period (.) in a regular expression matches not only itself but any other character.

Regular expressions greatly expand the types of searches you can perform with find_system. For example, regular expressions allow you to do partial-word searches. You can search for all objects that have a specified parameter that contains or begins or ends with a specified string of characters.

To use regular expressions effectively, you need to learn the meanings of the special characters that regular expressions can contain. The following table lists the special characters supported by find_subsystem and explains their usage.

Expression	Usage
.	Matches any character. For example, the string 'a.' matches 'aa', 'ab', 'ac', etc.
*	Matches zero or more of preceding character. For example, 'ab*' matches 'a', 'ab', 'abb', etc. The expression '.*' matches any string, including the empty string.
+	Matches one or more of preceding character. For example, 'ab+' matches 'ab', 'abb', etc.
^	Matches start of string. For example, '^a.*' matches any string that starts with 'a'.

Expression	Usage
$	Matches end of string. For example, `'.*a$'` matches any string that ends with `'a'`.
\	Causes the next character to be treated as an ordinary character. This escape character lets regular expressions match expressions that contain special characters. For example, the search string `'\\'` matches any string containing a \ character.
[ ]	Matches any one of a specified set of characters. For example, `'f[oa]r'` matches `'for'` and `'far'`. Some characters have special meaning within brackets. A hyphen (`-`) indicates a range of characters to match. For example, `'[a-zA-Z1-9]'` matches any alphanumeric character. A circumflex (`^`) indicates characters that should not produce a match. For example, `'f[^i]r'` matches `'far'` and `'for'` but not `'fir'`.
\w	Matches a word character. (This is a shorthand expression for `[a-z_A-Z0-9]`.) For example, `'^\w'` matches `'mu'` but not `'&mu'`.
\d	Matches any digit (shorthand for `[0-9]`). For example, `'\d+'` matches any integer.
\D	Matches any nondigit (shorthand for `[^0-9]`).
\s	Matches a white space (shorthand for `[ \t\r\n\f]`).
\S	Matches a non white-space (shorthand for `[^ \t\r\n\f]`).
\<WORD\>	Matches WORD exactly, where WORD is a string of characters separated by white space from other words. For example, `'\<to\>'` matches `'to'` but not `'today'`.

To use regular expressions to search Simulink systems, specify the `'regexp'` search constraint as `'on'` in a `find_system` command and use a regular expression anywhere you would use an ordinary search value string.

For example, the following command finds all the inport and outport blocks in the clutch model demo provided with Simulink.

```
find_system('clutch', 'regexp', 'on', 'blocktype', 'port')
```

See Also   get_param, set_param

gcb

Purpose	Get the pathname of the current block
Syntax	`gcb` `gcb('sys')`

Description   gcb returns the full block pathname of the current block in the current system.

gcb('sys') returns the full block pathname of the current block in the specified system.

The current block is one of these:

- During editing, the current block is the block most recently clicked.

- During simulation of a system that contains S-Function blocks, the current block is the S-Function block currently executing its corresponding MATLAB function.

- During callbacks, the current block is the block whose callback routine is being executed.

- During evaluation of the `MaskInitialization` string, the current block is the block whose mask is being evaluated.

Examples   This command returns the path of the most recently selected block.

```
gcb
ans =
    clutch/Locked/Inertia
```

This command gets the value of the Gain parameter of the current block.

```
get_param(gcb,'Gain')
ans =
    1/(Iv+Ie)
```

See Also   gcbh, gcs

Purpose   Get the handle of the current block

Syntax   gcbh

Description   gcbh returns the handle of the current block in the current system.

You can use this command to identify or address blocks that have no parent system. The command should be most useful to blockset authors.

Examples   This command returns the handle of the most recently selected block.

```
gcbh

ans =

    281.0001
```

See Also   gcb

gcs

Purpose   Get the pathname of the current system

Syntax   gcs

Description gcs returns the full pathname of the current system.

The current system is one of these:

- During editing, the current system is the system or subsystem most recently clicked.

- During simulation of a system that contains S-Function blocks, the current system is the system or subsystem containing the S-Function block that is currently being evaluated.

- During callbacks, the current system is the system containing any block whose callback routine is being executed.

- During evaluation of the MaskInitialization string, the current system is the system containing the block whose mask is being evaluated.

The current system is always the current model or a subsystem of the current model. Use bdroot to get the current model.

Examples   This example returns the path of the system that contains the most recently selected block.

```
gcs
ans =
    clutch/Locked
```

See Also   bdroot , gcb

Purpose   Get a model's active configuration set.

Syntax   getActiveConfigSet('model')

Description getActiveConfigSet('model') returns a Simulink.ConfigSet object
representing the active configuration set of 'model', where 'model' is
the name of an open model.

Examples   The following command

        cs = getActiveConfigSet(gcs);

returns the active configuration set of the currently selected model.

See Also   attachConfigSet, setActiveConfigSet

getCallbackAnnotation

Purpose   Get information about an annotation

Syntax   `getCallbackAnnotation`

Description   `getCallbackAnnotation` is intended to be invoked by annotation callback functions. If it is invoked from an annotation callback function, it returns an instance of `Simulink.Annotation` class that represents the annotation associated with the callback function. The callback function can then use the instance to get and set the annotation's properties, such as its text, font and color. If this function is not invoked from an annotation callback function, it returns nothing, i.e., `[ ]`.

Purpose   Get one of a model's configuration sets

Syntax   getConfigSet('model', configSetName)

Description   getConfigSets('model', configSetName) returns a
Simulink.ConfigSet object representing the configuration
set named configSetName whose owner is 'model', where model is a
string specifying the name of a model.

Note Use getConfigSets to get the names of the configuration sets
owned by a model.

Examples   The following command gets the configuration set of the currently
selected model whose name is 'DevelopmentConfiguration'.

```
hCs = getConfigSet(gcs, 'DevelomentConfiguration');
```

See Also   attachConfigSet, getActiveConfigSet, getConfigSets,
setActiveConfigSet

getConfigSets

Purpose   Get the names of a model's configuration sets

Syntax   getConfigSets('model')

Description   getConfigSets('model') returns a cell array of strings specifying the
                   names of the configuration sets owned by 'model', where 'model' is
                   the name of a model.

Examples   The following command displays the names of the configuration sets
                   owned by the current selected model at the MATLAB command line.

                       getConfigSets(gcs)

See Also   attachConfigSet, setActiveConfigSet

Purpose   Get system and block parameter values

Syntax
```
get_param('obj', 'parameter')
get_param( { objects }, 'parameter')
get_param(handle, 'parameter')
get_param(O, 'parameter')
get_param('obj', 'ObjectParameters')
get_param('obj', 'DialogParameters')
```

Description   get_param('obj', 'parameter'), where 'obj' is a system or block pathname, returns the value of the specified parameter. Some parameters are case-sensitive, and some are not. To prevent problems, treat all parameters as case-sensitive.

get_param({ objects }, 'parameter') accepts a cell array of full path specifiers, enabling you to get the values of a parameter common to all objects specified in the cell array.

get_param(handle, 'parameter') returns the specified parameter of the object whose handle is handle.

get_param(O, 'parameter') returns the current value of a Simulink session parameter or the default value of a model or block parameter.

get_param('obj', 'ObjectParameters') returns a structure that describes obj's parameters. Each field of the returned structure corresponds to a particular parameter and has the parameter's name. For example, the Name field corresponds to the object's Name parameter. Each parameter field itself contains three fields, Name, Type, and Attributes, that specify the parameter's name (for example, 'Gain'), data type (for example, string), and attributes (for example, read-only), respectively.

get_param('obj', 'DialogParameters') returns a cell array containing the names of the dialog parameters of the specified block.

Chapter 10, "Model and Block Parameters" contains lists of model and block parameters.

Examples   This command returns the value of the Gain parameter for the Inertia block in the Requisite Friction subsystem of the clutch system.

```
get_param('clutch/Requisite Friction/Inertia','Gain')
ans =
    1/(Iv+Ie)
```

These commands display the block types of all blocks in the mx + b system (the current system), described in "Masked Subsystem Example" in "Using Simulink".

```
blks = find_system(gcs, 'Type', 'block');
listblks = get_param(blks, 'BlockType')

listblks =

    'SubSystem'
    'Inport'
    'Constant'
    'Gain'
    'Sum'
    'Outport'
```

This command returns the name of the currently selected block.

```
get_param(gcb, 'Name')
```

The following commands get the attributes of the currently selected block's Name parameter.

```
p = get_param(gcb, 'ObjectParameters');
a = p.Name.Attributes

ans =
    'read-write'    'always-save'
```

The following command gets the dialog parameters of a Sine Wave block.

```
p = get_param('untitled/Sine Wave', 'DialogParameters')
p =
    'Amplitude'
    'Frequency'
    'Phase'
    'SampleTime'
```

See Also   find_system, set_param

libinfo

Purpose   Get information about the library blocks referenced by a model

Syntax   libdata = libinfo('sys')

Description libdata = libinfo('sys') returns information about library blocks
referenced by sys and all of the systems underneath it. The command
returns an array of structures that describes each library block
referenced by the model. Each structure has the following fields:

- Block

  Path of the link to the library block.

- Library

  Name of the library containing the referenced block.

- ReferenceBlock

  Path of the library block.

- LinkStatus

  Value of the LinkStatus parameter for the link to the library block.

This command also accepts search constraints as additional arguments.
For instance:

```
libdata=libinfo(Sys,'FollowLinks','off')
```

See find_system for more information.

load_system

Purpose   Invisibly load a Simulink model

Syntax   load_system('*sys*')

Description load_system('sys') loads 'sys', where sys is the name of a Simulink
model, into memory without making its model window visible.

Examples   The command

    load_system('vdp')

loads the vdp sample model into memory.

See Also   close_system, open_system

modeladvisor

Purpose   Open the Model Advisor

Syntax   `modeladvisor(model)`

Description   `modeladvisor(model)` opens the Model Advisor (see the "Consulting the Model Advisor" in "Using Simulink") on the model or subsystem specified by model, where `model` is a path or handle to the `model` or subsystem. If the specified model or subsystem is not open, this command opens it.

Examples   The command

```
modeladvisor('vdp')
```

opens the Model Advisor on the `vdp` demo model.

The command

```
modeladvisor('f14/Aircraft Dynamics Model')
```

opens the Model Advisor on the Aircraft Dynamics Model subsystem of the `f14` demo model. The command

```
modeladvisor(gcs)
```

opens the Model Advisor on the currently selected subsystem.

The command

```
modeladvisor(bdroot)
```

opens the Model Advisor on the currently selected model.

Purpose   Create an empty Simulink system

Syntax   ```
new_system('sys')
new_system('sys', 'Model')
new_system('sys', 'Model', 'subsystem_path')
new_system('sys', 'Model', 'ErrorIfShadowed')
new_system('sys', 'Library')
```

**Description**    `new_system('sys')` or `new_system('sys', 'Model')` creates an empty system where *'sys'* is the name of the new system. This command displays an error if *'sys'* is a MATLAB keyword, `'simulink'`, or more than 63 characters long.

`new_system('sys', 'Model', 'subsystem_path')` creates a system from a subsystem where `'subsystem_path'` is the full path of the subsystem. The model that contains the subsystem must be open when this command is executed.

`new_system('sys', 'Model', 'ErrorIfShadowed')` creates an empty system having the specified name. This command generates an error if another model, M-file, or variable of the same name exists on the MATLAB path or workspace.

`new_system('sys', 'Library')` creates an empty library.

---

**Note** The `new_system` command does not open the window of the system or library that it creates.

---

See Chapter 10, "Model and Block Parameters" for a list of the default parameter values for the new system.

**Examples**    This command creates a new system named `'mysys'`.

```
new_system('mysys')
```

new_system

The command

```
new_system('mysys','Library')
```

creates, but does not open, a new library named 'sys'.

The command

```
new_system('vdp','Model','ErrorIfShadowed')
```

returns an error because 'vdp' is the name of a model on the MATLAB path.

The commands

```
load_system('f14')
new_system('mycontroller','Model','f14/Controller')
```

create a new model named mycontroller that has the same contents as does the subsystem named Controller in the f14 demo model.

See Also   close_system, open_system, save_system

Purpose   Open a Simulink system window or a block dialog box

Syntax
```
open_system('sys')
open_system('blk')
open_system('blk', 'force')
open_system('blk', 'parameter')
open_system('blk', 'mask')
open_system('blk', 'OpenFcn')
open_system('sys', 'replace')
open_system('sys', 'reuse')
```

Description   open_system('sys') opens the specified system or subsystem window, where 'sys' is the name of a model on the MATLAB path, the fully qualified pathname of a model, or the relative pathname of a subsystem of an already open system (for example, engine/Combustion). On UNIX, the fully qualified pathname of a model can start with a tilde (~), signifying your home directory.

open_system('blk'), where 'blk' is a full block pathname, opens the dialog box associated with the specified block. If the block's OpenFcn callback parameter is defined, the routine is evaluated.

open_system('blk', **'force'**), where 'blk' is a full pathname or a masked system, looks under the mask of the specified system. This command is equivalent to using the **Look Under Mask** menu item.

open_system('blk', 'parameter') opens this block's parameter dialog box.

open_system('sys', 'mask') opens this block's mask.

open_system('blk', 'OpenFcn') runs this block's open function.

open_system('sys', 'replace') the window of the parent system with the window of the subsystem opened by this command.

open_system('sys', 'reuse') uses the parent system's window to display the subsystem opened by this command.

open_system

Note Use the MATLAB `sprintf` command to insert carriage return or line feed characters into paths passed to the open_system command. For example, the path to the Aircraft Dynamics Model subsystem of the f14 demo model contains line feeds. To open the subsystem, enter the following command at the MATLAB command line:

```
open_system(['f14/Aircraft' sprintf('\n') 'Dynamics' sprintf('\n') 'Mod
```

Examples   This command opens the `controller` system in its default screen location.

```
open_system('controller')
```

This command opens the block dialog box for the Gain block in the `controller` system.

```
open_system('controller/Gain')
```

Suppose that `mymodel` contains a masked subsystem, A, and a block, B, whose `OpenFcn` contains the following lines:

```
open_system('mymodel/B', 'parameter');
open_system('mymodel/A', 'mask');
```

Then opening block B causes both the parameter dialog box for B and the mask dialog box for A to appear.

See Also   close_system, load_system, new_system, save_system

Purpose   Replace blocks in a Simulink model

Syntax   replace_block('sys', 'blk1', 'blk2', 'noprompt')
                     replace_block('sys', 'Parameter', 'value', 'blk', ...)

Description   replace_block('sys', 'blk1', 'blk2') replaces all blocks in 'sys'
                     having the block or mask type 'blk1' with 'blk2'. If 'blk2' is a
                     Simulink built-in block, only the block name is necessary. If 'blk' is in
                     another system, its full block pathname is required. If 'noprompt' is
                     omitted, Simulink displays a dialog box that asks you to select matching
                     blocks before making the replacement. Specifying the 'noprompt'
                     argument suppresses the dialog box from being displayed. If a return
                     variable is specified, the paths of the replaced blocks are stored in that
                     variable.

                     replace_block('sys', 'Parameter', 'value', ..., 'blk')
                     replaces all blocks in 'sys' having the specified values for the specified
                     parameters with 'blk'. You can specify any number of parameter
                     name/value pairs.

                     Note Because it may be difficult to undo the changes this command
                     makes, it is a good idea to save your system first.

Examples   This command replaces all Gain blocks in the f14 system with
                     Integrator blocks and stores the paths of the replaced blocks in
                     RepNames. Simulink lists the matching blocks in a dialog box before
                     making the replacement.

```
RepNames = replace_block('f14','Gain','Integrator')
```

replace_block

This command replaces all blocks in the Unlocked subsystem in the
clutch system having a Gain of 'bv' with the Integrator block.
Simulink displays a dialog box listing the matching blocks before
making the replacement.

```
replace_block('clutch/Unlocked','Gain','bv','Integrator')
```

This command replaces the Gain blocks in the f14 system with
Integrator blocks but does not display the dialog box.

```
replace_block('f14','Gain','Integrator','noprompt')
```

See Also   find_system, set_param

Purpose   Save a Simulink system

Syntax
```
save_system
save_system('sys')
save_system('sys', 'newname')
save_system('sys', 'newname', 'BreakLinks')
save_system('sys', 'newname', 'SaveModelWorkspace')
save_system('sys', 'newname', 'BreakLinks', 'SaveModelWorkspace')
save_system('sys', 'newname', 'ErrorIfShadowed')
save_system('sys', 'newname', '', 'version')
save_system('sys', 'newname', 'BreakLinks', 'version')
```

Description   save_system saves the current top-level system to a file with its current name.

save_system('sys') saves the specified top-level system to a file with its current name. The system must be open.

save_system('sys', 'newname') saves the specified top-level system to a file with the specified new name. The system to be saved must be open. The new name can be a file name, in which case Simulink saves the system in the working directory, or a fully qualified pathname. On UNIX, the fully qualified pathname can start with a tilde (~), signifying your home directory. This command displays an error if you enter any of the following as the new model name:

   A MATLAB keyword
   'simulink'
   More than 63 characters

save_system('sys', 'newname', 'BreakLinks') saves the specified top-level system to a file with the specified new name, replacing links to library blocks with copies of the library blocks in the saved file.

save_system('sys', 'newname', 'SaveModelWorkspace') saves the specified top-level system to a file with the specified new name. If the model workspace DataSource is a MAT-file, this command also saves

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the contents of the model workspace. 'SaveModelWorkspace' is most useful when `DataSource` is a MAT-file.

save_system(*'sys'*, *'newname'*, 'BreakLinks','SaveModelWorkspace') saves the specified top-level system to a file with the specified new name, replacing links to library blocks with copies of the library blocks in the saved file. If the model workspace `DataSource` is a MAT-file, this command also saves the contents of the model workspace. 'SaveModelWorkspace' is most useful when `DataSource` is a MAT-file. The positions of 'BreakLinks' and 'SaveModelWorkspace' are interchangeable.

save_system(*'sys'*, *'newname'*, 'ErrorIfShadowed',) saves the specified top-level system to a file with the specified new name. This command generates an error if the specified new name already exists on the MATLAB path or workspace.

save_system(*'sys'*, *'newname'*, '', *'version'*) saves the specified top-level system in a form that can be loaded by a specified version of Simulink. Valid values for *'version'* include 'R14', 'R13SP1', 'R13', 'R12P1', and 'R12'. If the system to be saved contains blocks not supported by the specified Simulink version, the command replaces the unsupported blocks with empty masked subsystem blocks colored yellow. As a result, the converted system may generate incorrect results.

save_system(*'sys'*, *'newname'*, 'BreakLinks', *'version'*) saves the specified top-level system with broken library links and in a form compatible with a specified version of Simulink.

Examples   This command saves the current system.

    save_system

This command saves the vdp system.

    save_system('vdp')

This command saves the vdp system to a file with the name 'myvdp'.

```
save_system('vdp', 'myvdp')
```

This command saves the vdp system to a file with the name 'myvdp' and replaces links to library blocks with copies of the library blocks in the saved file.

```
save_system('vdp','myvdp','BreakLinks')
```

This command tries to save the vdp system to a file with the name 'max', but returns an error because 'max' is the name of a MATLAB function.

```
save_system('vdp', 'max', 'ErrorIfShadowed')
```

This command saves the vdp system to Simulink Version R13SP1 with the name 'myvdp'. It does not replace links to library blocks with copies of the library blocks.

```
save_system('vdp','myvdp','','R13SP1)
```

See Also   close_system, new_system, open_system

setActiveConfigSet

Purpose	Sets a model's active configuration set
Syntax	setActiveConfigSet(`'model'`, `'configSetName'`)
Description	setActiveConfigSet(`'model'`, `'configSetName'`) sets the active configuration set of model, where model is the name of an open model, to *configSetName*, where *configSetName* specifies the name of one of the model's configuration sets.
Examples	The following example

```
setActiveConfigSet(gcs, 'develConfigSet');
```

makes it the active configuration set of the currently selected model.

See Also	attachConfigSet, getActiveConfigSet

Purpose   Set Simulink system and block parameters

Syntax

```
set_param('obj', 'parameter1', value1, 'parameter2', value2, ...)
set_param(0, 'modelparm1', value1, 'modelparm2', value2, ...)
```

Description   `set_param('obj', 'parameter1', value1, 'parameter2', value2, ...)`, where `'obj'` is a system or block path, sets the specified parameters to the specified values. Value strings are case sensitive. Case is ignored for parameter names. Any parameters that correspond to dialog box entries have string values. Model and block parameters are listed in Chapter 10, "Model and Block Parameters".

`set_param(0, 'modelparm1', value1, 'modelparm2', value2, ...)` sets the specified model parameters to default values, i.e., to values that Simulink assigns to the parameters when it creates a model. You can use this form of `set_param` in your MATLAB startup file to specify your own default values for Simulink model parameters.

You can change block parameter values in the workspace during a simulation and update the block diagram with these changes. To do this, make the changes in the command window, then make the model window the active window, then choose **Update Diagram** from the **Edit** menu.

Note Most block parameter values must be specified as strings. Two exceptions are the `Position` and `UserData` parameters, common to all blocks.

Examples   This command sets the `Solver` and `StopTime` parameters of the `vdp` system.

```
set_param('vdp', 'Solver', 'ode15s', 'StopTime', '3000')
```

This command sets the Gain parameter of block Mu in the vdp system to 1000.

```
set_param('vdp/Mu', 'Gain', '1000')
```

This command sets the position of the Fcn block in the vdp system.

```
set_param('vdp/Fcn', 'Position', [50 100 110 120])
```

This command sets the Zeros and Poles parameters for the Zero-Pole block in the mymodel system.

```
set_param('mymodel/Zero-Pole','Zeros','[2 4]','Poles','[1 2 3]')
```

This command sets the Gain parameter for a block in a masked subsystem. The variable k is associated with the Gain parameter.

```
set_param('mymodel/Subsystem', 'k', '10')
```

This command sets the OpenFcn callback parameter of the block named Compute in system mymodel. The function 'my_open_fcn' executes when you double-click on the Compute block (see "Using Callback Functions").

```
set_param('mymodel/Compute', 'OpenFcn', 'my_open_fcn')
```

See Also   find_system, get_param

Purpose   Create and access Signal Builder blocks

Syntax
```
[time, data] = signalbuilder(block)
[time, data, siglabels] = signalbuilder(block)
[time, data, siglabels, grouplabels] = signalbuilder(block)
block = signalbuilder([],'create', time, data, siglabels,
grouplabels)
block = signalbuilder(block,'append', time, data, siglabels,
grouplabels)
[time, data] = signalbuilder(block,'get', signal, group)
signalbuilder(block, 'set', signal, group, time, data)
index = signalbuilder(block, 'activegroup')
signalbuilder(block, 'activegroup', index)
```

Description   [*time*, *data*] = signalbuilder(*block*) returns the time (x coordinate) and amplitude (y coordinate) data of the Signal Builder *block*.

The output arguments, time and data, take different formats depending on the block configuration:

Configuration	Time/Data Format
1 signal, 1 group	Row vector of break points.
>1 signal, 1 group	Column cell vector where each element corresponds to a separate signal and contains a row vector of breakpoints.
1 signal, >1 group	Row cell vector where each element corresponds to a separate group and contains a row vector of breakpoints.
>1 signal, >1 group	Cell matrix where each element (i,j) corresponds to signal i and group j.

[*time*, *data*, *siglabels*] = signalbuilder(*block*) returns the signal labels, *siglabels*, in a string or a cell array of strings.

signalbuilder

[*time*, *data*, *siglabels*, *grouplabels*] = signalbuilder(*block*)
returns the group labels, *grouplabels*, in a string or a cell array of
strings.

block = signalbuilder([],'create', *time*, *data*, *siglabels*,
grouplabels) creates a Signal Builder block in a new Simulink model
using the specified values. If *data* is a cell array and *time* is a vector,
the *time* values are duplicated for each element of data. Each vector
in *time* and *data* must be the same length and have at least two
elements. If *time* is a cell array, all elements in a column must have
the same initial and final value. Signal labels, *siglabels*, and group
labels, *grouplabels*, can be omitted to use default values. The function
returns the path to the new block, *block*.

block = signalbuilder(*block*,'append', *time*, *data*, *siglabels*,
grouplabels) appends new groups to the Signal Builder block, *block*.
The *time* and *data* arguments must have the same number of signals
as the existing block.

Get/Set Methods for Specific Signals and Groups

[*time*, *data*] = signalbuilder(*block*,'get', *signal*, *group*) gets
the time and data values for the specified signal(s) and group(s). The
signal argument can be the name of a signal, a scalar index of a signal,
or an array of signal indices. The group argument can be a group label,
a scalar index, or an array of indices.

signalbuilder(*block*,'set', *signal*, *group*, *time*, *data*) sets the
time and data values for the specified signal(s) and group(s). Use empty
values of *time* and *data* to remove groups and signals.

Query and Set the Active Group

index = signalbuilder(*block*, 'activegroup') gets the index of
the active group.

signalbuilder(*block*, 'activegroup', *index*) sets the active group
index to *index*.

Purpose   Open the Simulink block library

Syntax   simulink
                   simulink('open')
                   simulink('close')

Description   On Microsoft Windows, simulink or simulink('open') opens the
                   Simulink block library browser. On UNIX, the command opens the
                   Simulink library window. simulink('close') closes the library window.

Simulink.Bus.cellToObject

Purpose   Convert a cell array containing bus information to bus objects

Syntax   Simulink.Bus.cellToObject(*busCell*)

Description   Simulink.Bus.cellToObject(busCell) creates a set of bus objects in the MATLAB base workspace from a cell array of bus information.

See Also   Simulink.Bus.save

Purpose   Creates bus objects for blocks

Syntax   busInfo = Simulink.Bus.createObject(model, blks)
                  busInfo = Simulink.Bus.createObject(model, blks, 'fileName')
                  busInfo = Simulink.Bus.createObject(model, blks, 'fileName',
                   'format')

Description   Simulink.Bus.createObject(*model*, *blks*, *'fileName'*, *'format'*') creates
                  bus objects, i.e., instances of Simulink.Bus class, in the MATLAB
                  workspace for specified blocks and optionally saves the bus objects in an
                  M-file. The function accepts the following arguments:

                  • *model* — Name or handle of a model

                  • *blks* — List of subsystem-level Inport blocks, root-level or
                    subsystem-level Outport blocks or Bus Creator blocks in the specified
                    model. If only one block needs to be specified, this argument can be
                    the full pathname of the block. Otherwise, this argument can be
                    either a cell array containing block pathnames or a vector of block
                    handles.

                  • *'fileName'* — Name of the file in which to save the bus objects
                    created by this function. If this argument is omitted, this function
                    does not save the created bus objects in a file.

                  • *'format'* — Format used to store the bus objects. May be 'cell' or
                    'object' or omitted in which case 'cell' is assumed. Use cell array
                    format to save the objects in a compact form.

                  This function returns a structure array containing bus information for
                  the specified blocks. Each element of the structure array corresponds to
                  one of the specified blocks and contains the following fields:

                  • block — Handle of the block

                  • busName — Name of the bus object associated with the block

See Also   Simulink.Bus.cellToObject, Simulink.Bus.save

Simulink.Bus.save

Purpose   Save bus objects in an M-file

Syntax
```
Simulink.Bus.save('fileName')
Simulink.Bus.save('fileName', 'format')
Simulink.Bus.save('fileName', 'format', busNames)
```

Description   Simulink.Bus.save(*'fileName'*, *'format'*, *busNames*) saves bus objects, i.e., instances of Simulink.Bus class, residing in the MATLAB workspace in an M-file. Executing the M-file restores the objects to the workspace. This function takes the following arguments:

- *'fileName'* — Name of the file in which to store the bus objects

- *'format'* — Format used to store the bus objects. May be 'cell' or 'object' or omitted in which case 'cell' is assumed. Use cell array format to save the objects in a compact form.

- *busNames* — A cell array containing names of bus objects to be saved. If the cell array is empty or omitted, this function saves all bus objects in the MATLAB workspace.

See also   Simulink.Bus.cellToObject

Simulink.SubSystem.convertToModelReference

Purpose   Converts an atomic subsystem to a model reference

Syntax
```
[success,mdlRefBlkH] =
Simulink.SubSystem.convertToModelReference(subsys,
mdlRef, 'opt1', 'val1', 'opt2', 'val2', ...)
```

Description
```
[success,mdlRefBlkH] =
Simulink.SubSystem.convertToModelReference(subsys, mdlRef,
'opt1', 'val1', 'opt2', 'val2', ...)
```
converts an atomic subsystem to a model reference. It does this by creating a model, copying the contents of the subsystem into the model, and reconfiguring the root level Inport and Outport blocks and configuration parameters of the new model. Then, based on its input arguments, this function either replaces the subsystem block with a Model block that references the new model, or it creates another, temporary model containing a Model block that references the model derived from the subsystem block.

Note Execute

```
sldemo_mdlref_conversion
```

at the MATLAB command line for a demonstration of this command's usage.

To be converted, your model must specify the following configuration parameter settings:

- The **Inline parameters** option in the **Optimization** pane must be on.

- The **Signal resolution** option in the **Data Validity** diagnostics pane must be set to Explicit only.

- The **Mux blocks used to create bus signals** diagnostic in the **Connectivity** diagnostics pane must be set to Error.

Simulink.SubSystem.convertToModelReference

You can use the following commands to set these parameters to the values required by this function:

```
set_param(mdlName, 'InlineParams', 'on');
set_param(mdlName, 'SignalResolutionControl', 'UseLocalSettings');
set_param(mdlName, 'StrictBusMsg', 'ErrorLevel1');
```

Note This function produces error or warning messages for models and subsystems that it cannot handle. Even if conversion is successful, you may still need to reconfigure the resulting model to meet your requirements.

This function accepts the following arguments:

- *subsys* — Full name or handle of the atomic subsystem block to be converted

- *mdlRef* — Name of the model to which the subsystem is to be converted

- *'opt1'*, *'val1'*, *'opt2'*, *'val2'*... — parameter/value pairs that specify various conversion options. This function support the following option pairs:

  - `'Replace Subsystem'`, `[true|{false}]` — If the option value is true, this function replaces the subsystem block with a Model block that references the model created from the subsystem. If you do not specify this option or specify its value as false, this function creates and opens a model containing a Model block that references the model derived from the subsystem block.

  - `'BusSaveFormat'`, `['Cell' | 'Object']` — If this option is specified, the function saves the bus objects that it creates in an M-file. See `Simulink.Bus.save` for more information.

  - `'BuildTarget'`, `['Sim' | 'RTW']` — If you specify this option, this function generates a model reference Sim or RTW target for the new model.

- • 'Force', [true|{false}] — If this parameter is true, this function reports some errors that would halt the conversion process as warnings and continues with the conversion. This allows you to use this function to do the initial steps of conversion and then complete the conversion process yourself. If you do not specify this option or specify it as false, this function halts the conversion if an error occurs.

This function returns the following outputs:

- • *success* — True if this function is successful; otherwise, false.
- • *mdlRefBlkH* — Handle of the Model block that references the new model

See Also   Simulink.Bus.save

slCharacterEncoding

Purpose   Change the MATLAB character set encoding

Syntax   slCharacterEncoding()
slCharacterEncoding(encoding)

Description   This command allows you to change the current MATLAB character set encoding to be compatible with the encoding of a model that you want to open.

slCharacterEncoding() returns the current MATLAB character set encoding.

slCharacterEncoding(encoding) change the MATLAB character set encoding to the specified encoding. Valid values include:

- 'US-ASCII'
- 'UTF-8'
- 'Shift_JIS'
- 'ISO-8859-1'

To display a complete list of the names of character set encodings supported by MATLAB and the characters supported by the encodings, use the ICU Converter Explorer. The first column of the ICU Converter Explorer lists the primary names of the character sets supported by MATLAB. The remaining columns list aliases for the character sets.

The `slCharacterEncoding` command accepts the aliases as well as the primary names of character sets. To display a table listing the characters supported by a character set and the encodings for the characters, click the character set's primary name in the ICU Converter Explorer.

Note You must close all open models or libraries before changing the MATLAB character set encoding except when changing from `'US-ASCII'` to another encoding.

---

sldiscmdl

Purpose   Discretize a Simulink model containing continuous blocks

Syntax
```
sldiscmdl('sys',sampletime)
sldiscmdl('sys',sampletime,'method')
sldiscmdl('sys',sampletime,{options})
sldiscmdl('sys',sampletime,'method',cf)
sldiscmdl('sys',sampletime,'method',{options})
sldiscmdl('sys',sampletime,'method',cf,{options})
```

Description   sldiscmdl('sys',sampletime) discretizes the model specified by 'sys' and sampletime. You can enter a sample time and an offset as a two-element vector for sampletime. The units for sampletime are seconds.

sldiscmdl('sys',sampletime,'method') discretizes the model with the transform method specified by 'method'. Available values for 'method' are shown below:

Value	Description
'zoh'	Zero-order hold on the inputs (the default if you do not specify a method)
'foh'	First-order hold on the inputs
'tustin'	Bilinear (Tustin) approximation
'prewarp'	Tustin approximation with frequency prewarping
'matched'	Matched pole-zero method (for SISO systems only)

sldiscmdl('sys',sampletime,{options}) discretizes the model with the criteria specified by {options}, where {options} is a cell array containing the following string elements:

{'target','ReplaceWith','PutInto','prompt'}

Available values for `'target'` are shown below:

Value	Description
`'all'`	Discretize all continuous blocks
`'selected'`	Discretize selected blocks only
`'<full path name of block>'`	Discretize specified block

Available values for `'ReplaceWith'` are shown below:

Value	Description
`'parammask'`	Create discrete blocks whose parameters are retained from the corresponding continuous block
`'hardcoded'`	Create discrete blocks whose parameters are "hard_coded" values placed directly into the block's dialog box.

Available values for `'PutInto'` are shown below:

Value	Description
`'current'`	Apply discretization to current model
`'configurable'`	Create discretization candidate in a configurable subsystem
`'untitled'`	Create discretization in a new untitled window
`'copy'`	Create discretization in copy of the original model

Available values for `'prompt'` are shown below:

Value	Description
`'on'`	Show the discretization information
`'off'`	Do not show the discretization information

`sldiscmdl('sys',sampletime,'method',cf)` discretizes the model with the critical frequency specified by `cf`. The units for `cf` are Hz. This is only used when the transform method is `'prewarp'`.

Examples

This command discretizes all of the continuous blocks in the f14 model with a 1 second sample time.

```
sldiscmdl('f14',1.0)
```

This command discretizes the Controller subsystem in the f14 model using a first-order hold transform method with a 1–second sample time and a 0.1–second sample time offset. The discretized block has "hard-coded" parameters that are placed directly into the block's dialog box.

```
sldiscmdl('f14',[1.0 0.1],'foh',{'f14/Controller',...
'hardcoded','copy','on'})
```

This command discretizes the Controller subsystem in the f14 model using a zero-order hold transform method with a 1–second sample time and a 0.1–second sample time offset. It returns to the command window a cell array for the original continuous blocks in the system and a cell array for the discretized blocks in the system.

```
[a, b] = sldiscmdl('f14',[1.0 0.1],'zoh', {'f14/Controller',...
'hardcoded', 'copy', 'on'})
a =

    [1x43 char]    [1x37 char]    [1x53 char]    [1x30 char]


b =

    [1x43 char]    [1x37 char]    [1x53 char]    [1x30 char]
```

You can index into the cell arrays to get the new names of the discretized blocks and the original names of the continuous blocks.

For example, this command returns the name of the second discretized block.

```
b{2}

ans =

f14_disc_copy/Controller/Pitch Rate
Lead Filter
```

slmdldiscui

Purpose   Open the Model Discretizer GUI

Syntax   slmdldiscui('name')

Description   slmdldiscui('name') opens the Model Discretizer with the library or
                  model specified by 'name'.

Examples   This command opens the Model Discretizer with the f14 model.

```
slmdldiscui('f14')
```

This command opens the Model Discretizer with the library named Test.

```
slmdldiscui('Test')
```

Purpose   Replace Mux blocks used to create buses with Bus Creator blocks

Syntax   `[muxes, uniqueMuxes, uniqueBds] = slreplace_mux(model, reportonly)`

Description   `slreplace_mux(model)` or `slreplace_mux(model, true)` reports all Mux blocks that create buses in `model` and in libraries referenced by `model`.

A signal created by a Mux block is a bus if the signal meets either or both of the following conditions:

- A Bus Selector block individually selects one or more of the signal's elements (as opposed to the entire signal).

- The signal's components have different data types, numeric types (complex or real), dimensionality, storage classes, or sampling modes.

> **Note** Before running this command, you should set the **Mux blocks used to create bus signals** connectivity diagnostic to `warning` or `none`. See "Connectivity Diagnostics" for more information.

`slreplace_mux(model, false)` replaces all Mux blocks in `model` that create buses, including Mux blocks in libraries, with Bus Creator blocks. This command saves the model, if changed, and saves and closes any library that it modifies.

> **Note** You should make a backup copy of your model and libraries before using this form of the command because it is difficult to undo its effects.

slreplace_mux

```
[muxes, uniqueMuxes, uniqueBds] = slreplace_mux(model)
```
returns the following output variables:

- `muxes`

  All Mux blocks used as Bus Creators in the model and in libraries referenced by the model

- `uniqueMuxes`

  All Mux blocks used as Bus Creators in the model and in libraries referenced by the model except blocks in the model that are copies of blocks in libraries

- `uniqueBds`

  Models and libraries that use Mux blocks as Bus Creators

Purpose   Replace blocks from previous releases with the latest versions

Syntax   slupdate('*sys*')
slupdate('*sys*', *prompt*)
slupdate('*sys*', 'OperatingMode', 'Analyze')

Description slupdate('*sys*') replaces blocks in model *sys* from a previous release
of Simulink with the latest versions.

Note The model to be updated must be open when you call slupdate.

---

slupdate('*sys*', *prompt*) specifies whether to prompt you before
replacing a block. If *prompt* equals 1, the command prompts you before
replacing the block. The prompt asks whether you want to replace the
block. Valid responses are

• y

  Replace the block (the default).

• n

  Do not replace the block.

• a

  Replace this and all subsequent obsolete blocks without further
  prompting.

If *prompt* equals 0, the command replaces all obsolete blocks without
prompting you.

In addition to replacing obsolete blocks, slupdate

• Reconnects broken links to masked blocks in libraries provided by
  the MathWorks to ensure that the model reflects changes made to the
  blocks in this release. This will overwrite any customizations that
  you have made to the masks of these blocks.

slupdate

- Updates obsolete configuration settings for the model.

  slupdate('*sys*', 'OperatingMode', 'Analyze') performs only
  the analysis portion without updating or changing the model. This
  command analyzes referenced models, linked libraries, and S-functions,
  and then returns a data structure with the following fields:

- Message — string containing a message summarizing the results

- blockList — cell array listing blocks that need to be updated

- blockReasons — cell array listing reasons for updating the
  corresponding blocks

- modelList — cell array listing referenced models and the parent
  model

- libraryList — cell array listing non-MathWorks libraries referenced

- configSetList — for internal use

- sfunList — cell array listing S-functions referenced

- sfunOK — logical array representing S-function status, where false
  indicates that an S-function needs updating and true indicates
  otherwise

- sfunType — cell array listing apparent S-function type (e.g., m, mex)

view_mdlrefs

Purpose Display a graph of model reference dependencies

Syntax view_mdlrefs('*model_name*')

Description view_mdlrefs('model_name') displays a graph of model reference dependencies for the model specified by model_name. The nodes in the graph represent Simulink models. The directed lines indicate model dependencies. For more information, see the sldemo_mdlref_depgraph demo.

See Also find_mdlrefs

Simulation Commands

The following section describes commands that you can use to run simulations manually.

Task-Oriented Command List

This table lists the tasks performed by commands described in this section. An alphabetical list follows.

Task	Command
Simulate a dynamic system represented by a Simulink model.	`sim`
Get simulation options.	`simget`
Set simulation options.	`simset`
Plot simulation output.	`simplot`
Execute a particular phase of the simulation of a model.	`model`
Display diagnostic information about a Simulink system.	`sldiagnostics`
Build simulation targets for models referenced by this model.	`slbuild`
Unpack a signal log.	`unpack`
List the names of signal logging objects in a signal log container object.	`who`
List the names and types of signal logging objects in a signal log container object.	`whos`
Register a listener for a block method execution event.	`add_exec_event_listener`

Simulation Commands — Alphabetical List

add_exec_event_listener
model
sim
simget
simplot
simset
slbuild
sldebug
sldiagnostics
unpack
who
whos

add_exec_event_listener

Purpose	Register a listener for a block method execution event
Syntax	h = add_exec_event_listener(**blk, event, listener**);

Description   h = add_exec_event_listener(**blk, event, listener**) registers a listener for a block method execution event where the listener is an M-file program that performs some task, such as logging runtime data for a block, when the event occurs (see "Listening for Method Execution Events" in "Using Simulink" for more information). Simulink invokes the registered listener whenever the specified event occurs during simulation of the model.

Note Simulink can register a listener only while a simulation is running. Invoking this function when no simulation is running results in an error message. To ensure that a listener catches all relevant events triggered by a model's simulation, you should register the listener in the model's StartFcn callback function (see "Model Callback Functions").

Arguments   blk

Specifies the block whose method execution event the listener is intended to handle. May be one of the following:

- Full pathname of a block

- A block handle

- A block runtime object (see "Accessing Block Data During Simulation" in "Using Simulink".)

event

Specifies the type of event for which the listener listens. It may be any of the following:

Event	Occurs...
'PreDerivatives'	Before a block's Derivatives method executes
'PostDerivatives'	After a block's Derivatives method executes
'PreOutputs'	Before a block's Outputs method executes.
'PostOutputs'	After a block's Outputs method executes
'PreUpdate'	Before a block's Update method executes
'PostUpdate'	After a block's Update method executes

listener

Specifies the listener to be registered. It may be either a string specifying a MATLAB expression, e.g., 'disp(''here'')' or a handle to a MATLAB function that accepts two arguments. The first argument is the block runtime object of the block that triggered the event. The second argument is an instance of EventData class that specifies the runtime object and the name of the event that just occurred.

Return Value

add_exec_event_listener returns a handle to the listener that it registered. To stop listening for an event, use the MATLAB clear command to clear the listener handle from the workspace in which the listener was registered.

model

Purpose   Execute a particular phase of the simulation of a model

Syntax
```
[sys,x0,str,ts] = model([],[],[],'sizes');
[sys,x0,str,ts] = model([],[],[],'compile');
outputs = model(t,x,u,'outputs');
derivs = model(t,x,u,'derivs');
dstates = model(t,x,u,'update');
model([],[],[],'term');
```

Description The `model` command executes a specific phase of the simulation of a
Simulink model whose name is `model`. The command's last (`flag`)
argument specifies the phase of the simulation to be executed. See
"Simulating Dynamic Systems" for a description of the steps that
Simulink uses to simulate a model.

This command is intended to allow linear analysis and other M-file
program-based tools to run a simulation step by step, gathering
information about the model's states and outputs at each step. It is not
intended to be used to run a model step by step, for example, to debug a
model. Use the Simulink debugger if you need to examine intermediate
results to debug a model.

Arguments

sys	Vector of model size data: • sys(1) = number of continuous states • sys(2) = number of discrete states • sys(3) = number of outputs • sys(4) = number of inputs • sys(5) = reserved • sys(6) = direct-feedthrough flag (1 = yes, 0 = no) • sys(7) = number of sample times (= number of rows in ts)
x0	Vector containing the initial conditions of the system's states
str	Vector of names of the blocks associated with the model's states. The state names and initial conditions appear in the same order in str and x0, respectively.
ts	An *m*-by-2 matrix containing the sample time (period, offset) information
outputs	Outputs of the model at time step t.
derivs	Derivatives of the continuous states of the model at time t.
dstates	Discrete states of the model at time t.
t	Time step
x	State vector

u	Inputs
flag	String that indicates the simulation phase to be executed: • `'sizes'` executes the size computation phase of the simulation. This phase determines the sizes of the model's inputs, outputs, state vector, etc. • `'compile'` executes the compilation phase of the simulation. The compilation phase propagates signal and sample time attributes. It is equivalent to selecting the **Update Diagram** (**Ctrl-D**) option from the Simulink **Edit** menu. • `'update'` computes the next values of the model's discrete states. • `'outputs'` computes the outputs of the model's blocks at time `t`. • `'derivs'` computes the derivatives of the model's continuous states at time step `t`. • `'term'` causes Simulink to terminate simulation of the model.

Examples This command executes the compilation phase of the `vdp` model that comes with Simulink.

```
vdp([], [], [], 'compile')
```

The following command terminates the simulation initiated in the previous example.

```
vdp([], [], [], 'term')
```

Note You must always terminate simulation of the model by invoking the model command with the `'term'` command. Simulink does not let you close the model until you have terminated the simulation.

See Also   sim

sim

Purpose   Simulate a dynamic system

Syntax
```
[t,x,y] = sim(model,timespan,options,ut);
[t,x,y1, y2, ..., yn] = sim(model,timespan,options,ut);
```

Description   The sim command executes a Simulink model, using all **Configuration Parameters** dialog box settings, including the options specified on the **Data Import/Export** pane.

You can supply a null ([ ]) matrix for any right-side argument except the first (the model name). The sim command uses default values for unspecified arguments and arguments specified as null matrices. The default values are the values specified by the model. You can set optional simulation parameters, using the sim command's options argument. Parameters set in this way override parameters specified by the model.

If you do not specify the left side arguments, the command logs the simulation data specified by the **Data Import/Export** pane of the **Configuration Parameters** dialog box (see "Data Import/Export Pane" in "Using Simulink").

If you want to simulate a continuous system, you must specify the solver parameter, using simset. The solver defaults to VariableStepDiscrete for purely discrete models.

Note The base workspace for a simulation launched by the sim command is the MATLAB workspace by default, with one exception. The exception is that the default workspace for To Workspace blocks is the current workspace, i.e., the workspace of the function that invoked the sim command. You can use the DstWorkspace and SrcWorkspace options of the sim command (see simset) to change these defaults. For example, suppose that you want to use the workspace of the function that invokes the sim command as the base workspace of the simulation. To do this, specify current as the value of the DstWorkspace and SrcWorkspace options.

Arguments

t	Returns the simulation's time vector.
x	Returns the simulation's state matrix consisting of continuous states followed by discrete states.
y	Returns the simulation's output matrix. Each column contains the output of a root-level Outport block, in port number order. If any Outport block has a vector input, its output takes the appropriate number of columns.
y1,...,yn	Each y_i returns the output of the corresponding root-level Outport block for a model that has n such blocks.
model	Name of a block diagram.
timespan	Simulation start and stop time. Specify as one of these: tFinal to specify the stop time. The start time is 0. [tStart tFinal] to specify the start and stop times. [tStart OutputTimes tFinal] to specify the start and stop times and time points to be returned in t. Generally, t will include more time points. OutputTimes is equivalent to choosing **Produce additional output** on the dialog box.

options	Optional simulation parameters specified as a structure created by the `simset` command (see `simset`).
ut	Optional external inputs to top-level Inport blocks. `ut` can be a MATLAB function (expressed as a string) that specifies the input `u = UT(t)` at each simulation time step, a table of input values versus time for all input ports, or a comma-separated list of tables, `ut1`, `ut2`, ..., each of which corresponds to a specific port. Tabular input for all ports can be in the form of a MATLAB array or a structure. Tabular input for individual ports must be in the form of a structure. See "Importing Data from the MATLAB Workspace" in the online documentation for a description of the array and structure input formats.

Examples   This command simulates the Van der Pol equations, using the vdp model that comes with Simulink. The command uses all default parameters.

```
[t,x,y] = sim('vdp')
```

This command simulates the Van der Pol equations, using the parameter values associated with the vdp model, but defines a value for the Refine parameter.

```
[t,x,y] = sim('vdp', [], simset('Refine',2));
```

This command simulates the Van der Pol equations for 1,000 seconds, saving the last 100 rows of the return variables. The simulation outputs values for t and y only, but saves the final state vector in a variable called xFinal.

```
[t,x,y] = sim('vdp', 1000, simset('MaxRows', 100,
          'OutputVariables', 'ty', 'FinalStateName', 'xFinal'));
```

See Also   simset, simget

simplot

Purpose	Plot simulation data in a figure window
Syntax	`simplot(data);` `simplot(time, data);`
Description	The `simplot` command plots output from a simulation in a Handle Graphics® figure window. The plot looks like the display on the screen of a Scope block. Plotting the output on a figure window allows you to annotate and print the output.

Arguments

data	Data produced by one of the Simulink output blocks (for example, a root-level Outport block or a To Workspace block) or in one of the output formats used by those blocks: **Array**, **Structure**, **Structure with time** (see "Data Import/Export Pane" in "Using Simulink").
time	The vector of sample times produced by an output block when you have selected **Array** or **Structure** as the simulation's output format. The `simplot` command ignores this argument if the format of the data is **Structure with time**.

Examples The following sequence of commands

```
vdp
set_param(gcs, 'SaveOutput', 'on')
set_param(gcs, 'SaveFormat', 'StructureWithTime')
sim(gcs)
simplot(yout)
```

plots the output of the vdp demo model on a figure window as follows.

See Also   sim, set_param

simget

Purpose   Get settings of a model's simulation parameters

Syntax
```
struct = simget(model)
value = simget(model, 'param')
value = simget(OptionStructure, param)
simget
```

Description   *struct* = simget(model) returns the current simulation parameter settings for the specified model as a structure compatible with the options argument of the sim command. You can use this command along with the simset command to override model-specified simulation options for a particular simulation run. See simset for more information. If the model uses a workspace variable to specify a simulation parameter, simget returns the variable's value, not its name. If the variable does not exist in the workspace, Simulink issues an error message.

value = simget(*model*, *'param'*) returns the value of the simulation parameter, *'param'*, specified by the model, *model*.

value = simget(*OptionStructure*, *param*) extracts the value of the specified simulation parameter from OptionStructure, returning an empty matrix if the value is not specified in the structure. param can be a cell array containing a list of parameter names. If a cell array is used, the output is also a cell array.

simget returns a structure containing the names of simulation parameters recognized by the simget command.

You need to enter only as many leading characters of a property name as are necessary to identify it.

Examples   This command retrieves the simulation options for the vdp model.

```
options = simget('vdp');
```

This command retrieves the value of the Refine property for the vdp model.

```
refine = simget('vdp', 'Refine');
```

See Also   sim, simset

simset

Purpose   Specify simulation options for simulations run via the `sim` command

Syntax
```
options = simset(param, value, ...);
options = simset(old_opstruct, param, value, ...);
options = simset(old_opstruct, new_opstruct);
simset
```

Description The `simset` command creates and returns the structure required by the `options` argument of the `sim` command. The structure specifies the simulation parameter values to be used for the simulation run initiated by the `sim` command to which the structure is passed.

> **Note** The parameter values specified by the structure apply only to the simulation run initiated by the `sim` command to which the structure is passed. They override the permanent values of the simulation parameters for that simulation run. If you want to set the permanent value of a simulation parameter, use the Model Editor's **Configuration Parameters** dialog box or the `set_param` command.

You can enter the values of the parameters as paired arguments of the simset command, e.g., `'Debug'`, `'on'`. You need enter only as many leading characters as are necessary to identify a parameter. The structure contains default values for parameters that you do not specify.

`options = simset(param, value, ...)` returns an options structure containing the specified values for the specified parameters and default values for unspecified parameters.

`options = simset(old_opstruct, param, value, ...)` modifies the specified parameters in `old_opstruct`, an existing structure. You can use this form of the command to override the values of simulation parameters specified by the model to be simulated. To do this, use the `simget` command to get the settings specified by the model and pass the settings to `simset` along with the parameters that you want to override.

`options = simset(old_opstruct, new_opstruct)` combines two existing options structures, `old_opstruct` and `new_opstruct`, into `options`. Any properties defined in `new_opstruct` overwrite the same properties defined in `old_opstruct`.

`simset` with no input arguments displays all parameter names and values that the `simset` command can specify.

Parameters
AbsTol   positive   scalar {1e-6}
  Absolute error tolerance. This scalar applies to all elements of the state vector. `AbsTol` applies only to the variable-step solvers.

Debug   'on' | {'off'} | cmds
  Debug. Starts the simulation in debug mode (see "Starting the Debugger" in "Using Simulink" for more information). The value of this option can be a cell array of commands to be sent to the debugger after it starts, e.g.,

```
opts = simset('debug', ...
  {'strace 4', ...
  'diary solvertrace.txt', ...
  'cont', ...
  'diary off', ...
  'cont'})
sim('vdp',[], opts);
```

Decimation   positive integer {1}
  Decimation for output variables. Decimation factor applied to the return variables t, x, and y. A decimation factor of 1 returns every data logging time point, a decimation factor of 2 returns every other data logging time point, etc.

DstWorkspace   base | {current} | parent
  Where to assign variables. Specifies the workspace in which to assign any variables defined as return variables or as output variables on the To Workspace block.

ExtrapolationOrder   1 | 2 | 3 | {4}
    ode14x extrapolation order. Specifies extrapolation order of the
    ode14x implicit fixed-step solver.

FinalStateName   string {''}
    Name of final states variable. This property specifies the name of
    a variable in which Simulink saves the model's states at the end
    of the simulation.

FixedStep   positive scalar
    Fixed step size. This property applies only to the fixed-step solvers.
    If the model contains discrete components, the default is the
    fundamental sample time; otherwise, the default is one-fiftieth of
    the simulation interval.

InitialState   vector {[]}
    Initial continuous and discrete states. The initial state vector
    consists of the continuous states (if any) followed by the discrete
    states (if any). InitialState supersedes the initial states
    specified in the model. The default, an empty matrix, causes the
    initial state values specified in the model to be used.

InitialStep   positive scalar {auto}
    Suggested initial step size. This property applies only to the
    variable-step solvers. The solvers try a step size of InitialStep
    first. By default, the solvers determine an initial step size
    automatically.

MaxOrder   1 | 2 | 3 | 4 | {5}
    Maximum order of ode15s. This property applies only to ode15s.

MaxDataPoints   nonnegative integer {0}
    Limit number of output data points. This property limits
    the number of data points returned in t, x, and y to the last
    MaxDataPoints data logging time points. If specified as 0, the
    default, no limit is imposed.

MaxStep   positive scalar {auto}
> *Upper bound on the step size*. This property applies only to the variable-step solvers and defaults to one-fiftieth of the simulation interval.

MinStep   [positive scalar, nonnegative integer] {auto}
> *Lower bound on the step size*. This property applies only to the variable-step solvers and defaults to one-fiftieth of the simulation interval.

NumberNewtonIterations   positive integer {1}
> *Number of Newton iterations*. Specifies number of Newton's Method iterations to be performed by the ode14x implicit fixed-step solver.

OutputPoints   {specified} | all
> *Determine output points*. When set to specified, the solver produces outputs t, x, and y only at the times specified in timespan. When set to all, t, x, and y also include the time steps taken by the solver.

OutputVariables   {txy} | tx | ty | xy | t | x | y
> *Set output variables*. If 't', 'x', or 'y' is missing from the property string, the solver produces an empty matrix in the corresponding output t, x, or y.

Refine   positive integer {1}
> *Output refine factor*. This property increases the number of output points by the specified factor, producing smoother output. Refine applies only to the variable-step solvers. It is ignored if output times are specified.

RelTol   positive scalar {1e-3}
> *Relative error tolerance*. This property applies to all elements of the state vector. The estimated error in each integration step satisfies

```
e(i) <= max(RelTol*abs(x(i)),AbsTol(i))
```

This property applies only to the variable-step solvers and defaults to 1e-3, which corresponds to accuracy within 0.1%.

```
Solver          VariableStepDiscrete |
                    ode45 | ode23 | ode113 | ode15s | ode23s |
                    FixedStepDiscrete |
                    ode5 | ode4 | ode3 | ode2 | ode1
```
Method to advance time. This property specifies the solver that is used to advance time.

```
SaveFormat      {base} | current | parent
```
Where to evaluate expressions. This property specifies the workspace in which to evaluate MATLAB expressions defined in the model.

```
SrcWorkspace    {'Array'} | 'Structure' | 'StructureWithTime'
```
How to save output to workspace. Specifies format for exporting model states and root-level outputs to the MATLAB workspace. See "Exporting Data to the MATLAB Workspace" for more information.

```
Trace           'minstep', 'siminfo', 'compile' {''}
```
Tracing facilities. This property enables simulation tracing facilities (specify one or more as a comma-separated list):

- The `'minstep'` trace flag specifies that simulation stops when the solution changes so abruptly that the variable-step solvers cannot take a step and satisfy the error tolerances. By default, Simulink issues a warning message and continues the simulation.

- The `'siminfo'` trace flag provides a short summary of the simulation parameters in effect at the start of simulation.

- The `'compile'` trace flag displays the compilation phases of a block diagram model.

```
ZeroCross       {on} | off
```
Enable/disable location of zero crossings. This property applies only to the variable-step solvers. If set to off, variable-step solvers do not detect zero crossings for blocks having intrinsic

zero-crossing detection. The solvers adjust their step sizes only to satisfy error tolerance.

SignalLogging   {on} | off
   Enable/disable signal logging. This parameter enables signal logging for the model, overriding the **Signal logging** setting in the **Configuration Parameters** dialog box.

SignalLoggingName   string
   Specify signal logging name. This parameter specifies the name of the signal logging object used to record logged signal data in the MATLAB workspace. It overrides the **Signal logging** name setting in the **Configuration Parameters** dialog box.

Examples   This command creates an options structure called myopts that defines values for the MaxDataPoints and Refine parameters, using default values for other parameters.

```
myopts = simset('MaxDataPoints', 100, 'Refine', 2);
```

This command simulates the vdp model for 10 seconds and uses the parameters defined in myopts.

```
[t,x,y] = sim('vdp', 10, myopts);
```

The following command overrides the signal logging setting specified by the vdp model.

```
sim('vdp', 10, simset(simget('vdp'), 'SignalLogging', 'on'))
```

See Also   sim, simget

slbuild

Purpose	Build standalone and model reference targets
Syntax	slbuild('*model*') slbuild('*model*', 'ModelReferenceSimTarget') slbuild('*model*', 'ModelReferenceRTWTarget') slbuild('*model*', 'ModelReferenceRTWTargetOnly')

Description

> **Note** Except where noted, this command requires a Real-Time Workshop license.

slbuild(*'model'*) builds a standalone executable from *model*, using the model's Real-Time Workshop configuration settings.

> **Note** The following commands honor the setting of the **Rebuild options** on the **Model Referencing** pane of the **Configuration Parameters** dialog for rebuilding the model reference target for this model and its referenced models.

slbuild('*model*', 'ModelReferenceSimTarget') builds a model reference simulation target for the model. This command does not require a Real-Time Workshop license.

slbuild(*'model'*, 'ModelReferenceRTWTarget') builds model reference simulation and Real-Time Workshop targets for *model*.

slbuild('*model*', 'ModelReferenceRTWTargetOnly') builds a model reference RTW target for the model.

If the **Rebuild option** on the **Model Referencing** pane of the **Configuration Parameters** dialog is set to Never, you can use two additional arguments, 'UpdateThisModelReferenceTarget' and *'Buildcond'*, to specify a rebuild option for building a model reference target for this *'model'*. For example,

```
slbuild('model','ModelReferenceSimTarget', ...
        'UpdateThisModelReferenceTarget', Buildcond)
```

conditionally builds the simulation target for this *'model'* based on the
value of *Buildcond*.

Note This option does not rebuild model reference targets for models
referenced by this model.

'Buildcond' must be one of the following:

- `'IfOutOfDateOrStructuralChange'`

  Causes `slbuild` to rebuild this model if it detects any changes.
  This option is equivalent to the `If any changes detected` rebuild
  option on the **Model Referencing** pane of the **Configuration
  Parameters** dialog box.

- `'IfOutOfDate'`

  Causes `slbuild` to rebuild this model if it detects any changes in
  known dependencies of this model. This option is equivalent to the `If
  any changes in known dependencies detected` rebuild option on
  the **Model Referencing** pane of the **Configuration Parameters**
  dialog box.

- `'Force'`

  Causes `slbuild` to always rebuild the model. This option
  is equivalent to the `"Always"` rebuild option on the **Model
  Referencing** pane of the **Configuration Parameters** dialog box.

sldebug

Purpose   Start a simulation in debug mode

Syntax   sldebug('sys')

Description   sldebug('sys') starts a simulation in debug mode. See "Simulink
                   Debugger" in the Simulink documentation and Chapter 7, "Simulink
                   Debugger Commands" in the Simulink Reference for information about
                   using the debugger.

Examples   The following command:

```
sldebug('vdp')
```

loads the Simulink demo model vdp into memory and starts the
simulation in debug mode. Alternatively, you can achieve the same
result by using both the sim and simset commands:

```
sim('vdp', [0,10], simset('debug', 'on'))
```

See Also   sim, simset

Purpose   Display diagnostic information about a Simulink system

Syntax
```
[txtRpt, sRpt] = sldiagnostics('sys')
[txtRpt, sRpt] = sldiagnostics('sys', options)
```

Description   sldiagnostics('sys') displays the following diagnostic information associated with the model or subsystem specified by sys:

- Number of each type of block

- Number of each type of Stateflow object

- Number of states, outputs, inputs, and sample times

- Names of libraries referenced and instances of the referenced blocks

- Time and additional memory used for each compilation phase of the root model

If the model specified by sys is not loaded, sldiagnostics loads the model, completes the diagnostics, and then closes the model. If sys is a subsystem, the root model must be loaded for sldiagnostics to operate successfully.

Note To see memory usage, you must first enable the memory integrity checking option in MATLAB at startup. This is accomplished by running MATLAB with the -check_malloc flag. For more information about this startup option, see matlab (Windows) or matlab (UNIX) in the MATLAB Function Reference.

---

sldiagnostics('sys', *options*) displays only the diagnostic information associated with the specific operations listed as *options* strings. The available options and their output are as follows:

sldiagnostics

Option	Description
CountBlocks	Lists all unique blocks in the system and the number of occurrences of each. This includes blocks that are nested in masked subsystems or hidden blocks.
CountSF	Lists all unique Stateflow objects in the system and the number of occurrences of each.
Sizes	Lists the number of states, outputs, inputs, and sample times, as well as a flag indicating direct feedthrough, used in the root model.
Libs	Lists all unique libraries referenced in the root model, as well as the names and numbers of the library blocks.
CompileStats	Lists the time and additional memory used for each compilation phase of the root model. The memory usage is displayed when the memory integrity checking option is enabled in MATLAB at startup. This information helps users troubleshoot model compilation speed and memory issues.
Verbose	Lists the results of the CompileStats diagnostic during the compilation phase. This is useful for diagnosing the compilation itself if it takes an unreasonable amount of time or hangs.
RTWBuildStats	Lists the same information as the CompileStats diagnostic. When issued with the second output argument sRpt, it captures the Real-Time Workshop build statistics in sRpt.rtwbuild.
All	Performs all diagnostics.

Note Running the CompileStats diagnostic before simulating a model for the first time will show greater memory usage. However, subsequent runs of the CompileStats diagnostic on the model will return a lesser amount of memory usage.

[txtRpt, sRpt] = sldiagnostics('sys') or [txtRpt, sRpt] = sldiagnostics('sys', *options*) returns the diagnostic information as a textual report txtRpt and a structure array sRpt, which contains the following fields that correspond to the diagnostic options:

- blocks
- stateflow
- sizes
- links
- compilestats
- rtwbuild

Examples   The following command counts and lists each type of block used in the sldemo_bounce model that comes with Simulink.

```
sldiagnostics('sldemo_bounce', 'CountBlocks')
```

The following command counts and lists both the unique blocks and Stateflow objects used in the sf_boiler model that comes with Stateflow; the textual report returned is captured as myReport.

```
myReport = sldiagnostics('sf_boiler', 'CountBlocks', 'CountSF')
```

The following commands open the f14 model that comes with Simulink, and counts the number of blocks used in the Controller subsystem.

```
f14; sldiagnostics('f14/Controller', 'CountBlocks')
```

sldiagnostics

The following command runs the `Sizes` and `CompileStats` diagnostics on the `f14` model, capturing the results as both a textual report and structure array.

```
[txtRpt, sRpt] = sldiagnostics('f14', 'Sizes', 'CompileStats')
```

See Also   find_system, get_param

Purpose	Extract signal logging objects from signal logs and write them into the MATLAB workspace.
Syntax	**log**.unpack **tsarray**.unpack **log**.unpack('systems') **log**.unpack('all')
Description	log.unpack or unpack(log) extracts the top level elements of the Simulink.ModelDataLogs or Simulink.SubsysDataLogs object named **log** (e.g., logsout).
	log.unpack('systems') or unpack(*log*, 'systems') extracts Simulink.Timeseries and Simulink.TsArray objects from the Simulink.ModelDataLogs or Simulink.SubsysDataLogs object named log . This command does not extract Simulink.Timeseries objects from Simulink.TsArray objects nor does it write intermediate Simulink.ModelDataLogs or Simulink.SubsysDataLogs objects to the MATLAB workspace.
	log.unpack('all') or unpack(*log*, 'all') extracts all the Simulink.Timeseries objects contained by the Simulink.ModelDataLogs, Simulink.TsArray, or Simulink.SubsysDataLogs object named log .
	tsarray.unpack extracts the time-series objects of class Simulink.Timeseries from the Simulink.TsArray object named tsarray.
See Also	whos, who

who

Purpose	List the contents of a signal log.

Syntax	`log.who`
	`tsarray.who`
	`log.who('systems')`
	`log.who('all')`

Description   `log.who` or `who(log)` lists the names of the top-level signal logging objects (i.e., objects of type `Simulink.Timeseries`, `Simulink.TsArray`, `Simulink.ModelDataLogs`, or `Simulink.SubsysDatalogs`) contained by `log` where `log` is the handle of a `Simulink.ModelDataLogs` object name.

`tsarray.who` or `who(tsarray)` lists the `Simulink.TimeSeries` objects contained by the `Simulink.TsArray` object named `tsarray`.

`log.who('systems')` or `who(log, 'systems')` lists the names of all signal logging objects contained by `log` except for `Simulink.Timeseries` objects stored in `Simulink.TsArray` objects contained by `log`.

`log.who('all')` or `who(log, 'all')` lists the names of all signal logging objects contained by `log`

See Also   `whos, unpack`

Purpose   List the names and types of simulink data logging objects contained by a `Simulink.ModelDataLogs` or `Simulink.SubsysDataLogs` object.

Syntax   **log**.whos
                 tsarray.whos
                 log.whos('systems')
                 log.whos('all')

Description log.whos or whos(log) lists the names and types of
                 the top-level signal logging objects (i.e., objects of type
                 `Simulink.Timeseries`, `Simulink.TsArray`, `Simulink.ModelDataLogs`,
                 or `Simulink.SubsysDatalogs`) contained by log where log is the
                 handle of a `Simulink.ModelDataLogs` object name.

                 tsarray.whos or whos(tsarray) lists the names and types of
                 `Simulink.TimeSeries` objects contained by the `Simulink.TsArray`
                 object named tsarray.

                 log.who('systems') or who(log, 'systems') lists the names
                 and types of all signal logging objects contained by log except for
                 `Simulink.Timeseries` objects stored in `Simulink.TsArray` objects
                 contained by log.

                 log.who('all') or who(log, 'all') lists the names and types of all
                 signal logging objects contained by log.

See Also   who, unpack

Mask Icon Drawing Commands

The following sections describe commands that you can use to draw the icons that represent masked blocks in a block diagram.

Command Summary

This table summarizes the commands that you can use to create icons for masked subsystems.

Command	Usage
disp	Display text centered on a mask icon.
dpoly	Display a transfer function on a mask icon.
fprintf	Display variable text on a mask icon.
image	Display an image on a mask icon.
patch	Draw a color patch of a specified shape on a mask icon.
plot	Display graphics on a mask icon.
port_label	Display a port label on a mask icon.
text	Display text at a specified location on a mask icon.

Mask Icon Drawing Commands — Alphabetical List

disp
dpoly, droots
fprintf
image
patch
plot
port_label
text

disp

Purpose   Display text on the icon of a masked subsystem

Syntax   disp(*text*)
                 disp(*text*, 'texmode', 'on')

Description disp(*text*) displays *text* centered on the icon where *text* is any
                 MATLAB expression that evaluates to a string.

                 disp(text, 'texmode', 'on') allows you to use TeX formatting
                 commands in *text*. The TeX formatting commands in turn allow you
                 to include symbols and Greek letters in icon text. See "Mathematical
                 Symbols, Greek Letters, and TeX Characters" in the MATLAB
                 documentation for information on the TeX formatting commands
                 supported by Simulink.

Examples   The following command

```
disp('{\itEquation:}  \alpha^2 + \beta^2 \rightarrow \gamma^2,
\chi, \phi_3 = {\bfcool}', 'texmode','on')
```

                 draws the equation that appears on this masked block icon.

Equation

See Also   fprintf, port_label, text

Purpose	Display a transfer function on the icon of a masked subsystem
Syntax	dpoly(*num*, *den*) dpoly(*num*, *den*, *'character'*) droots(*zero*, *pole*, *gain*) droots(*zero*, *pole*, *gain*,'z') droots(*zero*, *pole*, *gain*,'z-')

Description dpoly(*num*, *den*) displays the transfer function whose numerator is *num* and denominator is den.

dpoly(num, den, *'character'*) allows you to specify the name of the transfer function's independent variable. The default is *s*.

droots(*zero*, *pole*, *gain*) displays the transfer function whose zero is a *zero*, pole is *pole*, and gain is *gain*.

droots(*zero*, *pole*, *gain*,'z') and droots(*zero*, *pole*, *gain*,'z-') express the equation in terms of *z* or *1/z*.

When the icon is drawn, the initialization commands are executed and the resulting equation is drawn on the icon:

- To display a continuous transfer function in descending powers of *s*, enter

```
dpoly(num, den)
```

For example, for num = [0 0 1]; and den = [1 2 1] the icon looks like this:

$$\frac{1}{s^2+2s+1}$$

- To display a discrete transfer function in descending powers of *z*, enter

```
dpoly(num, den, 'z')
```

For example, for num = [0 0 1]; and den = [1 2 1]; the icon looks like this:

$$\frac{1}{z^2+2z+1}$$

- To display a discrete transfer function in ascending powers of *1/z*, enter

```
dpoly(num, den, 'z-')
```

For example, for num and den as defined previously, the icon looks like this:

$$\frac{z^2}{1+2z^{-1}+z^{-2}}$$

- To display a zero-pole gain transfer function, enter

```
droots(z, p, k)
```

For example, the preceding command creates this icon for these values:

```
z = []; p = [-1 -1]; k = 1;
```

$$\frac{1}{(s+1)(s+1)}$$

If the parameters are not defined or have no values when you create the icon, Simulink displays three question marks (? ? ?) in the icon. When the parameter values are entered in the mask dialog box, Simulink evaluates the transfer function and displays the resulting equation in the icon.

See Also   disp, port_label, text

Purpose   Display variable text centered on the icon of a masked subsystem

Syntax   fprintf(*text*)
                  fprintf(*format*, *var*)

Description   The fprintf command displays formatted text centered on the icon and
                  can display *format* along with the contents of *var*.

> **Note** While this command is identical in name to its corresponding
> MATLAB function, it provides only the functionality described above.

See Also   disp, port_label, text

image

Purpose	Display an image on the icon of a masked subsystem

Syntax	`image(a)`
	`image(a, [x, y, w, h])`
	`image(a, [x, y, w, h], rotation)`

Description	`image(a)` displays the image *a*, where *a* is an M-by-N-by-3 array of RGB values. You can use the MATLAB commands `imread` and `ind2rgb` to read and convert bitmap files (such as GIF) to the necessary matrix format.

Description `image(a, [x, y, w, h])` creates the image at the specified position relative to the lower-left corner of the mask.

`image(a, [x, y, w, h], rotation)` allows you to specify whether the image rotates (`'on'`) or remains stationary (`'off'`) as the icon rotates. The default is `'off'`.

Examples This command

```
image(imread('icon.tif'))
```

reads the icon image from a TIFF file named `icon.tif` in the MATLAB path.

The following commands read and convert a GIF file, `label.gif`, to the appropriate matrix format. You can type these commands in the **Initialization** pane of the Mask Editor.

```
[data, map]=imread('label.gif');
pic=ind2rgb(data,map);
```

Then type the command

```
image(pic)
```

in the **Icon** pane of the Mask Editor to read the converted label image.

See Also   patch, plot

patch

Purpose	Draw a color patch of a specified shape on the icon of a masked subsystem
Syntax	patch(*x*, *y*) patch(*x*, *y*, [*r g b*])
Description	patch(*x*, *y*) creates a solid patch having the shape specified by the coordinate vectors x and y. The patch's color is the current foreground color.

patch(*x*, *y*, [*r g b*]) creates a solid patch of the color specified by the vector [r g b], where r is the red component, g the green, and b the blue. For example,

```
patch([0 .5 1], [0 1 0], [1 0 0])
```

creates a red triangle on the mask's icon.

Examples   This command

```
patch([0 .5 1], [0 1 0], [1 0 0])
```

creates a red triangle on the mask's icon.

See Also   image, plot

Purpose   Draw a graph connecting a series of points

Syntax   plot(*Y*)
                plot(*X1*,*Y1*,*X2*,*Y2*,...)

Description plot(*Y*) plots, for a vector *Y*, each element against its index. If *Y* is a
                matrix, it plots each column of the matrix as though it were a vector.

                plot(*X1*,*Y1*,*X2*,*Y2*,...) plots the vectors *Y1* against *X1*, *Y2* against
                X2, and so on. Vector pairs must be the same length and the list must
                consist of an even number of vectors.

                Plot commands can include NaN and inf values. When NaNs or infs are
                encountered, Simulink stops drawing, then begins redrawing at the
                next numbers that are not NaN or inf.

                The appearance of the plot on the icon depends on the value of the
                Drawing coordinates parameter. For more information, see "Icon
                options" in in the Using Simulink documentation.

                Simulink displays three question marks (? ? ?) in the block icon and
                issues warnings in these situations:

                • When the values for the parameters used in the drawing commands
                  are not yet defined (for example, when the mask is first created and
                  values have not yet been entered in the mask dialog box)

                • When a masked block parameter or drawing command is entered
                  incorrectly

Examples   This command

                    plot([0 1 5], [0 0 4])

                generates the plot that appears on the icon for the Ramp block, in the
                Sources library.

plot

Ramp

See Also   image

Purpose   Draw a port label on the icon of a masked subsystem

Syntax   port_label('*port_type*', *port_number*, *'label'*)
port_label('*port_type*', *port_number*, *'label'*,'texmode','on')

Description   port_label('*port_type*', *port_number*, *'label'*) draws a label on a
port where *port_type* is either 'input' or 'output', *port_number* is an
integer, and *label* is a string specifying the port's label.

port_label('*port_type*', *port_number*, *'label'*,'texmode','on')
lets you use TeX formatting commands in label. The TeX formatting
commands allow you to include symbols and Greek letters in the port
label. See "Mathematical Symbols, Greek Letters, and Tex Characters"
in the MATLAB documentation for information on the TeX formatting
commands supported by Simulink.

Examples   The command

```
port_label('input', 1, 'a')
```

defines a as the label of input port 1.

The commands

```
disp('Card\nSwapper');
port_label('input',1,'\spadesuit','texmode','on');
port_label('output',1,'\heartsuit','texmode','on');
```

draw playing card symbols as the labels of the ports on a masked
subsystem.

port_label

See Also   disp, fprintf, text

Purpose	Display text at a specific location on the icon of a masked subsystem

Syntax

```
text(x, y, 'text')
text(x, y, 'text', 'horizontalAlignment', 'halign',
  'verticalAlignment', 'valign')
text(x, y, 'text', 'texmode', 'on')
```

Description

The text command places a character string at a location specified by the point (x,y). The units depend on the **Drawing coordinates** parameter. For more information, see "Icon options".

text(*x*,*y*, *text*, 'texmode', 'on') allows you to use TeX formatting commands in *text*. The TeX formatting commands in turn allow you to include symbols and Greek letters in icon text. See "Mathematical Symbols, Greek Letters, and TeX Characters" in the MATLAB documentation for information on the TeX formatting commands supported by Simulink.

You can optionally specify the horizontal and/or vertical alignment of the text relative to the point (x, y) in the text command.

The text command offers the following horizontal alignment options.

Option	**Aligns**
'left'	The left end of the text at the specified point
'right'	The right end of the text at the specified point
'center'	The center of the text at the specified point

The text command offers the following vertical alignment options.

Option	**Aligns**
'base'	The baseline of the text at the specified point
'bottom'	The bottom line of the text at the specified point
'middle'	The midline of the text at the specified point

text

Option	Aligns
`'cap'`	The capitals line of the text at the specified point
`'top'`	The top of the text at the specified point

Note While this command is identical in name to its corresponding MATLAB function, it provides only the functionality described above.

Examples   The command

```
text(0.5, 0.5, 'foobar', 'horizontalAlignment', 'center')
```

centers foobar in the icon.

The command

```
text(.05,.5,'{\itEquation:}  \Sigma \alpha^2 +
\beta^2 \rightarrow \infty, \Pi, \phi_3 = {\bfcool}',
'hor','left','texmode','on')
```

draws a left-aligned equation on the icon.

Equation

See Also   disp, fprintf, port_label

Simulink Debugger Commands

The following sections describe commands that you can use to pinpoint bugs in a model.

Command Summary

The following table lists the debugger commands. The table's Repeat column specifies whether pressing the **Enter** key at the command line repeats the command. Detailed descriptions of the commands follow the table.

Command	Short Form	Repeat	Description
animate	ani	No	Enable/disable animation mode.
ashow	as	No	Show an algebraic loop.
atrace	at	No	Set algebraic loop trace level.
bafter	ba	No	Insert a breakpoint after a method.
break	b	No	Insert a breakpoint before a method.
bshow	bs	No	Show a specified block.
clear	cl	No	Clear breakpoints from a model.
continue	c	Yes	Continue the simulation.
disp	d	Yes	Display a block's I/O when the simulation stops.
ebreak	eb	No	Break at recoverable solver errors.
elist	el	No	Display method execution order.
emode	em	No	Toggle between accelerated and normal mode.
etrace	et	No	Enable or disable method tracing.
help	? or h	No	Display help for debugger commands.

Command	Short Form	Repeat	Description
nanbreak	na	No	Set or clear nonfinite value break mode.
next	n	Yes	Go to start of the next time step.
probe	p	No	Display block data.
quit	q	No	Abort simulation.
rbreak	rb	No	Toggle solver reset breakpoint.
run	r	No	Run the simulation to completion.
stimes	sti	No	Display a model's sample times.
slist	sli	No	Display a model's sorted lists.
states	state	No	Display current state values.
status	stat	No	Display debugging options in effect.
step	s	Yes	Advance the simulation by one or more methods.
stop	sto	No	Stop the simulation.
strace	i	No	Set solver trace level.
systems	sys	No	List a model's nonvirtual systems.
tbreak	tb	No	Set or clear a time breakpoint.
trace	tr	Yes	Display a block's I/O each time the block executes.
undisp	und	Yes	Remove a block from the debugger's list of display points.

Command	Short Form	Repeat	Description
untrace	unt	Yes	Remove a block from the debugger's list of trace points.
where	w	No	Display the current location of the simulation in the simulation loop.
xbreak	x	No	Break when the debugger encounters a step-size-limiting state.
zcbreak	zcb	No	Toggle breaking at nonsampled zero-crossing events.
zclist	zcl	No	List blocks containing nonsampled zero crossings.

Simulink Debugger Commands — Alphabetical List

animate
ashow
atrace
bafter
break
bshow
clear
continue
disp
ebreak
elist
emode
etrace
help
nanbreak
next
probe
quit
rbreak
run
slist
states
status
step
stimes
stop
strace
systems
tbreak
trace
undisp
untrace
where
xbreak
zcbreak

zclist

Purpose	Enable or disable animation mode

Syntax   animate [delay | **stop**]

Arguments
delay	Length in seconds between method calls (1 second by default).
stop	Disable animation mode.

Description animate without any arguments enables animation mode. animate delay enables animation mode and specifies delay as the time delay in seconds between method calls. animate **stop** disables animation mode.

See Also   continue

ashow

Purpose	Show an algebraic loop
Syntax	ashow <gcb | s:b | s#n | **clear**>

Arguments

gcb	Current block.
s:b	The block whose system index is s and block index is b.
s#n	The algebraic loop numbered n in system s.
clear	Switch that clears loop coloring.

Description   ashow without any arguments lists all of a model's algebraic loops in the MATLAB Command Window. ashow gcb or ashow s:b highlights the algebraic loop that contains the specified block. ashow s#n highlights the nth algebraic loop in system s. The ashow **clear** command removes algebraic loop highlights from the model diagram.

See Also   atrace, slist

Purpose   Set algebraic loop trace level

Syntax   atrace level

Arguments   level   Trace level (0 = none, 4 = everything).

Description   The atrace command sets the algebraic loop trace level for a simulation.

Command	Displays for Each Algebraic Loop
atrace 0	No information
atrace 1	The loop variable solution, the number of iterations required to solve the loop, and the estimated solution error
atrace 2	Same as level 1
atrace 3	Level 2 plus Jacobian matrix used to solve loop
atrace 4	Level 3 plus intermediate solutions of the loop variable

See Also   states, systems

bafter

Purpose   Insert a breakpoint after a specified method

Syntax
```
bafter
bafter m:mid
bafter <sid:bid | gcb> [mth] [tid:TID]
bafter <s:sid | gcs> [mth] [tid:TID]
bafter mdl [mth] [tid:TID]
```

Arguments

mid	Method ID
sid:*bid*	Block ID
gcb	Currently selected block
sid	System ID
gcs	Currently selected system
mdl	Currently selected model
mth	A method name, e.g., Outputs.Major
TID	Task ID

Description   bafter inserts a breakpoint after the current method.

bafter **m:***mid* inserts a breakpoint after the method specified by *mid* (see "Method ID").

bafter *sid*:*bid* inserts a breakpoint after each invocation of the method of the block specified by *sid*:*bid* (see "Block ID") in major time steps. bafter gcb inserts a breakpoint after each invocation of a method of the currently selected block (see gcb) in major times steps.

bafter **s:***sid* inserts a breakpoint after each method of the root system or nonvirtual subsystem specified by the system ID: *sid*.

> **Note** The systems command displays the system IDs for all nonvirtual systems in the currently selected model.

bafter **gcs** inserts a breakpoint after each method of the currently selected nonvirtual system.

bafter **mdl** inserts a breakpoint after each method of the currently selected model.

The optional *mth* parameter allow you to set a breakpoint after a particular block, system, or model method and task. For example, bafter **gcb** Outputs sets a breakpoint after the Outputs method of the currently selected block.

The optional TID parameter allows you to set a breakpoint after invocation of a method by a particular task. For example, suppose that the currently selected nonvirtual subsystem operates on task 2 and 3. Then bafter **gcs** Outputs **tid:**2 sets a breakpoint after the invocation of the subsystem's Outputs method that occurs when task 2 is active.

See Also   break, ebreak, tbreak, xbreak, nanbreak, zcbreak, rbreak, clear, where, slist, systems

break

Purpose   Insert a breakpoint before a specified method

Syntax
```
break
break m:mid
break <sid:bid | gcb> [mth] [tid:TID]
break <s:sid | gcs> [mth] [tid:TID]
break mdl [mth] [tid:TID]
```

Arguments

mid	Method ID
sid:*bid*	Block ID
gcb	Currently selected block
sid	System ID
gcs	Currently selected system
mdl	Currently selected model
mth	A method name, e.g., Outputs.Major
TID	task ID

Description   break inserts a breakpoint before the current method.

break **m:***mid* inserts a breakpoint before the method specified by *mid* (see "Method ID").

break *sid*:*bid* inserts a breakpoint before each invocation of the method of the block specified by *sid*:*bid* (see "Block ID") in major time steps. break gcb inserts a breakpoint before each invocation of a method of the currently selected block (see gcb) in major times steps.

break **s:***sid* inserts a breakpoint at each method of the root system or nonvirtual subsystem specified by the system ID: *sid*.

> **Note** The `systems` command displays the system IDs for all nonvirtual systems in the currently selected model.

`break gcs` inserts a breakpoint at each method of the currently selected nonvirtual system.

`break mdl` inserts a breakpoint at each method of the currently selected model.

The optional *mth* parameter allow you to set a breakpoint at a particular block, system, or model method. For example, `break gcb Outputs` sets a breakpoint at the Outputs method of the currently selected block.

The optional TID parameter allows you to set a breakpoint at the invocation of a method by a particular task. For example, suppose that the currently selected nonvirtual subsystem operates on task 2 and 3. Then `break gcs Outputs tid:2` sets a breakpoint at the invocation of the subsystem's Outputs method that occurs when task 2 is active.

See Also   `bafter, clear, ebreak, nanbreak, rbreak, systems, tbreak, where, xbreak, zcbreak, slist`

bshow

Purpose　　Show a specified block

Syntax　　`bshow s:b`

Arguments　　`s:b`　　The block whose system index is s and block index is b.

Description　　The `bshow` command opens the model window containing the specified block and selects the block.

See Also　　`slist`

Purpose　　　Clear breakpoints from a model

Syntax　　　```
clear
clear m:mid
clear id
clear <sid:bid | gcb>
```

Arguments

mid	Method ID
id	Breakpoint ID
sid:*bid*	Block ID
gcb	Currently selected block

Description　　`clear` clears a breakpoint from the current method.

`clear m:mid` clears a breakpoint from the method specified by *mid*.

`clear id` clears the breakpoint specified by the breakpoint ID *id*.

`clear sid:bid` clears any breakpoints set on the methods of the block specified by *sid:bid*.

`clear gcb` clears any breakpoints set on the methods of the currently selected block.

See Also　　`break, bafter, slist`

continue

Purpose   Continue the simulation

Syntax   `continue`

Description   The `continue` command continues the simulation from the current breakpoint. If animation mode is not enabled, the simulation continues until it reaches another breakpoint or its final time step. If animation mode is enabled, the simulation continues in animation mode to the first method of the next major time step, ignoring breakpoints.

See Also   `run`, `stop`, `quit`, `animate`

disp

Purpose	Display a block's I/O when the simulation stops

Syntax
```
disp
disp gcb
disp s:b
```

Arguments

s:b	The block whose system index is s and block index is b.
gcb	Current block.

Description The disp command registers a block as a display point. The debugger displays the inputs and outputs of all display points in the MATLAB Command Window whenever the simulation halts. Invoking disp without arguments shows a list of display points. Use undisp to unregister a block.

See Also undisp, slist, probe, trace

ebreak

Purpose	Enable (or disable) a breakpoint on solver errors.
Syntax	`ebreak`
Description	This command causes the simulation to stop if the solver detects a recoverable error in the model. If you do not set or disable this breakpoint, the solver recovers from the error and proceeds with the simulation without notifying you.
See Also	`break`, `bafter`, `tbreak`, `xbreak`, `nanbreak`, `zcbreak`, `rbreak`, `clear`, `where`, `slist`, `systems`

Purpose   List simulation methods in the order in which they are executed during a simulation

Syntax   elist **m:***mid* [**tid:***TID*]
elist <**gcs** | **s:***sid*> [*mth*] [**tid:***TID*]
elist <**gcb** | *sid***:***bid*> [*mth*] [**tid:***TID*]

Description elist **m:***mid* lists the methods invoked by the system or nonvirtual subsystem method corresponding to the method id *mid* (see the where command for information on method IDs), e.g.,

```
(sldebug @19): elist m:19

RootSystem.Outputs 'vdp' [tid=0] :          ←———— Calling method
  0:0 Integrator.Outputs 'vdp/x1' [tid=0]
  0:1 Outport.Outputs 'vdp/Out1' [tid=0]
  0:2 Integrator.Outputs 'vdp/x2' [tid=0]
              ...

  Block id        Method           Block     Task id
```

The method list specifies the calling method followed by the methods that it calls in the order in which they are invoked. The entry for the calling method includes

- The name of the method

  The name of the method is prefixed by the type of system that defines the method, e.g., RootSystem.

- The name of the model or subsystem instance on which the method is invoked

- The ID of the task that invokes the method

The entry for each called method includes

elist

- The ID (*sid*:*bid*) of the block instance on which the method is invoked

  The block ID is prefixed by a number specifying the system that contains the block (the *sid*). This allows Simulink to assign the same block ID to blocks residing in different subsystems.

- The name of the method

  The method name is prefixed with the type of block that defines the method, e.g., Integrator.

- The name of the block instance on which the method is invoked

- The task that invokes the method

The optional task ID parameter (**tid:***TID*) allows you to restrict the displayed lists to methods invoked for a specified task. You can specify this option only for system or atomic subsystem methods that invoke Outputs or Update methods.

elist <**gcs** | **s:**sid> lists the methods executed for the currently selected system (specified by the gcs command) or the system or nonvirtual subsystem specified by the system ID *sid*, e.g.,

```
(sldebug @19): elist gcs

RootSystem.Start 'vdp':
  0:0 Integrator.Start 'vdp/x1'
  0:2 Integrator.Start 'vdp/x2'
  0:4 Scope.Start 'vdp/Scope'
  0:5 Fcn.Start 'vdp/Fcn'
  0:6 Product.Start 'vdp/Product'
  0:7 Gain.Start 'vdp/Mu'
  0:8 Sum.Start 'vdp/Sum'

RootSystem.Initialize 'vdp':
  0:0 Integrator.Initialize 'vdp/x1'
            ...
```

The system ID of a model's root system is 0. You can use the debugger's `systems` command to determine the system IDs of a model's subsystems.

Note The `elist` and `where` commands use block IDs to identify subsystems in their output. The block ID for a subsystem is not the same as the system ID displayed by the `systems` command. Use the `elist` *sid*:*bid* form of the `elist` command to display the methods of a subsystem whose block ID appears in the output of a previous invocation of the `elist` or `where` command.

`elist <`**gcs** `|` **s:**`sid> ` *mth* lists methods of type *mth* to be executed for the system specified by the `gcs` command or the system ID *sid*, e.g.,

```
(sldebug @19): elist gcs Start

RootSystem.Start 'vdp':
  0:0 Integrator.Start 'vdp/x1'
  0:2 Integrator.Start 'vdp/x2'
  0:4 Scope.Start 'vdp/Scope'
  0:5 Fcn.Start 'vdp/Fcn'
  0:6 Product.Start 'vdp/Product'
  0:7 Gain.Start 'vdp/Mu'
  0:8 Sum.Start 'vdp/Sum'
            . . .
```

Use `elist `**gcb** to list the methods invoked by the nonvirtual subsystem currently selected in the model.

See Also   `where`, `slist`, `systems`

emode

Purpose   Toggle model execution between accelerated and normal mode

Syntax   emode

Description   Toggles the simulation between accelerated and normal mode when using the Simulink Accelerator. See "Using the Simulink Accelerator with the Simulink Debugger" in "Using Simulink" for more information.

Purpose   Enable or disable method tracing

Syntax   `etrace` **`level`** `level-number`

Description   This command enables or disables method tracing, depending on the value of `level`:

Level	Description
0	Turn tracing off.
1	Trace model methods.
2	Trace model and system methods.
3	Trace model, system, and block methods.

When method tracing is on, the debugger prints a message at the command line every time a method of the specified level is entered or exited. The message specifies the current simulation time, whether the simulation is entering or exiting the method, the method id and name, and the name of the model, system, or block to which the method belongs.

See Also   `elist`, `where`, `trace`

help

Purpose   Display help for debugger commands

Syntax   `help`

Description   The `help` command displays a list of debugger commands in the command window. The list includes the syntax and a brief description of each command.

Purpose   Set or clear nonfinite value break mode

Syntax   `nanbreak`

Description   The `nanbreak` command causes the debugger to break whenever the
                  simulation encounters a nonfinite (`NaN` or `Inf`) value. If nonfinite break
                  mode is set, `nanbreak` clears it.

See Also   `break`, `bafter`, `ebreak`, `rbreak`, `tbreak`, `xbreak`, `zcbreak`

next

Purpose   Advance the simulation to the start of the next method at the current level in the model's execution list

Syntax   next

Description   The next command advances the simulation to the start of the next method at the current level in the model's method execution list.

Note The next command has the same effect as the step over command. See step for more information.

See Also   step

Purpose   Display block data.

Syntax
```
probe
probe s:b
probe gcb
probe level level-type
```

Arguments

s:b	The block whose system index is s and block index is b.
gcb	Currently selected block.
level-type	The type of information displayed [io | all].

Description   probe causes the debugger to enter an interactive probe mode. In this mode, the debugger displays the I/O of any block you select with a click of a mouse button. To exit probe mode, enter any command or press the **Enter** key.

probe s:b displays the I/O of the block whose index is s:b.

probe gcb displays the I/O of the currently selected block.

probe **level** level-type specifies the type of information displayed, depending on the value of level-type:

Level	Displays
io	Block's I/O
all	All information regarding a block's current state, including inputs and outputs, states, and zero crossings

By default, level-type is set to all.

See Also   disp, trace

quit

Purpose   Abort simulation

Syntax   quit

Description   The quit command terminates the current simulation.

See Also   stop

Purpose   Break when the simulation requires a solver reset.

Syntax   `rbreak`

Description   This command enables (or disables) a solver reset breakpoint if the breakpoint is disabled (or enabled). The breakpoint causes the debugger to halt the simulation whenever an event that requires a solver reset occurs. The halt occurs before the solver is reset.

See Also   `break, bafter, ebreak, nanbreak, tbreak, xbreak, zcbreak,`

run

Purpose   Run the simulation to completion

Syntax   `run`

Description The `run` command runs the simulation from the current breakpoint to its final time step. It ignores breakpoints and display points.

See Also   `continue`, `stop`, `quit`

Purpose   Display the sorted list of a model's root system and of each of its
nonvirtual subsystems

Syntax   slist

Description The slist command displays the sorted list of a model's root system
and each of its nonvirtual subsystems. For example, the sorted list
for the vdp model's root system is

```
---- Sorted list for 'vdp' [9 nonvirtual blocks, directFeed=0]
  0:0    'vdp/x1' (Integrator)
  0:1    'vdp/Out1' (Outport)
  0:2    'vdp/x2' (Integrator)
  0:3    'vdp/Out2' (Outport)
  0:4    'vdp/Scope' (Scope)
  0:5    'vdp/Fcn' (Fcn)
  0:6    'vdp/Product' (Product)
  0:7    'vdp/Mu' (Gain)
  0:8    'vdp/Sum' (Sum)
```

For each system (root or nonvirtual), the slist command displays a
title line followed by an entry for each block in the order in which the
blocks appear in the sorted list. The title line specifies the name of the
system, the number of nonvirtual blocks that the system contains, and
the number of blocks in the system that have direct feedthrough ports.
Each block entry lists the block's id and the name and type of the block.
The block id consists of a system index and a block index separated by
a colon (s:b). The block index is the position of the block in the sorted
list. The system index is the order in which Simulink generated the
system's sorted list. The system index has no special significance. It
simply allows blocks that appear in the same position in different sorted
lists to have unique identifiers.

A sorted list is a list of a root system or nonvirtual subsystem's blocks
sorted according to data dependencies and other criteria. Simulink
uses sorted lists to create block method execution lists (see elist)
for root system and nonvirtual subsystem methods that invoke the

slist

corresponding methods of the blocks that the root system or subsystem contains. In general, root system and nonvirtual subsystem methods invoke the block methods in the same order as the blocks appear in the sorted list. However, significant exceptions occur. For example, execution lists for multitask models group all blocks operating at the same rate (i.e., in the same task) together with slower groups appearing later than faster groups. The grouping of methods by task can result in an order of block method execution that differs from the order in which blocks appear in the sorted list. However, within groups, methods execute in the same order as the corresponding blocks appear in the sorted list.

See Also   systems, elist

Purpose   Display current state values

Syntax   states

Description   The states command displays a list of the current states of the model.
                   The display lists the index, current value, system:block:element ID,
                   state vector name, and block name for each state.

Example   The following command displays information about the states for the
                   hardstop demo:

```
(sldebug @41): >> states

Continuous States:
Idx  Value              (system:block:element  Name   'BlockName')
  0  -0.5               (0:1:0  CSTATE  'hardstop/position')
  1  100                (0:9:0  CSTATE  'hardstop/velocity')
```

status

Purpose   Display debugging options in effect

Syntax   status

Description   The status command displays a list of the debugging options in effect.

Purpose   Advance the simulation by one or more methods

Syntax   step [**in into**]
                step **over**
                step **out**
                step **top**
                step **blockmth**

Description This command advances the simulation

   • Into (step [**in into**]), over (step **over**), or out of the method at
     which the simulation is currently stopped (step **out**)

   • To the top of the simulation loop (step **top**), i.e., to the start of the
     first method executed at the start of the next time step

   • To the next method that operates on a block (step **blockmth**)

   The following diagram illustrates the effect of various forms of the
   step command.
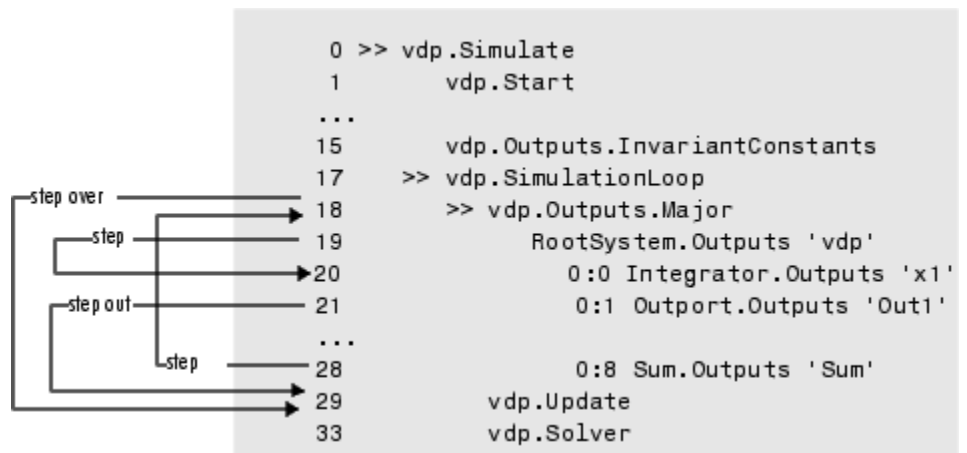
step

If this command advances the simulation to the start of a block method, the debugger points the debug pointer at the block on which the method operates.

See Also   next, where, elist

Purpose   Display the sample times defined by the model being debugged.

Syntax   stimes

Description This command displays information about the sample times defined by this model, including the sample time's period, offset, and task ID.

Example   The following command displays the sample times for the f14 demo:

```
(sldebug @0): >> stimes

--- Sample times  for 'f14' [Number of sample times = 3]
 1. [0     , 0     ]  tid=0 (continuous sample time)
 2. [0     , 1     ]  tid=1 (continuous but fixed in minor step)
 3. [0.1   , 0     ]  tid=2
```

stop

Purpose   Stop the simulation

Syntax   `stop`

Description The `stop` command stops the simulation.

See Also   `continue, run, quit`

Purpose   Set solver trace level

Syntax   strace level

Arguments   level   Trace level (0 = none, 1 = everything).

Description   The strace command causes the solver to display diagnostic
                  information in the MATLAB Command Window, depending on the value
                  of level. Valid values are 0 (no information) or 1 (maximum detail).

Command	**Displays**
strace 0	No information
strace 1	Information about time steps, integration steps, zero crossings, and solver resets

When diagnostic tracing is on, the debugger displays the sizes of major
and minor time steps:

```
[TM = 13.21072088374186 ] Start of Major Time Step
[Tm = 13.21072088374186 ] Start of Minor Time Step
```

The debugger also displays integration information, including the time
step of the integration method, the step size of the integration method,
the outcome of the integration step, the normalized error, and the index
of the state:

```
[Tm = 13.21072088374186 ] [H  = 0.2751116230148764 ] Begin Integration Step
[Tf = 13.48583250675674 ] [Hf = 0.2751116230148764 ] Fail  [Er = 1.0404e+000] [Ix = 1]
[Tm = 13.21072088374186 ] [H  = 0.2183536061326544 ] Retry
[Ts = 13.42907448987452 ] [Hs = 0.2183536061326539 ] Pass  [Er = 2.8856e-001] [Ix = 1]
```

When a zero crossing is detected, the debugger displays information
about the iterative search algorithm used to identify when the zero
crossing occurred. This includes the time step of the zero crossing, the

step size of the zero crossing detection algorithm, the length of the time interval bracketing the zero crossing, and a flag denoting the rising or falling direction of the zero crossing:

```
[Tz = 3.615333333333301 ] Detected 1 Zero Crossing Event O[F]
                         Begin iterative search to bracket zero crossing event
[Tz = 3.621111157580072 ] [Hz = 0.005777824246771424 ] [Iz = 4.2222e-003] O[F]
[Tz = 3.621116982080098 ] [Hz = 0.005783648746797265 ] [Iz = 4.2164e-003] O[F]
[Tz = 3.621116987943544 ] [Hz = 0.005783654610242994 ] [Iz = 4.2163e-003] O[F]
[Tz = 3.621116987943544 ] [Hz = 0.005783654610242994 ] [Iz = 1.1804e-011] O[F]
[Tz = 3.621116987949452 ] [Hz = 0.005783654616151157 ] [Iz = 5.8962e-012] O[F]
[Tz = 3.621116987949452 ] [Hz = 0.005783654616151157 ] [Iz = 5.1514e-014] O[F]
                         End iterative search to bracket zero crossing event
```

When solver resets occur, the debugger displays the time at which the solver was reset:

```
[Tr = 6.246905153573676 ] Process Solver Reset
[Tr = 6.246905153573676 ] Reset Zero Crossing Cache
[Tr = 6.246905153573676 ] Reset Derivative Cache
```

For more information about the notation displayed by strace, type the following command at the sldebug prompt:

```
help time
```

See Also   atrace, etrace, states, trace, zclist

Purpose   List a model's nonvirtual systems

Syntax   `systems`

Description   The `systems` command lists a model's nonvirtual systems in the
                  MATLAB Command Window.

See Also   `slist`

tbreak

Purpose	Set or clear a time breakpoint
Syntax	`tbreak`
	`tbreak t`
Description	The `tbreak` command sets a breakpoint at the specified time step. If a breakpoint already exists at the specified time, `tbreak` clears the breakpoint. If you do not specify a time, `tbreak` toggles a breakpoint at the current time step.
See Also	`break`, `bafter`, `ebreak`, `xbreak`, `nanbreak`, `zcbreak`, `rbreak`

Purpose   Display a block's I/O each time the block executes

Syntax   trace **gcb**
trace s:b

Arguments

s:b   The block whose system index is s and block index is b.

gcb   Current block.

Description   The trace command registers a block as a trace point. The debugger displays the I/O of each registered block each time the block executes.

See Also   disp, probe, untrace, slist, strace

undisp

Purpose   Remove a block from the debugger's list of display points

Syntax   ```
undisp gcb
undisp s:b
```

**Arguments**
s:b     The block whose system index is s and block index is b.

gcb     Current block.

**Description**     The undisp command removes the specified block from the debugger's list of display points.

**See Also**     disp, slist

**Purpose**        Remove a block from the debugger's list of trace points

**Syntax**         untrace gcb
                   untrace s:b

**Arguments**      s:b      The block whose system index is s and block index is b.

                   gcb      Current block.

**Description**    The untrace command removes the specified block from the debugger's
                   list of trace points.

**See Also**       trace, slist

# where

**Purpose**    Display the current location of the simulation in the simulation loop

**Syntax**    `where [detail]`

**Description**    The `where` command displays the current location of the simulation in the simulation loop, for example,



The display consists of a list of simulation nodes with the last entry being the node that is about to be entered or exited. Each entry contains the following information:

- Method ID

  The method ID identifies a specific invocation of a method.

- A symbol specifying its state:

  - `>>` (active)

  - `>|` (about to be entered)

  - `<|` (about to be exited)

- Name of the method invoked (e.g., RootSystem.Start)

- Name of the block or system on which the method is invoked (e.g., Sum)

- System and block ID (`sid:bid`) of the block on which the method is invoked

For example, `0:8` indicates that the specified method operates on block `8` of system `0`.

`where detail`, where `detail` is any nonnegative integer, includes inactive nodes in the display.

```
0 >> vdp.Simulate
    1     >> vdp.Start
    2        >> RootSystem.Start 'vdp'
    3           0:4 Scope.Start 'Scope'
    4             0:5 Fcn.Start 'Fcn'
    5             0:6 Product.Start
'Product'
    6             0:7 Gain.Start 'Mu'
    7           >| 0:8 Sum.Start 'Sum'
```

See Also   step

xbreak

Purpose   Break when the debugger encounters a step-size-limiting state

Syntax   xbreak

Description The xbreak command pauses execution of the model when the debugger encounters a state that limits the size of the steps that the solver takes. If xbreak mode is already on, xbreak turns the mode off.

See Also   break, bafter, ebreak, zcbreak, tbreak, nanbreak, rbreak

Purpose   Toggle breaking at nonsampled zero-crossing events

Syntax   zcbreak

Description   The zcbreak command causes the debugger to break when a
nonsampled zero-crossing event occurs. If zero-crossing break mode is
already on, zcbreak turns the mode off.

See Also   break, bafter, xbreak, tbreak, nanbreak, zclist

zclist

Purpose   List blocks containing nonsampled zero crossings

Syntax   `zclist`

Description   The `zclist` command displays a list of blocks in which nonsampled zero crossings can occur. The command displays the list in the MATLAB Command Window.

See Also   `zcbreak`

8

Data Type Functions

The following sections describes functions that create MATLAB structures or Simulink objects that define data types. You can use these functions in Simulink models to specify user-defined data types.

Data Type Functions — Alphabetical List

fixdt
fixptbestexp
fixptbestprec
fixpt_evenspace_cleanup
fixpt_interp1
fixpt_look1_func_approx
fixpt_look1_func_plot
fixpt_set_all
float
fxptdlg
num2fixpt
sfix
sfrac
sint
ufix
ufrac
uint

Purpose   Create a `Simulink.NumericType` object describing a fixed-point or floating-point data type

Syntax
```
a = fixdt(Signed, WordLength)
a = fixdt(Signed, WordLength, FractionLength)
a = fixdt(Signed, WordLength, TotalSlope, Bias)
a = fixdt(Signed, WordLength, SlopeAdjustmentFactor,
    FixedExponent, Bias)
a = fixdt(DataTypeNameString)
[DataType,IsScaledDouble] = fixdt(DataTypeNameString)
```

Description   `fixdt(Signed, WordLength)` returns a `Simulink.NumericType` object describing a fixed-point data type with unspecified scaling. The scaling would typically be determined by another block parameter. `Signed` can be `0` (false) for unsigned or `1` (true) for signed.

`fixdt(Signed, WordLength, FractionLength)` returns a `Simulink.NumericType` object describing a fixed-point data type with binary point scaling.

`fixdt(Signed, WordLength, TotalSlope, Bias)` or `fixdt(Signed, WordLength, SlopeAdjustmentFactor, FixedExponent, Bias)` returns a `Simulink.NumericType` object describing a fixed-point data type with slope and bias scaling.

`fixdt(DataTypeNameString)` returns a `Simulink.NumericType` object describing an integer, fixed-point, or floating-point data type specified by a data type name. The data type name can be either the name of a built-in Simulink data type or the name of a fixed-point data type that conforms to the naming convention for fixed-point names established by the Simulink Fixed Point product.

`[DataType,IsScaledDouble] = fixdt(DataTypeNameString)` returns a `Simulink.NumericType` object describing an integer, fixed-point, or floating-point data type specified by a data type name and a flag that indicates whether the specified data type name was the name of a scaled double data type.

See Also   `float`, `sfix`, `sfrac`, `sint`, `ufix`, `ufrac`, `uint`

fixptbestexp

Purpose   Determine the exponent that gives the best precision fixed-point representation of a value

Syntax
```
out = fixptbestexp(RealWorldValue,TotalBits,IsSigned)
out = fixptbestexp(RealWorldValue,FixPtDataType)
```

Description   `out = fixptbestexp(RealWorldValue,TotalBits,IsSigned)` determines the exponent that gives the best precision for the fixed-point representation of the real-world value specified by `RealWorldValue`. You specify the number of bits for the fixed-point number with `TotalBits`, and you specify whether the fixed-point number is signed with `IsSigned`. If `IsSigned` is 1, the number is signed. If `IsSigned` is 0, the number is not signed. The exponent is returned to `out`.

`out = fixptbestexp(RealWorldValue,FixPtDataType)` determines the exponent that gives the best precision based on the data type specified by `FixPtDataType`.

Examples   The following command returns the exponent that gives the best precision for the real-world value 4/3 using a signed, 16-bit number:

```
out = fixptbestexp(4/3,16,1)
out =
   -14
```

Alternatively, you can specify the fixed-point data type:

```
out = fixptbestexp(4/3,sfix(16))
out =
   -14
```

This value means that the maximum precision representation of 4/3 is obtained by placing 14 bits to the right of the binary point:

01.01010101010101

You would specify the precision of this representation in fixed-point blocks by setting the scaling to `2^-14` or `2^fixptbestexp(4/3,16,1)`.

See Also   fixptbestprec

fixptbestprec

Purpose Determine the maximum precision available for the fixed-point representation of a value

Syntax
```
out = fixptbestprec(RealWorldValue,TotalBits,IsSigned)
out = fixptbestprec(RealWorldValue,FixPtDataType)
```

Description `out = fixptbestprec(RealWorldValue,TotalBits,IsSigned)` determines the maximum precision for the fixed-point representation of the real-world value specified by `RealWorldValue`. You specify the number of bits for the fixed- point number with `TotalBits`, and you specify whether the fixed-point number is signed with `IsSigned`. If `IsSigned` is 1, the number is signed. If `IsSigned` is 0, the number is not signed. The maximum precision is returned to `out`.

`out = fixptbestprec(RealWorldValue,FixPtDataType)` determines the maximum precision based on the data type specified by `FixPtDataType`.

Examples **Example 1.**

The following command returns the maximum precision available for the real-world value 4/3 using a signed, 8-bit number:

```
out = fixptbestprec(4/3,8,1)
out =
   0.015625
```

Alternatively, you can specify the fixed-point data type:

```
out = fixptbestprec(4/3,sfix(8))
out =
   0.015625
```

This value means that the maximum precision available for 4/3 is obtained by placing six bits to the right of the binary point since 2^{-6} equals 0.015625:

01.010101

Example 2.

You can use the maximum precision as the scaling parameter in fixed-point blocks. This enables you to use `fixptbestprec` to perform a type of autoscaling if you would like to designate a known range of your simulation. For example, if your known range is -13 to 22, and you are using a safety margin of 30%:

```
knownMax = 22;
knownMin = -13;
localSafetyMargin = 30;
slope = max( fixptbestprec( (1+localSafetyMargin/100)* ...
  [knownMax,knownMin], sfix(16) ) );
```

The variable `slope` can then be used in the **Output scaling value** parameter in a block mask in your model. Be sure to select the **Lock output scaling against changes by the autoscaling tool** parameter in the same block to prevent the scaling from being overridden by the Fixed-Point Settings interface. If you know the range, you can use this technique in place of relying on a model simulation to provide the range to the autoscaling tool, as described in `autofixexp` in "Simulink Fixed Point".

See Also   `fixptbestexp`

fixpt_evenspace_cleanup

Purpose   Modify lookup table input data to be evenly spaced

Syntax   xdata_adjusted = fixpt_evenspace_cleanup(xdata_original, xdt,
                         xscale)

Description xdata_adjusted = fixpt_evenspace_cleanup(xdata_original,
                 xdt, xscale) modifies lookup table input data to be evenly spaced if it
                 is not quite evenly spaced after quantization. For example, 0:0.005:1
                 appears evenly spaced, but if it is quantized with scaling $2\texttt{\^{}}-12$, it is not
                 evenly spaced. Loss of even spacing can make a significant impact on
                 the efficiency of your implementation. Code generated by Real-Time
                 Workshop to implement an uneven lookup table is more complicated.
                 In addition, unevenly spaced input data is stored in data memory. If
                 you modify the input data to remain evenly spaced after quantization,
                 Real-Time Workshop generates simpler code and excludes the input
                 data from memory, thereby saving significant amounts of data memory.

                 The modifications to the lookup table input data are likely to change
                 the numerical behavior of the table. The numerical changes may or
                 may not be trivial, so you should test the model using simulation, rapid
                 prototyping, or other appropriate methods. This function is intended for
                 use with nontunable data. Tunable data is always treated as if it were
                 unevenly spaced. Even if tunable data starts out evenly spaced, it may
                 later be tuned to values that are unevenly spaced.

                 It is important to note that the data is judged to be "almost" evenly
                 spaced relative to the scaling slope. Consider the data vector [0 2 5],
                 which has spacing value 2 and 3. A natural first impression is that the
                 data has significantly uneven spacing. However, the difference between
                 the maximum spacing 3 and the minimum spacing 2 equals 1. If the
                 scaling slope is 1 or greater, then a spacing variation of 1 represents a
                 one bit change or less. A spacing variation of one bit or less is judged
                 to be "almost" evenly spaced, and this function will adjust the data to
                 force it to be evenly spaced.

                 The required input parameters of this function are as follows.

Input	Value	Example
`xdata_original`	Input lookup data	0:0.005:1
`xdt`	Input data type	`sfix(16)`
`xscale`	Input scaling	2^-12

See Also   `fixdt`, `fixpt_interp1`, `fixpt_look1_func_approx`, `sfix`, `ufix`

fixpt_interp1

Purpose   Implement a 1-D lookup table

Syntax   `y = fixpt_interp1(xdata,ydata,x,xdt,xscale,ydt,yscale,rndmeth)`

Description   `fixpt_interp1(xdata,ydata,x,xdt,xscale,ydt,yscale,rndmeth)` implements a lookup table to find output(s) y for input(s) x. If x falls between two xdata values, then y is found by interpolating between the corresponding ydata pair. If x falls above the range given by xdata, y is given as the maximum ydata value. If x falls below the range given by xdata, y is given as the minimum ydata value.

If either the input data type, xdt, or the output data type, ydt, is floating point, then floating-point calculation is used to perform the interpolation. Otherwise, integer-only calculation is used. This calculation handles the input scaling, xscale, and the output scaling, yscale, appropriately, and obeys the designated rounding method, rndmeth.

Examples   Define xdata as a vector of 33 evenly spaced points between 0 and 8, and ydata as the sinc of xdata.

```
xdata = linspace(0,8,33).';
ydata = sinc(xdata);
```

Now define your input x as a vector of 201 evenly spaced points between -1 and 9.

```
x = linspace(-1,9,201).';
```

Notice that x includes some values that are both lower and higher than the range of xdata.

You can now use fixpt_interp1 to interpolate outputs for x.

```
y = fixpt_interp1(xdata,ydata,x,sfix(8),2^-3,sfix(16),...
 2^-14,'Floor')
```

See Also   `fixpt_look1_func_approx`, `fixpt_look1_func_plot`

fixpt_look1_func_approx

Purpose   Optimize for a fixed-point function, the x values, or breakpoints, that are generated for a lookup table

Syntax
```
[xdata,ydata,errworst]=fixpt_look1_func_approx('funcstr',...
xmin,xmax,xdt,xscale,ydt,yscale,rndmeth,errmax,nptsmax)

[xdata,ydata,errworst]=fixpt_look1_func_approx('funcstr',...
xmin,xmax,xdt,xscale,ydt,yscale,rndmeth,errmax,[])

[xdata,ydata,errworst]=fixpt_look1_func_approx('funcstr',...
xmin,xmax,xdt,xscale,ydt,yscale,rndmeth,[],nptsmax)

[xdata,ydata,errworst]=fixpt_look1_func_approx('funcstr',...
xmin,xmax,xdt,xscale,ydt,yscale,rndmeth,errmax,nptsmax,spacing)
```

Description   `fixpt_look1_func_approx('funcstr',xmin,xmax,xdt,xscale,ydt,` `yscale,rndmeth,errmax,nptsmax)` optimizes the breakpoints of a lookup table over a specified range. The lookup table satisfies the maximum acceptable error, maximum number of points, and spacing requirements given by the optional parameters. The breakpoints refer to the x values of the lookup table. The command

```
[xdata,ydata,errworst]=fixpt_look1_func_approx('funcstr',...
 xmin,xmax,xdt,xscale,ydt,yscale,rndmeth,errmax,[])
```

returns the *x-* and *y-* coordinates of the lookup table as vectors xdata and ydata, respectively. It also returns the maximum absolute error of the lookup table as a variable errworst.

The fixed-point approximation is found by interpolating between the lookup table data points. The required input parameters are as follows.

Input	Value
'funcstr'	Function of x funcstr is the function for which breakpoints are approximated.
xmin	Minimum value of x
xmax	Maximum value of x
xdt	Data type of x
xscale	Scaling for the x values
ydt	Data type of y
yscale	Scaling for the y values
rndmeth	Rounding mode supported by fixed-point Simulink blocks: 'Toward Zero', 'Nearest', 'Floor' (default value), 'Ceiling'

- xmin and xmax specify the range over which the breakpoints are approximated.
- xdt, xscale, ydt, yscale, and rndmeth follow conventions used by fixed-point Simulink blocks.
- rndmeth has a default value listed in the input table.

In addition to the required parameters, there are three optional inputs, as follows.

Input	Value
errmax	Maximum acceptable error
nptsmax	Maximum number of points
spacing	Spacing: 'even', 'pow2' (even power of 2), 'unrestricted' (default value)

Of these, you must use at least one of the parameters errmax and nptsmax. If you omit one of these, you must use brackets, [], in place of

the omitted parameter. The function will then ignore that requirement for the lookup table.

The outputs of the function are as follows.

Output	Value
xdata	The breakpoints for the lookup table
ydata	The ideal function applied to the breakpoints
errworst	The worst case error, which is the maximum absolute error between the ideal function and the approximation given by the lookup table

Criteria For Optimizing the Breakpoints: errmax, nptsmax, and spacing

The approximation produced from the lookup table must satisfy the requirements for the maximum acceptable error, errmax, the maximum number of points, nptsmax, and the spacing, spacing. The requirements are

- The maximum absolute error is less than errmax.

- The number of points required is less than nptsmax.

- The spacing is specified as unrestricted, even or even power of 2.

Modes for errmax and nptsmax

- If both errmax and nptsmax are specified

  The returned breakpoints will meet both criteria if possible. The errmax parameter is given priority, and nptsmax is ignored, if both criteria cannot be met with the specified spacing.

- If only errmax is specified

  The breakpoints that meet the error criteria, and have the least number of points are returned

- If only nptsmax is specified

The breakpoints that require nptsmax or fewer, and give the smallest worst case error are returned

Modes for Spacing

If no spacing is specified, and more than one spacing method meets the requirements given by errmax and nptsmax, power of 2 spacing is chosen over even spacing, which in turn is chosen over uneven spacing. This case occurs when the errmax and nptsmax are both specified, but typically does not occur when only one is specified:

- If unrestricted is entered, the function chooses the spacing that provides the best optimization.

- If even is entered, the function chooses an evenly spaced set of points, including the pow2 spacing.

- If pow2 spacing is entered, the function chooses an even power of 2 spaced set of points.

Note The global optimum may not be found. The worst case error can depend on fixed-point calculations, which are highly nonlinear. Furthermore, the optimization approach is heuristic.

The spacing you choose depends on the parameters you want to optimize: execution speed, function approximation error, ROM usage, and RAM usage:

- The execution speed depends on the bisection search, and the interpolation method.

- The error depends on how accurately the method approximates the nonuniform curvature of the function.

- The ROM usage depends on the amount of data and command ROM used.

- The RAM usage depends on how much global and stack RAM is used.

When the lookup table has even power of two spacing, division is replaced by a bit shift. As a result, the execution speed is faster than for evenly spaced data.

Using the Approximation Function

1 Choose a function and use the `eval('funcstr');` command to view the function before creating the lookup table.

2 Define the remaining inputs.

3 Run the `fixpt_look1_func_approx` function.

4 Use the `fixpt_look1_func_plot` function to plot the function from the selected breakpoints, and to calculate the error and the number of points used.

5 Vary the inputs to produce sets of breakpoints that generate functions with varying number of points required and worst case error.

6 Compare the number of points required and worst case error from various runs to choose the best set of breakpoints.

Calculating the Output Function

To calculate the function, use the returned breakpoints with

- The `eval` function
- A function lookup table. The `x` values are the breakpoints from the `fixpt_look1_func_approx` function, and the `y` values can be supplied using the `eval` function.

See "Tutorial: Producing Lookup Table Data" in "Simulink Fixed Point" for a tutorial on using `fixpt_look1_func_approx`.

The following table summarizes the effect of spacing on the execution speed, error, and memory used.

Parameter	Even Power of 2 Spaced Data	Evenly Spaced Data	Unevenly Spaced Data
Execution Speed	The execution speed is the fastest. The position search and interpolation are the same as for evenly spaced data. However, to increase the speed more, the position search is replaced by a bit shift, and the interpolation is replaced with a bit mask.	The execution speed is faster than that for unevenly spaced data because the position search is faster and the interpolation requires a simple division.	The execution speed is the slowest of the different spacings because the position search is slower, and the interpolation requires more operations.
Error	The error can be larger than that for unevenly spaced data because approximating a function with nonuniform curvature requires more points to achieve the same accuracy.	The error can be larger than that for unevenly spaced data because approximating a function with nonuniform curvature requires more points to achieve the same accuracy.	The error can be smaller because approximating a function with nonuniform curvature requires fewer points to achieve the same accuracy.
ROM Usage	Uses less command ROM, but more data ROM.	Uses less command ROM, but more data ROM.	Uses more command ROM, and less data ROM.
RAM Usage	Not significant.	Not significant.	Not significant.

fixpt_look1_func_approx

Examples

This example produces a lookup table for a sine function. The inputs for the example are as follows:

```
funcstr = 'sin(2*pi*x)';
xmin = 0;
xmax = 0.25;
xdt = ufix(16);
xscale = 2^-16;
ydt = sfix(16);
yscale = 2^-14;
rndmeth = 'Floor';
errmax = 2^-10;
spacing = 'pow2';
```

To create the lookup table, type

```
[xdata, ydata, errWorst]=fixpt_look1_func_approx(funcstr,...
 xmin,xmax,xdt,xscale,ydt,yscale,rndmeth,errmax,[],spacing);
```

The brackets [ ] are a place holder for the nptsmax parameter, which is not used in this example.

You can then plot the ideal function, the approximation, and the errors by typing

```
fixpt_look1_func_plot(xdata,ydata,funcstr,xmin,xmax,xdt,...
 xscale,ydt,yscale,rndmeth);
```

The fixpt_look1_func_plot function produces a plot of the fixed-point sine function, using these breakpoints, and a plot of the error between the ideal function and the fixed-point function. The maximum absolute error and the number of points required are listed with the plot. The error drops to zero at a breakpoint, and increases between breakpoints due to the difference in curvature of the ideal function and the line drawn between breakpoints.

The resulting plots are shown.

The lookup table requires 33 points to achieve a maximum absolute error of 2^-11.3922.

See Also   fixpt_look1_func_plot

fixpt_look1_func_plot

Purpose   Plot a function with x values generated by the `fixpt_look1_func_approx` function

Syntax   `errworst = fixpt_look1_func_plot(xdata,ydata,'funcstr',`
            `xmin,xmax,xdt,xscale,ydt,yscale,rndmeth)`

Description `fixpt_look1_func_plot(xdata,ydata,'funcstr',xmin,xmax,xdt,xscale,`
`ydt,yscale,rndmeth)` plots a lookup table approximation function and its error from the ideal function. You can use the `fixpt_look1_func_approx` function to generate `xdata` and `ydata`, the *x* and *y* data points for the lookup table. The function returns the maximum absolute error as a variable `errworst`. The inputs are as follows.

Input	Value
`xdata`	x values for the lookup table
`ydata`	y values for the lookup table
`'funcstr'`	Function of x
`xmin`	Minimum input of interest
`xmax`	Maximum input of interest
`xdt`	Data type of x
`xscale`	Scaling for the x values
`ydt`	Data type of y
`yscale`	Scaling for the y values
`rndmeth`	Rounding mode supported by the blockset: `'Toward Zero'`, `'Nearest'`, `'Floor'`, `'Ceiling'`

The `fixpt_look1_func_approx` function applies the ideal function to the points in `xdata` to produce `ydata`. While this is the easiest way to generate `ydata`, you are not required to use these values for `ydata` as input for the `fixpt_look1_func_approx` function. Choosing different

values for ydata can, in some cases, produce a lookup table with a smaller maximum absolute error.

See "Tutorial: Producing Lookup Table Data" in "Simulink Fixed Point" for a tutorial on using fixpt_look1_func_plot. For an example of the function, see fixpt_look1_func_approx function.

See Also   fixpt_look1_func_approx

fixpt_set_all

Purpose   Set a property for every fixed-point block in a subsystem

Syntax   fixpt_set_all(SystemName,fixptPropertyName,fixptPropertyValue)

Description   fixpt_set_all sets the property fixptPropertyName of every
                   applicable block in the model or subsystem SystemName to the value
                   fixptPropertyValue.

Examples   To set every fixed-point block in a model called Filter_1 to round
                   toward the floor and to saturate upon overflow, type

```
fixpt_set_all('Filter_1','RndMeth','Floor')
fixpt_set_all('Filter_1','DoSatur','on')
```

Purpose
Create a MATLAB structure describing a floating-point data type

Syntax
```
a = float('single')
a = float('double')
a = float(TotalBits, ExpBits)
```

Description
`float('single')` returns a MATLAB structure that describes the data type of an IEEE single (32 total bits, 8 exponent bits).

`float('double')` returns a MATLAB structure that describes the data type of an IEEE double (64 total bits, 11 exponent bits).

`float(TotalBits, ExpBits)` returns a MATLAB structure that describes a nonstandard floating-point data type that mimics the IEEE style. That is, the numbers are normalized with a hidden leading one for all exponents except the smallest possible exponent. However, the largest possible exponent might not be treated as a flag for Infs and NaNs.

`float` is automatically called when a floating-point number is specified in a block dialog box.

Examples
Define a nonstandard, IEEE-style, floating-point data type with 31 total bits (excluding the hidden leading one) and 9 exponent bits:

```
a = float(31,9)
a =
        Class: 'FLOAT'
     MantBits: 21
      ExpBits: 9
```

See Also
`fixdt, sfix, sfrac, sint, ufix, ufrac, uint`

fxptdlg

Purpose Invokes the Fixed-Point Settings interface

Syntax `fxptdlg('model')`

Description `fxptdlg('model')` brings up the Fixed-Point Settings interface for the MDL-file `model`. You can also invoke this interface by

- Selecting **Fixed-Point Settings** in the **Tools** menu in the model window
- Right-clicking in any subsystem and selecting **Fixed-Point Settings** from the menu that pops up

With the Simulink Fixed Point product, the Fixed-Point Settings interface provides convenient access to global data type overrides and logging settings, the logged data, the automatic scaling script, and the Plot System interface. You can invoke the Fixed-Point Settings interface for any system or subsystem, and it controls the model specified by the **Select current system** parameter.

If Simulink Fixed Point is installed, the Fixed-Point Settings interface displays the name, minimum simulation value, maximum simulation value, data type, and scaling of each block in the model that logs data. Additionally, if a signal saturates or overflows, a message is displayed for the associated block indicating how many times saturation or overflow occurred. You can display a block's dialog box by double-clicking on the appropriate block entry in this pane.

Most of the functionality in the Fixed-Point Settings interface is for use with the Simulink Fixed Point product. However, even if you do not have Simulink Fixed Point, you can use data type override mode to simulate a model that specifies fixed-point data types. In this mode, Simulink replaces fixed-point values with floating-point values when simulating the model. Data type override mode allows you to share fixed-point models with people in your company who do not have Simulink Fixed Point.

To simulate a model in data type override mode:

1 Select **Fixed-Point Settings** from the Simulink **Tools** menu.

The **Fixed-Point Settings** dialog box appears.

2 Set the **Logging mode** parameter to Force off.

3 Set the **Data type override** parameter to True doubles or True singles.

Note If you specify a fi object as a fixed-point parameter in your model, you need a Fixed-Point Toolbox license to simulate the model in data type override mode.

Parameters and Dialog Box

Select current system

Displays the names of all systems and subsystems in currently opened models in a hierarchical format. The menu can be expanded and collapsed using the + and - signs. The information displayed in the rest of the Fixed-Point Settings interface applies to the subsystem designated by this parameter.

Logging mode

Controls which blocks log data. The value of this parameter for parent systems controls logging for all child subsystems, unless `Use local settings` is selected:

- `Use local settings` — Data is logged according to the value of this parameter set for each subsystem. Otherwise, settings for parent systems always override those of child systems.

- `Min, max and overflow` — Minimum value, maximum value, and overflow data is logged for all blocks in the current system or subsystem.

- `Overflow` — Only overflow data is logged for all blocks in the current system or subsystem.

- `Force off` — No data is logged for any block in the current system or subsystem. Use this selection to work with models containing fixed-point enabled blocks if you do not have a Simulink Fixed Point license.

Data type override

Controls data type override of blocks that allow you to specify data types in their block masks. The value of this parameter for parent systems controls data type override for all child subsystems, unless `Use local settings` is selected:

- `Use local settings` — Data types are overridden according to the value of this parameter set for each subsystem. Otherwise, settings for parent systems override those of child systems.

- `Scaled doubles` — The output data type of all blocks in the current system or subsystem is overridden with doubles;

however, the scaling and bias specified in the mask of each block is maintained.

- `True doubles` — The output data type of all blocks in the current system or subsystem is overridden with true doubles. The overridden values have no scaling or bias.

- `True singles` — The output data type of all blocks in the current system or subsystem is overridden with true singles. The overridden values have no scaling or bias.

- `Force off` — No data type override is performed on any block in the current system or subsystem.

Set this parameter to `True doubles` or `True singles` to work with models containing fixed-point enabled blocks if you do not have a Simulink Fixed Point license.

Note The following Simulink blocks allow you to set data types in their block masks, but ignore the **Data Type Override** setting: Probe, Trigger, Width.

Block Name
　　Displays blocks that log data in the selected system or subsystem. The block path is described in terms of the blockset model name. The minimum value, maximum value, data type, and scaling are shown opposite each block name when the simulation is run.

Logging type
　　Controls the logging type:

- `Overwrite log` – Information in the **Simulation data logged for current system** pane is completely cleared before new logging data is entered.

- `Merge log` – New logging data is merged with any information previously appearing in the **Simulation data logged for current system** pane.

Safety margin

The **Safety margin** parameter is used as part of the automatic scaling procedure. Before automatic scaling is performed, you must run the simulation to collect min/max data. To learn how to do this, refer to "Tutorial: Feedback Controller Simulation".

Simulation values are multiplied by the factor designated by this parameter, allowing you to specify a range different from that defined by the maximum and minimum values logged to the workspace. For example, a value of 55 specifies that a range *at least* 55 percent larger is desired. A value of -15 specifies that a range *up to* 15 percent smaller is acceptable.

The Fixed-Point Settings interface contains eight buttons:

- **Run** runs the model and updates the display with the latest simulation information.

- **Pause** pauses the simulation.

- **Stop** stops the simulation from running.

- **Show plot dialog** invokes the **Plot systems** interface, which displays any To Workspace, Outport, or Scope blocks found in the model.

- **Open System** invokes the Fixed-Point Settings interface for the system or subsystem displayed in the **Select current system** parameter.

- **Autoscale Blocks** invokes the automatic scaling script `autofixexp`.

- **Close** closes the interface.

- **Help** displays the HTML-based help for the `fxptdlg` function.

The **Plot systems** interface is shown below. In this example, the interface is displaying variable names that correspond to Scope block outputs from the `fxpdemo_feedback` demo.

To plot the simulation results, select one or more variable names, and then select the appropriate plot button:

- **Plot Signals** plots the raw signal data for the selected variable(s).

- **Plot Doubles** plots doubles data for the selected variable(s). Doubles are generated when the **Data type override** parameter is set to True doubles.

- **Plot Both** plots both raw signal data and doubles data for the selected signal(s). Note that the doubles override does not overwrite the raw data.

- **Cancel** allows you to exit the interface without plotting.

Examples   To learn how to use the Fixed-Point Settings interface, see "Tutorial: Feedback Controller Simulation" in "Simulink Fixed Point".

See Also   showfixptsimerrors, showfixptsimranges

num2fixpt

Purpose   Convert a number to the nearest value representable by a specified fixed-point data type

Syntax   outValue = num2fixpt(OrigValue, FixPtDataType, FixPtScaling, RndMeth, DoSatur)

Description num2fixpt(OrigValue, FixPtDataType, FixPtScaling, RndMeth, DoSatur) returns the result of converting OrigValue to the nearest value representable by the fixed-point data type FixPtDataType. Both OrigValue and outValue are of data type double. As illustrated in the example that follows, you can use num2fixpt to investigate quantization error that might result from converting a number to a fixed-point data type. The arguments of num2fixpt include:

OrigValue	Value to be converted to a fixed-point representation. Must be specified using a double data type.
FixPtDataType	The fixed-point data type used to convert OrigValue.
FixPtScaling	Scaling of the output in either Slope or [Slope Bias] format. If FixPtDataType does not specify a generalized fixed-point data type using the sfix or ufix command, FixPtScaling is ignored.

RndMeth	Rounding technique used if the fixed-point data type lacks the precision to represent `OrigValue`. If `FixPtDataType` specifies a floating-point data type using the `float` command, `RndMeth` is ignored. Valid values are `Zero`, `Nearest`, `Ceiling`, or `Floor` (the default).
DoSatur	Indicates whether the output should be saturated to the minimum or maximum representable value upon underflow or overflow. If `FixPtDataType` specifies a floating-point data type using the `float` command, `DoSatur` is ignored. Valid values are `on` or `off` (the default).

Examples   Suppose you wish to investigate the quantization effect associated with representing the real-world value 9.875 as a signed, 8-bit fixed-point number. The command

```
num2fixpt(9.875, sfix(8), 2^-1)

ans =

    9.50000000000000
```

reveals that a slope of 2^-1 results in a quantization error of 0.375. The command

```
num2fixpt(9.875, sfix(8), 2^-2)

ans =

    9.75000000000000
```

demonstrates that a slope of 2^-2 reduces the quantization error to 0.125. But a slope of 2^-3, as used in the command

```
num2fixpt(9.875, sfix(8), 2^-3)
```

num2fixpt

```
ans =

    9.87500000000000
```

eliminates the quantization error entirely.

See Also   `fixptbestexp`, `fixptbestprec`

sfrac

Purpose   Create a MATLAB structure describing a signed fractional data type

Syntax   a = sfrac(TotalBits)
                a = sfrac(TotalBits, GuardBits)

Description sfrac(TotalBits) returns a MATLAB structure that describes the data
                type of a signed fractional number with a word size given by TotalBits.

                sfrac(TotalBits, GuardBits) returns a MATLAB structure that
                describes the data type of a signed fractional number. The total word
                size is given by TotalBits with GuardBits bits located to the left of
                the sign bit.

                sfrac is automatically called when a signed fractional data type is
                specified in a block dialog box.

                The default binary point for this data type is assumed to lie immediately
                to the right of the sign bit. If guard bits are specified, they lie to the left
                of the binary point in addition to the sign bit.

Examples   Define an 8-bit signed fractional data type with 4 guard bits. Note that
                the range of this number is -2^4 = -16 to $(1 - 2^{(1 - 8)}).2^4$ = 15.875:

```
a = sfrac(8,4)
a =
         Class: 'FRAC'
      IsSigned: 1
      MantBits: 8
     GuardBits: 4
```

See Also   fixdt, float, sfix, sint, ufix, ufrac, uint

Purpose   Create a MATLAB structure describing a signed integer data type

Syntax   a = sint(TotalBits)

Description   sint(TotalBits) returns a MATLAB structure that describes the data type of a signed integer with a word size given by TotalBits.

sint is automatically called when a signed integer is specified in a block dialog box.

The default binary point for this data type is assumed to lie to the right of all bits.

Examples   Define a 16-bit signed integer data type:

```
a = sint(16)
a =
        Class: 'INT'
     IsSigned: 1
     MantBits: 16
```

See Also   fixdt, float, sfix, sfrac, ufix, ufrac, uint

ufix

Purpose	Create a MATLAB structure describing an unsigned generalized fixed-point data type
Syntax	`a = ufix(TotalBits)`
Description	`ufix(TotalBits)` returns a MATLAB structure that describes the data type of an unsigned generalized fixed-point data type with a word size given by `TotalBits`. `ufix` is automatically called when an unsigned generalized fixed-point data type is specified in a block dialog box. **Note** The default binary point is not included in this data type description. Instead, the scaling must be explicitly defined in the block dialog box.

Examples	Define a 16-bit unsigned generalized fixed-point data type:
	
	`a = ufix(16)`
	`a =`
	`        Class: 'FIX'`
	`     IsSigned: 0`
	`     MantBits: 16`

See Also	`fixdt, float, sfix, sfrac, sint, ufrac, uint`

Purpose   Create a MATLAB structure describing an unsigned fractional data type

Syntax   a = ufrac(TotalBits)
                 a = ufrac(TotalBits, GuardBits)

Description ufrac(TotalBits) returns a MATLAB structure that describes the
                 data type of an unsigned fractional number with a word size given by
                 TotalBits.

                 ufrac(TotalBits, GuardBits) returns a MATLAB structure that
                 describes the data type of an unsigned fractional number. The total
                 word size is given by TotalBits with GuardBits bits located to the left
                 of the binary point.

                 ufrac is automatically called when an unsigned fractional data type
                 is specified in a block dialog box.

                 The default binary point for this data type is assumed to lie immediately
                 to the left of all bits. If guard bits are specified, then they lie to the left
                 the default binary point.

Examples   Define an 8-bit unsigned fractional data type with 4 guard bits. Note
                 that the range of this number is from 0 to $(1 - 2^{-8}).2^4 = 15.9375$:

```
a = ufrac(8,4)
a =
        Class: 'FRAC'
     IsSigned: 0
      MantBits: 8
     GuardBits: 4
```

See Also   fixdt, float, sfix, sfrac, sint, ufix, uint

uint

Purpose   Create a MATLAB structure describing an unsigned integer data type

Syntax   a = uint(TotalBits)

Description uint(TotalBits) returns a MATLAB structure that describes the data type of an unsigned integer with a word size given by TotalBits.

uint is automatically called when an unsigned integer is specified in a block dialog box.

The default binary point for this data type is assumed to lie to the right of all bits.

Examples   Define a 16-bit unsigned integer:

```
a = uint(16)
a =
        Class: 'INT'
     IsSigned: 0
     MantBits: 16
```

See Also   fixdt, float, sfix, sfrac, sint, ufix, ufrac

9

Data Object Classes

The following sections describe the properties and usage of the following classes of Simulink data objects (see "Working with Data Objects" in "Using Simulink" for general information on creating and using Simulink data objects).

Class Summary

The following table briefly describes the purpose of each Simulink data object class.

Class	Purpose
EventData	Provides information about block method execution events.
Simulink.AliasType	Specifies an alternate name for an existing data type.
Simulink.BlockCompDworkData	Provides postcompilation information about a block's Dwork vector.
Simulink.BlockCompInputPortData	Provides postcompilation information about a block input port.
Simulink.BlockCompOutputPortData	Provides postcompilation information about a block output port.
Simulink.BlockData	Provide run-time information about block-related data, such as block parameters.
Simulink.BlockPortData	Describe a block input or output port.
Simulink.BlockPreCompInputPortData	Provides precompilation information about a block input port.
Simulink.BlockPreCompOutputPortData	Provides precompilation information about a block output port.
Simulink.Bus	Describes a signal bus.
Simulink.BusElement	Describe an element of a signal bus.

Class	Purpose
`Simulink.ConfigSet`	Access a model configuration set.
`Simulink.ModelAdvisor`	Run the Model Advisor programmatically.
`Simulink.ModelDataLogs`	Stores a model's signal logs.
`Simulink.ModelWorkspace`	Accesses a model's workspace.
`Simulink.MSFcnRunTimeBlock`	Get run-time information about a Level-2 M-file S-function block.
`Simulink.NumericType`	Describes a numeric data type.
`Simulink.Parameter`	Describes the value of a block parameter.
`Simulink.ParamRTWInfo`	Specify information needed to generate code for a parameter.
`Simulink.RunTimeBlock`	Allow Level-2 M-file S-function and other M-file programs to get information about a block while a simulation running.
`Simulink.ScopeDataLogs`	Log data displayed by a Scope viewer.
`Simulink.Signal`	Describes the value of a block output.
`Simulink.StructElement`	Describes an element of a data structure.
`Simulink.StructType`	Describes a data structure.
`Simulink.SubsysDataLogs`	Stores a subsystem's signal logs.

Class	Purpose
Simulink.TimeInfo	Provide information about the time data in a Simulink.Timeseries object.
Simulink.Timeseries	Log for an elementary signal.
Simulink.TsArray	Log for a composite signal.

Classes — Alphabetical List

EventData
Simulink.AliasType
Simulink.Annotation
Simulink.BlockCompDworkData
Simulink.BlockCompInputPortData
Simulink.BlockCompOutputPortData
Simulink.BlockData
Simulink.BlockPortData
Simulink.BlockPreCompInputPortData
Simulink.BlockPreCompOutputPortData
Simulink.Bus
Simulink.BusElement
Simulink.ConfigSet
Simulink.ModelAdvisor
Simulink.ModelDataLogs
Simulink.ModelWorkspace
Simulink.MSFcnRunTimeBlock
Simulink.NumericType
Simulink.Parameter
Simulink.ParamRTWInfo
Simulink.RunTimeBlock
Simulink.ScopeDataLogs
Simulink.Signal
Simulink.StructElement
Simulink.StructType
Simulink.SubsysDataLogs
Simulink.TimeInfo
Simulink.Timeseries
Simulink.TsArray

EventData

Purpose	Provides information about block method execution events.
Description	Simulink creates an instance of this class when a block method execution event occurs during simulation and passes it to any listeners registered for the event (see add_exec_event_listener). The instance specifies the type of event that occurred and the block whose method execution triggered the event. See "Accessing Block Data During Simulation" in "Using Simulink" for more information.
Parent	None
Children	None

Property Summary

Name	Description
"Type"	Type of method execution event that occurred.
"Source"	Block that triggered the event.

Properties

Type

Description

Type of method execution event that occurred. Possible values are:

Event	Occurs...
'PreOutputs'	Before a block's Outputs method executes.
'PostOutputs'	After a block's Outputs method executes.
'PreUpdate'	Before a block's Update method executes.
'PostUpdate'	After a block's Update method executes.
'PreDerivatives'	Before a block's Derivatives method executes.
'PostDerivatives'	After a block's Derivatives method executes.

Data Type
string

Access
RO

Source

Description
Block that triggered the event

Data Type
Simulink.RunTimeBlock

Access
RO

Simulink.AliasType

Purpose   Create an alias for a signal and/or parameter data type

Description   This class allows you to designate MATLAB variables as aliases for signal and parameter data types. You do this by creating instances of this class and assigning them to variables in the MATLAB or model workspaces (see "Creating a Data Type Alias" on page 9-8). The MATLAB variable to which a `Simulink.AliasType` object is assigned is called a data type alias. The data type to which an alias refers is called its base type. Simulink allows you to set the `BaseType` property of the object that the variable references, thereby designating the data type for which it is an alias.

Simulink lets you use aliases instead of actual type names in dialog boxes and `set_param` commands to specify the data types of Simulink block outputs and parameters. Using aliases to specify signal and parameter data types can greatly simplify global changes to the signal and parameter data types that a model specifies. In particular, changing the data type of all signals and parameters whose data type is specified by an alias requires only changing the base type of the alias. By contrast, changing the data types of signals and parameters whose data types are specified by an actual type name requires respecifying the data type of each signal and parameter individually.

Note Suppose you specify an instance of the `Simulink.AliasType` class as the value of a `Simulink.Parameter` object's **Data type** property. If you enter the parameter object in a subsystem's mask, the subsystem displays the data type's base type instead of its alias name.

Creating a Data Type Alias

You can use either the Model Explorer or MATLAB commands (see "MATLAB Commands for Creating Data Type Aliases" on page 9-9) to create a data type alias.

To use the Model Explorer to create an alias:

1 Select `Base Workspace` (i.e., the MATLAB workspace) in the Model Explorer's **Model Hierarchy** pane.

You must create data type aliases in the MATLAB workspace. If you attempt to create an alias in a model workspace, Simulink displays an error.

2 Select **Simulink.AliasType** from the Model Explorer's **Add** menu.

Simulink creates an instance of a `Simulink.AliasType` object and assigns it to a variable named `Alias` in the MATLAB workspace.

3 Rename the variable to a more appropriate name, for example, a name that reflects its intended usage.

To change the name, edit the name displayed in the **Name** field in the Model Explorer's **Contents** pane.

4 Enter the name of the data type that this alias represents in the **Base type** field in the Model Explorer's **Dialog** pane.

You can specify the name of any existing standard or user-defined data type in this field. Skip this step if the desired base type is `double` (the default).

5 Use the MATLAB `save` command to save the newly created alias in a MAT-file that can be loaded by the models in which it is used.

MATLAB Commands for Creating Data Type Aliases

Use the following syntax to create a data type alias at the MATLAB command line or in a MATLAB program

```
ALIAS = Simulink.AliasType;
```

where `ALIAS` is the name of the variable that you want to serve as the alias. For example, the following line creates an alias names `MyFloat`.

```
MyFloat = Simulink.AliasType;
```

Simulink.AliasType

The following notations get and set the properties of a data type alias, respectively,

```
PROPVALUE = ALIAS.PROPNAME;
ALIAS.PROPNAME = PROPVALUE;
```

where `ALIAS` is the name of the alias, `PROPNAME` is the name of the alias object's properties, and `PROPVALUE` is the property's value. For example, the following code saves the current value of `MyFloat`'s `BaseType` property and assigns it a new value.

```
old = MyFloat.BaseType;
MyFloat.BaseType = 'single';
```

See "Properties" on page 9-11 for information on the names, permitted values, and usage of the properties of data type alias objects.

Parent   None

Children   None.

Property Dialog Box

Base type

The data type to which this alias refers. The default is `double`. To specify another data type, select the data type from the adjacent pull-down list of standard data types or enter the data type's

name in the edit field. Note that you can, with one exception, specify a nonstandard data type, e.g, a data type defined by a `Simulink.NumericType` object, by entering the data type's name in the edit field. The exception is a `Simulink.NumericType` whose `Category` is `Fixed-point:  unspecified scaling`.

Note `Fixed-point:  unspecified scaling` is a partially specified type whose definition is completed by the block that uses the `Simulink.NumericType`. Forbidding its use in alias types avoids creating aliases that have different base types depending on where they are used.

Header file
Name of a user-supplied C header file that defines a data type having the same name as this alias (i.e., as the MATLAB variable that references this alias object). If this field is not empty, code generated from this model defines the alias type by including the specified header file. If this field is empty, the generated code defines the alias type itself.

Description
Describes the usage of the data type referenced by this alias.

Properties

Name	Description
BaseType	A string specifying the name of a standard or custom data type. (**Base Type**)
Description	A string that describes the usage of the data type. May be a null string. (**Description**)
HeaderFile	A string that specifies the name of a C header file that defines a data type having the same name as the alias. (**Header File**)

Simulink.Annotation

Purpose Specify properties of a model annotation

Description Instances of this class specify the properties of annotations. You can use getCallbackAnnotation in an annotation callback function to get the Simulink.Annotation instance for the annotation associated with the callback function. You can use find_system and get_param to get the Simulink.Annotation instance associated with any annotation in a model. For example, the following code gets the annotation object for the first annotation in the currently selected model and turns on its drop shadow

```
ah = find_system(gcs, 'FindAll', 'on', 'type', 'annotation');
ao = get_param(ah(1), 'Object');
ao.DropShadow = 'on';
```

Parent None

Children None.

Property Summary

Property	Description
Text	String specifying text of annotation.
FontName	String specifying name of annotation's font. The default value, 'auto', specifies use of the model's preferred font.
FontSize	Integer specifying size of annotation's font in points. The default value, -1, specifies use of the model's preferred font size.
FontWeight	String specifying the angle of the annotation's font. The default value, 'auto', specifies use of the model's preferred font angle.

Property	Description
Selected	String specifying whether this annotation is currently selected ('on') or not selected ('off').
Position	Two-element vector specifying the x-y coordinates of this annotation relative to the top, left corner of the block diagram, e.g., [236 83].
HorizontalAlignment	String specifying the horizontal alignment of this annotation, e.g., 'center'.
VerticalAlignment	String specifying the vertical alignment of this annotation, e.g., 'middle'.
ForegroundColor	String specifying foreground color of this annotation.
BackgroundColor	String specifying background color of this annotation.
DropShadow	String specifying whether to display a drop shadow. Options are 'on' or 'off'.
TeXMode	String specifying whether to render TeX markup. Options are 'on' or 'off'.
LoadFcn	String specifying M-code to be executed when the model containing this annotation is loaded. See "Annotation Callback Functions" in the online Simulink documentation.
DeleteFcn	String specifying M-code to be executed before deleting this annotation. See "Annotation Callback Functions" in the online Simulink documentation.

Simulink.Annotation

Property	Description
UseDisplayTextAsClick-Callback	String specifying whether to use the contents of the Text property as this annotation's click function. Options are 'on' or 'off'. A click function is a valid MATLAB expression. If you enable this option, clicking the annotation executes the associated MATLAB expression. If this option is not enabled, clicking on the annotation has no effect. See "Associating Click Functions with Annotations" in the Using Simulink documentation for more information.
UserData	Any data that you want to associate with this annotation.

Purpose   Provides postcompilation information about a block's Dwork vector.

Description   Simulink returns an instance of this class when an M-file program, e.g., a Level-2 M-file S-function, invokes the "Dwork" on page 9-111 method of a block's run-time object after the model containing the block has been compiled.

Parent   `Simulink.BlockData`

Children   None

Property Summary

Name	Description
"UsedAsDiscState"	True if this Dwork vector is being used to store the values of a block's discrete states.

Properties

`UsedAsDiscState`

Description
True if this Dwork vector is being used to store the values of a block's discrete states.

Data Type
Boolean

Access
`RW` for M-file S-function blocks, `RO` for other blocks.

Simulink.BlockCompInputPortData

Purpose	Provides postcompilation information about a block input port
Description	Simulink returns an instance of this class when an M-file program, e.g., a Level-2 M-file S-function, invokes the "InputPort" on page 9-112 method of a block's run-time object after the model containing the block has been compiled.
Parent	Simulink.BlockPortData
Children	None

Property Summary

Name	Description
"DirectFeedthrough"	True if this port has direct feedthrough.
"Overwritable"	True if this port is overwritable.

Properties

DirectFeedthrough

Description
True if this input port has direct feedthrough.

Data Type
Boolean

Access
RW for M-file S functions, RO for other blocks.

Overwritable

Description
True if this input port is overwritable.

Data Type
Boolean

Access
RW for M-file S functions, RO for other blocks.

Simulink.BlockCompOutputPortData

Purpose   Provides postcompilation information about a block output port.

Description   Simulink returns an instance of this class when an M-file program, e.g.,
a Level-2 M-file S-function, invokes the "OutputPort" on page 9-113
method of a block's run-time object after the model containing the block
has been compiled.

Parent   Simulink.BlockPortData

Children   None

Property Summary

Name	Description
"Reusable"	Specifies whether an output port's memory is reusable.

Properties

Reusable

Description
Specifies whether an output port's memory is reusable. Options are:
NotReusableAndGlobal and ReusableAndLocal.

Data Type
string

Access
RW for M-file S functions, RO for other blocks.

Simulink.BlockData

Purpose	Provide run-time information about block-related data, such as block parameters
Description	This class defines properties that are common to objects that provide run-time information about a block's ports and work vectors.
Parent	None
Children	Simulink.BlockPortData, Simulink.BlockCompDworkData

Property Summary

Name	Description
"Complexity"	Numeric type (real or complex) of the block data.
"Data"	The block data.
"DataAsDouble"	The block data in double form.
"Datatype"	Data type of the block data.
"DatatypeID"	Index of the data type of the block data.
"Dimensions"	Dimensions of the block data.
"Name"	Name of the block data.
"Type"	Type of block data (e.g., a parameter).

Properties

Complexity

Description
Numeric type (real or complex) of the block data.

Data Type
string

Access
RW for M-file S functions, RO for other blocks.

Data

Description
The block data.

Data Type
The data type specified by the "Datatype" or "DatatypeID" properties of this object.

Access
RW

DataAsDouble

Description
The block data's in double form.

Data Type
double

Access
RO

Datatype

Description
Data type of the values of the block-related object.

Data Type
string

Access
RO

DatatypeID

Description
Index of the data type of the values of the block-related object.

Data Type
integer

Simulink.BlockData

Access

`RW` for M-file S functions, `RO` for other blocks

`Dimensions`

Description

Dimensions of the block-related object, e.g., parameter or DWork vector.

Data Type

array

Access

`RW` for M-file S functions, `RO` for other blocks

`Name`

Description

Name of block-related object, e.g., a block parameter or Dwork vector.

Data Type

string

Access

`RW` for M-file S functions, `RO` for other blocks

`Type`

Description

Type of block data. Possible values are:

Type	Description
`'BlockPreCompInputPortData'`	This object contains data for an input port before the model is compiled.
`'BlockPreCompOutputPortData'`	This object contains data for an output port before the model is compiled.

Type	Description
`'BlockCompInputPortData'`	This object contains data for an input port after the model is compiled.
`'BlockCompOutputPortData'`	This object contains data for an output port after the model is compiled.
`'BlockPreCompDworkData'`	This object contains data for a Dwork vector before the model is compiled.
`'BlockCompDworkData'`	This object contains data for a Dwork vector after the model is compiled.
`'BlockDialogPrmData'`	This object describes a dialog box parameter of a Level-2 M-file S-function.
`'BlockRuntimePrmData'`	This object describes a run-time parameter of a Level-2 M-file S-function.
`'BlockCompContStatesData'`	This object describes the continuous states of the block at the current time step.
`'BlockDerivativesData'`	This object describes the derivatives of the block's continuous states at the current time step.

Data Type
string

Access
RO

Simulink.BlockPortData

Purpose   Describe a block input or output port

Description   This class defines properties that are common to objects that provide run-time information about a block's ports.

Parent   `Simulink.BlockData`

Children   `Simulink.BlockPreCompInputPortData,`
`Simulink.BlockPreCompOutputPortData,`
`Simulink.BlockCompInputPortData,`
`Simulink.BlockCompOutputPortData`

Property Summary

Name	Description
"IsBus"	True if this port is connected to a bus.
"IsSampleHit"	True if this port produces output or accepts input at the current simulation time step.
"SampleTime"	Sample time of this port.
"SampleTimeIndex"	Sample time index of this port.
"SamplingMode"	Sampling mode of the port.

Properties

IsBus

Description
True if this port is connected to a bus.

Data Type
Boolean

Access
RO

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IsSampleHit

Description
True if this port produces output or accepts input at the current simulation time step.

Data Type
Boolean

Access
RO

SampleTime

Description
Sample time of this port.

Data Type
[period offset] where period and offset are values of type double. See "Specifying Sample Time" for more information.

Access
RW for M-file S functions, RO for other blocks

SampleTimeIndex

Description
Sample time index of this port.

Data Type
integer

Access
RO

SamplingMode

Description
Sampling mode of the port. Valid values are:

Simulink.BlockPortData

Value	Description
'frame'	Port accepts or outputs frame-based signals. The use of frame-based signals requires a Signal Processing Blockset license.
'inherited'	Sampling mode is inherited from the port to which this port is connected.
'sample'	Port accepts or outputs sampled data.

Data Type
string

Access
RW for M-file S functions, RO for other blocks

Simulink.BlockPreCompInputPortData

Purpose   Provides precompilation information about a block input port

Description   Simulink returns an instance of this class when an M-file program, e.g., a Level-2 M-file S-function, invokes the "InputPort" on page 9-112 method of a block's run-time object before the model containing the block has been compiled.

Parent   Simulink.BlockPortData

Children   None

Property Summary

Name	Description
"DirectFeedthrough"	True if this port has direct feedthrough.
"Overwritable"	True if this port is overwritable.

Properties

DirectFeedthrough

Description
True if this input port has direct feedthrough.

Data Type
Boolean

Access
RW for M-file S functions, RO for other blocks

Overwritable

Description
True if this input port is overwritable.

Data Type
Boolean

Access
RW for M-file S functions, RO for other blocks

Simulink.BlockPreCompOutputPortData

Purpose	Provide precompilation information about a block output port.
Description	Simulink returns an instance of this class when an M-file program, e.g., a Level-2 M-file S-function, invokes the "OutputPort" on page 9-113 method of a block's run-time object before the model containing the block has been compiled.
Parent	`Simulink.BlockPortData`
Children	none

Property Summary

Name	Description
"Reusable"	Specifies whether an output port's memory is reusable.

Properties

Reusable

Description
Specifies whether an output port's memory is reusable. Options are:
`NotReusableAndGlobal` and `ReusableAndLocal`.

Data Type
string

Access
`RW` for M-file S functions, `RO` for other blocks

Purpose   Specify the properties of a signal bus

Description   Objects of this class (in conjunction with objects of the
`Simulink.BusElement` class) specify the properties of a signal bus. You
can use these objects to enable Simulink to check the validity of buses
connected to the inputs of blocks in your model. You do this by entering
the name of a bus object defining a bus in the **Bus object** field of a
block's parameter dialog box. When you update the model's diagram
or start a simulation of the model, Simulink checks whether the buses
connected to the blocks have the properties specified by the bus objects.
If not, Simulink halts and displays an error message.

You can use the Model Explorer's **Add > Simulink Bus** command (see
"Using the Model Explorer to Create Data Objects"), the Simulink
Bus Editor (see "Bus Editor"), or MATLAB commands (see "Working
with Data Objects") to create bus objects. You must use the Bus Editor
or the MATLAB command line to set the properties of a bus object.
Simulink also provides a set of utility functions for creating and saving
bus objects. See the documentation for the following functions for more
information:

- `Simulink.Bus.save`
- `Simulink.Bus.createObject`
- `Simulink.Bus.cellToObject`

Simulink.Bus

Property Dialog Box

Bus elements

>Table that displays the properties of the bus's elements. You cannot edit this table. You must use either the Simulink **Bus Editor** (see "Bus Editor" in "Using Simulink") or MATLAB commands to add or delete bus elements or change the properties of existing bus elements. To launch the bus editor, click the **Launch Bus Editor** button at the bottom of this dialog box or select **Bus Editor** from the model editor's **Tools** menu.

Header file

>Name of a C header file that declares the structure of this bus. This field is intended for use by Real-Time Workshop (see "Code Generation with User-Defined Data Types" "Real-Time Workshop Embedded Coder User's Guide"). Simulink ignores this field.

Description

>Description of this structure. This field is intended for you to use to document this bus. Simulink itself does not use this field.

Properties

Name	Access	Description
Description	RW	String that describes this bus. This property is intended for user use. Simulink itself does not use it. (Description)
Elements	RW	An array of Simulink.BusElement objects that define the names, data types, dimensions, and other properties of the bus's elements. The elements must have unique names. (Bus elements)
HeaderFile	RW	String that specifies the name of a C header file that declares the structure of this bus. This property is intended for use by Real-Time Workshop. Simulink does not use it. (Header file)

See Also   Simulink.BusElement

Simulink.BusElement

Purpose   Describe an element of a signal bus

Description   Objects of this class define elements of buses defined by objects of the
`Simulink.Bus` class.

**Property
Summary**

Name	Description
"Complexity"	Numeric type of this bus element.
"DataType"	Data type of this bus element.
"Dimensions"	Dimensions of this bus element.
"Name"	Name of this bus element.
"SampleTime"	Sample time of this bus element.
"SamplingMode"	Sampling mode of this bus element.

Properties

Complexity

Numeric type (`'real'` or `'complex'`) of this element. Must be `'real'`
if this bus element is itself a bus.

Data Type: string

Access: RW

DataType

Name of the data type of this element. The value of this field can be
the name of a

- built-in Simulink data type, e.g., `double` or `uint8`

- `Simulink.NumericType` object, with one exception. The exception
  is a `Simulink.NumericType` whose `Category` is `Fixed-point:
  unspecified scaling`.

> **Note** `Fixed-point:  unspecified scaling` is a partially specified
> type whose definition is completed by the block that uses the
> `Simulink.NumericType`. Forbidding its use for bus elements avoids
> creating bus elements that have different data types depending on
> where they are used.

- `Simulink.Bus` object. This allows you to create bus objects that
  specify hierarchical buses, i.e., buses that contain other buses.

`Data Type: string`

`Access:` RW

`Dimensions`

A vector specifying the dimensions of this element. Must be `1` if this
element is itself a bus.

`Data Type: array.`

`Access:` RW

`Name`

Name of this element.

`Data Type: string`

`Access:` RW

`SampleTime`

Size of the interval between times when this signal's value must be
recomputed. Must be -1 (inherited) if this bus element is itself a bus
or if the bus that includes this element passes through a block that
changes the bus's sample time, such as a Rate Transition block. See
"Specifying Sample Time" for more information.

```
Data Type: double
```

```
Access: RW
```

```
SamplingMode
```

Sampling mode of this element. Must be sample-based if this element is itself a bus. This field is intended to be used by applications based on Simulink.

```
Data Type: string
```

```
Access: RW
```

See Also   `Simulink.Bus`

Purpose   Access a model configuration set.

Description   Instances of this handle class allow you to write programs to create, modify, and attach configuration sets to models. See "Configuration Set API" for more information.

Property Summary

Name	Description
"Components"	Components of the configuration set.
"Description"	Description of the configuration set.
"Name"	Name of the configuration set.
"SimulationMode"	Mode used to simulation this configuration.

Note You can use the **Model Configuration** dialog box to set the Name, Description, and SimulationMode properties of a model's active configuration set. See "Model Configuration Dialog Box" in "Using Simulink" for more information.

Method Summary

Name	Description
"attachComponent"	Attach a component to a configuration set.
"copy"	Create a copy of a configuration set.
"getComponent"	Get a component of a configuration set.
"getFullName"	Get the full pathname of a configuration set.
"getModel"	Get the handle of the model that owns a configuration set.
"get_param"	Get the value of a configuration set parameter.

Simulink.ConfigSet

Name	Description
"isActive"	Determine whether a configuration set is the active set of the model that owns it.
"isValidParam"	Determine whether a specified parameter is a valid parameter of a configuration set.
"setPropEnabled"	Prevent or allow a user to change a parameter.
"set_param"	Set the value of a configuration set parameter.

Properties

Components

Description

Array of `Simulink.ConfigComponent` objects representing the components of the configuration set, e.g., solver parameters, data import/export parameters, etc.

Data Type

array

Access

RW

Description

Description

Description of the configuration set. You can use this property to provide additional information about a configuration set, such as its purpose.

Data Type

string

Access

RW

Name

Description

Configuration set's name.

Data Type
string

Access
RW

SimulationMode

Description
Model's simulation mode. Valid values are normal, accelerator, or external.

Data Type
string

Access
RW

Methods

attachComponent

Purpose
Attach a component to this configuration set.

Syntax
attachComponent(component)

Arguments

component
    Instance of Simulink.ConfigComponent class.

Description
This method replaces a component in this configuration set with a component having the same name.

Example
The following example replaces the solver component of the active configuration set of model A with the solver component of the active configuration set of model B.

```
hCs = getActiveConfigSet('B');
```

Simulink.ConfigSet

```
hSolverConfig = hCs.getComponent('Solver');
hSolverConfig = hSolverConfig.copy;
hCs = getActiveConfigSet('A');
hCs.attachComponent(hSolverConfig);
```

---

copy

Purpose
Create a copy of this configuration set.

Syntax
copy

Description
This method creates a copy of this configuration set.

Note You must use this method to create copies of configuration sets. This is because `Simulink.ConfigSet` is a handle class. See "Handle Versus Value Classes" in "Using Simulink" for more information.

---

getComponent

Purpose
Get a component of this configuration set.

Syntax
getComponent(componentName)

Arguments

componentName
      String specifying the name of the component to be returned.

Description
Returns the specified component. Omit the argument to get a list of the names of the components that this configuration set contains.

Example

The following code gets the solver component of the active configuration set of the currently selected model.

```
hCs = getActiveConfigSet(gcs);
hSolverConfig = hCs.getComponent('Solver');
```

The following code displays the names of the components of the currently selected model's active configuration set at the MATLAB command line.

```
hCs = getActiveConfigSet(gcs);
hCs.getComponent
```

getFullName

Purpose
Get the full path name of a configuration set.

Syntax
getFullName

Description
This method returns a string specifying the full pathname of a configuration set, e.g., `'vdp/Configuration'`.

getModel

Purpose
Get the model that owns this configuration set.

Syntax
getModel

Description
Returns a handle to the model that owns this configuration set.

Example
The following command opens the block diagram of the model that owns the configuration set referenced by the MATLAB workspace variable hCs.

```
open_system(hCs.getModel);
```

---

get_param

Purpose
Get the value of a configuration set parameter.

Syntax
`get_param(paramName)`

Arguments

paramName
> String specifying the name of the parameter whose value is to be returned.

Description
This method returns the value of the specified parameter.
`config.get_param('ObjectParameters')` returns the names of the valid parameters in the configuration set named `config`.

Example
The following command gets the name of the solver used by the selected model's active configuration.

```
hAcs = getActiveConfigSet(bdroot);
hAcs.get_param('SolverName');
```

Note You can also use the `get_param` model construction command to get the values of parameters of a model's active configuration set, e.g., `get_param(bdroot, 'SolverName')` gets the solver name of the currently selected model.

---

isActive

Purpose

Determine whether this configuration set is its model's active configuration set.

Syntax

isActive

Description

Returns `true` if this configuration set is the active configuration set of the model that owns this configuration set.

---

isValidParam

Purpose

Determine whether a specified parameter is a valid parameter of this configuration set. A parameter is valid if it is compatible with other parameters in the configuration set. For example, if SolverType is set to `'variable-step'`, FixedStep is an invalid parameter.

Syntax

isValidParam(paramName)

Arguments

paramName

      String specifying the name of the parameter whose validity is to be determined.

Description

This method returns true if the specified parameter is a valid parameter of this configuration set; otherwise, it returns false.

Example

The following code sets the parameter StopTime only if it is a valid parameter of the currently selected model's active configuration set.

```
hAcs = getActiveConfigSet(gcs);
if hAcs.isValidParam('StopTime')
 set_param('StopTime', '20');
end
```

`setPropEnabled`

Purpose
Enable a configuration set parameter to be changed.

Syntax
`setPropEnabled(paramName, isEnabled)`

Arguments

`paramName`
    Name of the parameter whose value is to be set.

`isEnabled`
    Specify as `true` to enable parameter; as `false`, to disable the parameter.

Description
This method sets the enabled status the parameter specified by `paramName` to the value specified by `isEnabled`. Disabling a parameter prevents the user from changing it.

Example
The following code prevents the user from setting the simulation stop time of the currently selected model.

```
hAcs = getActiveConfigSet(gcs);
hAcs.setPropEnabled('StopTime', false);
```

`set_param`

Purpose
Set the value of a configuration set parameter.

Syntax
`set_param(paramName, paramValue)`

Arguments

paramName
    Name of the parameter whose value is to be set.

paramValue
    Value to assign to the parameter.

Description
This method sets the configuration set parameter specified by
paramName to the value specified by paramValue.

Example
The following command sets the simulation stop time of the selected
model's active configuration.

```
hAcs = getActiveConfigSet(gcs);
hAcs.set_param('StopTime', '20');
```

Note You can also use the set_param model construction command to
set the parameters of the active configuration set, e.g., set_param(gcs,
'StopTime', '20') sets the simulation stop time of the currently
selected model.

Simulink.ModelAdvisor

Purpose   Run Model Advisor from M-file

Description   Use instances of this class in M-file programs to run the Model Advisor, for example, to perform a standard set of checks. Simulink creates an instance of this object for each model that you open in the current MATLAB session. To get a handle to a model's Model Advisor object, execute the following command

```
ma = Simulink.ModelAdvisor.getModelAdvisor(model);
```

where *model* is the name of the model or subsystem that you want to check. Your program can then use the Model Advisor object's methods to initialize and run the Model Advisor's checks.

About Title IDs

Many Simulink.ModelAdvisor object methods require or return title IDs. A *title ID* is a string that identifies a Model Advisor check or task. A title ID is often, but not necessarily, the same as the title of the check or task that it identifies. Hence, its name. A Simulink.ModelAdvisor object includes methods that enable you to retrieve the title ID or IDs for all checks and tasks, checks belonging to groups and tasks, the active check, and selected checks and tasks. See the Simulink.ModelAdvisor "Method Summary" for more information.

Method Summary

Name	Description
"deselectCheck"	Deselect check(s).
"deselectCheckAll"	Deselect all checks.
"deselectCheckForGroup"	Deselect a group of checks.
"deselectCheckForTask"	Deselect checks that belong to a specified task or set of tasks.
"deselectTask"	Deselect task(s).
"deselectTaskAll"	Deselect all tasks.

Name	Description
"displayReport"	Display Model Advisor report.
"exportReport"	Copy report to a specified location.
"getBaselineMode"	Get baseline mode setting for the Model Advisor.
"getCheckAll"	Get the title IDs of the checks performed by the Model Advisor.
"getCheckForGroup"	Get checks belonging to a check group.
"getCheckForTask"	Get checks belonging to a task.
"getCheckResult"	Get check results.
"getCheckResultData"	Get check result data.
"getCheckResultStatus"	Get pass/fail status of a check or set of checks.
"getGroupAll"	Get the title IDs of the groups of tasks performed by the Model Advisor.
"getModelAdvisor"	Get the Model Advisor for a model or subsystem.
"getSelectedCheck"	Get selected checks.
"getSelectedTask"	Get path of system currently targeted by the Model Advisor.
"getSelectedTask"	Get selected tasks.

Simulink.ModelAdvisor

Name	Description
"getTaskAll"	Get the title IDs of the tasks performed by the Model Advisor.
"Simulink.ModelAdvisor.reportExists"	Determine whether a report exists for a system or subsystem.
"runCheck"	Run selected checks.
"runTask"	Run checks for selected tasks.
"selectCheck"	Select check(s).
"selectCheckAll"	Select all checks.
"selectCheckForGroup"	Select a group of checks.
"selectCheckForTask"	Select checks that belong to a specified task.
"selectTask"	Select task(s).
"selectTaskAll"	Select all tasks.
"setBaselineMode"	Set baseline mode for the Model Advisor.
"setCheckResult"	Set result for the currently running check.
"setCheckResultData"	Set result data for the currently running check.
"setCheckResultStatus"	Set pass/fail status for the currently running check.
"verifyCheckRan"	Verify that checks have run.
"verifyCheckResult"	Generate a baseline set of check results or compare the current set of results to the baseline results.

Name	Description
"verifyCheckResultStatus"	Verify that a model has passed or failed a set of checks.
"verifyHTML"	Generate a baseline report or compare the current report to a baseline report.

Methods

deselectCheck

Purpose
Deselect a check.

Syntax
```
success = deselectCheck(titleID)
```

Arguments

titleID
    String or cell array that specifies the title IDs of the checks to be deselected

success
    True (1) if the check is deselected.

Description
This method deselects the checks specified by titleID.

Note This method cannot deselect disabled checks.

See Also
"getCheckAll", "deselectCheckForGroup", "selectCheck"

deselectCheckAll

Purpose
Deselect all checks.

Simulink.ModelAdvisor

Syntax

```
success = deselectCheckAll
```

Arguments

```
success
```
    True (1) if all checks are deselected.

Description

Deselects all checks that are not disabled.

See Also

"selectCheckAll"

deselectCheckForGroup

Purpose

Deselect a group of checks.

Syntax

```
success = deselectCheckForGroup(groupName)
```

Arguments

```
groupName
```
    String or cell array that specifies the names of the groups to be deselected

```
success
```
    True (1) if the method succeeds in deselecting the specified group.

Description

Deselects a specified group of checks.

See Also

"selectCheckForGroup"

deselectCheckForTask

Purpose

Deselect checks that belong to a specified task or set of tasks.

Syntax

```
success = deselectCheckForTask(titleID)
```

Arguments

`titleID`
>   String or cell array of strings that specify the title IDs of tasks
>   whose checks are to be deselected.

`success`
>   True (1) if the specified tasks are deselected.

Description
Deselects checks belonging to the tasks specified by the `titleID`
argument.

See Also
"getTaskAll", "selectCheckForTask"

deselectTask

Purpose
Deselect a task.

Syntax
`success = deselectTask(titleID)`

Arguments

`titleID`
>   String or cell array that specifies the title ID of tasks to be
>   deselected

`success`
>   True (1) if the method succeeded in deselecting the specified tasks

Description
Deselects the tasks specified by `titleID`.

See Also
"selectTask", "getTaskAll"

deselectTaskAll

Purpose
Deselect all tasks.

Simulink.ModelAdvisor

Syntax

`success = deselectTaskAll`

Arguments

`success`
> True (1) if this method succeeds in deselecting all tasks

Description
Deselects all tasks.

See Also
"selectTaskAll"

displayReport

Purpose
Display report in Model Advisor.

Syntax
`displayReport`

Description
Displays the report associated with this Model Advisor object in the Model Advisor window. The report includes the most recent results of running checks on the system associated with this Model Advisor object and the current selection status of checks, groups, and tasks for the system.

See Also
"Simulink.ModelAdvisor.reportExists"

exportReport

Purpose
Create a copy of a report generated by Model Advisor.

Syntax
`[success message] = exportReport(destination)`

Arguments

`destination`
> Pathname of copy to be made of the report file

success
> True (1) if this method succeeded in creating a copy of the report at the specified location

message
> Empty if the copy was successful; otherwise, the reason the copy did not succeed.

Description
This method creates a copy of the last report generated by the Model Advisor and stores the copy at the specified location.

See Also
"Simulink.ModelAdvisor.reportExists"

getBaselineMode

Purpose
Determine whether the Model Advisor is in baseline data generation mode.

Syntax
```
mode = getBaselineMode
```

Arguments

mode
> Boolean value indicating baseline mode

Description
The mode output variable returns true if the Model Advisor is in baseline data mode. Baseline mode causes the Model Advisor's verification methods, e.g., "verifyHTML", to generate baseline data.

See Also
"setBaselineMode", "verifyHTML", "verifyCheckResult", "verifyCheckResultStatus"

getCheckAll

Purpose
Get the title IDs of all checks.

Simulink.ModelAdvisor

Syntax

```
titleIDs = getCheckAll
```

Arguments

titleIDs
    Cell array of strings specifying the title IDs of all checks performed by the Model Advisor

Description

Returns a cell array of strings specifying the title IDs of all checks performed by the Model Advisor.

See Also

"getTaskAll", "getGroupAll"

getCheckForGroup

Purpose

Get checks that belong to a check group.

Syntax

```
titleIDs = getCheckForTask(groupName)
```

Arguments

groupName
    String specifying the name of a group

titleIDs
    Cell array of title IDs

Description

Returns a cell array of title IDs of the tasks belonging to the group specified by groupName.

See Also

"getCheckForTask"

getCheckForTask

Purpose

Get the checks that belong to a task.

Syntax

```
checkIDs = getCheckForTask(taskID)
```

Arguments

```
taskID
```
  Title ID of a task

```
checkIDs
```
  Cell array of title IDs of checks belonging to the specified task

Description

Returns a cell array of title IDs of the checks belonging to the task specified by `taskID`.

See Also

"getCheckForGroup"

getCheckResult

Purpose

Get the results of running a check or set of checks.

Syntax

```
result = getCheckResult(titleID)
```

Arguments

```
titleID
```
  Title ID of a check or cell array of check title IDs

```
result
```
  A check result or cell array of check results

Description

Gets check results for the specified checks. The format of the results depends on the checks that generated the data.

Simulink.ModelAdvisor

Note This method is intended for accessing check results generated by custom checks created with the Model Advisor's customization API, an optional feature available with Simulink Verification and Validation (see the online Simulink Verification and Validation documentation for more information).

See Also

"getCheckResultData", "getCheckResultStatus"

getCheckResultData

Purpose

Get the data resulting from running a check or set of checks.

Syntax

```
result = getCheckResultData(titleID)
```

Arguments

titleID
    Check title ID or cell array of check title IDs

result
    Data from a check result or cell array of data from check results

Description

Gets the check result data for the specified checks. The format of the data depends on the checks that generated the data.

Note This method is intended for accessing check result data generated by custom checks created with the Model Advisor's customization API, an optional feature available with Simulink Verification and Validation (see the online Simulink Verification and Validation documentation for more information).

See Also

"getCheckResult", "getCheckResultStatus"

getCheckResultStatus

Purpose
Get the pass/fail status of a check or set of checks.

Syntax
```
result = getCheckResultStatus(titleID)
```

Arguments

`titleID`
>   Check title ID or cell array of check title IDs

`result`
>   Boolean or a cell array of Boolean values indication the pass/fail
>   status of a check or set of checks

Description
Invoke this method after running a set of checks to determine whether
the checks passed or failed.

See Also
"getCheckResult", "getCheckResultData"

getGroupAll

Purpose
Get all groups of checks performed by the Model Advisor.

Syntax
```
titleIDs = getGroupAll
```

Arguments

`titleIDs`
>   Cell array of title IDs of all groups of checks performed by the
>   Model Advisor.

Description
Returns a cell array of title IDs of all groups of checks performed by
the Model Advisor.

Simulink.ModelAdvisor

getModelAdvisor

Purpose
Get a Model Advisor object for a system or subsystem.

Syntax
```
obj = Simulink.ModelAdvisor.getModelAdvisor(system)
```

Arguments

system
    Name of model for which the Model Advisor is to be gotten

obj
    Model Advisor object

Description
This static method (see "Static Methods") creates and returns an instance of `Simulink.ModelAdvisor` class for the model or subsystem specified by `system`.

getSelectedCheck

Purpose
Get the currently selected checks.

Syntax
```
titleIDs = getSelectedCheck
```

Arguments

titleIDs
    Cell array of title IDs of currently selected checks

Description
Returns the checks currently selected in the Model Advisor.

getSelectedSystem

Purpose
Get system currently targeted by the Model Advisor.

Syntax
```
path = getSelectedSystem
```

Arguments

path
> Path of the system selected system

Description
Gets the path of the system currently targeted by the Model Advisor, i.e., the system or subsystem most recently selected for checking either interactively by the user or programmatically via `Simulink.ModelAdisor.getModelAdvisor`.

See Also
"getModelAdvisor"

getSelectedTask

Purpose
Get selected tasks.

Syntax
```
titleIDs = getSelectedTask
```

Arguments

titleIDs
> Cell array of title IDs of currently selected tasks.

Description
Returns the tasks currently selected in the Model Advisor.

See Also
"getSelectedCheck"

getTaskAll

Purpose

Simulink.ModelAdvisor

Get the tasks performed by the Model Advisor.

Syntax
```
titleIDs = getTaskAll
```

Arguments

`titleIDs`
> Cell array of title IDs of tasks performed by the Model Advisor.

Description
Returns a cell array of title IDs of tasks performed by the Model Advisor.

See Also
"getCheckAll", "getGroupAll"

Simulink.ModelAdvisor.reportExists

Purpose
Determine whether a report exists for a model or subsystem.

Syntax
```
exists = reportExists('system')
```

Arguments

`'system'`
> String specifying pathname of a system or subsystem

`exists`
> True (1) if a report exists for `system`

Description
This method returns true (1) if a report file exists for the model (system) or subsystem specified by `system` in the `slprj/modeladvisor` subdirectory of MATLAB's working directory.

See Also
"exportReport"

runCheck

Purpose
Run the currently selected checks.

Syntax

```
success = runCheck
```

Arguments

success
>   True (1) if the checks were run.

Description

Runs the checks currently selected in the Model Advisor. Invoking this method is equivalent to selecting the **Run Advisor** button on the Model Advisor window.

See Also

"selectCheck"

runTask

Purpose

Run the currently selected tasks.

Syntax

```
success = runTask
```

Arguments

success
>   True (1) if the tasks were run.

Description

Runs the tasks currently selected in the Model Advisor. Invoking this method is equivalent to selecting the **Run Advisor** button on the Model Advisor window.

See Also

"selectTask"

selectCheck

Purpose

Select a check.

Syntax

```
success = selectCheck(titleID)
```

Simulink.ModelAdvisor

Arguments

`titleID`
>   Title ID or cell array of title IDs of checks to be selected

`success`
>   True (1) if this method succeeded in selecting the specified checks

Description
This method cannot select a check that is disabled.

See Also
"selectCheckAll", "selectCheckForGroup", "deselectCheck"

selectCheckAll

Purpose
Select all checks.

Syntax
`success = selectCheckAll`

Arguments

`success`
>   True (1) if this method succeeded in selecting all checks.

Description
Selects all checks that are not disabled.

See Also
"selectCheck", "selectCheckForGroup", "deselectCheck"

selectCheckForGroup

Purpose
Select a group of checks.

Syntax
`success = selectCheckForGroup(titleID)`

Arguments

```
titleID
```
    Title ID or cell array of group title IDs

```
success
```
    True (1) if this method succeeded in selecting the specified groups

Description
Selects the groups specified by `titleID`.

See Also
"deselectCheckForGroup"

selectCheckForTask

Purpose
Select checks that belong to a specified task or set of tasks.

Syntax
```
success = selectCheckForTask(titleID)
```

Arguments

```
titleID
```
    Title ID or cell array of title IDs of tasks whose checks are to be
    selected

```
success
```
    True (1) if this method succeeded in selecting the checks for the
    specified tasks

Description
Selects checks belonging to the tasks specified by the `titleID` argument.

See Also
"deselectCheckForTask"

selectTask

Purpose
Select a task.

Syntax
```
success = selectTask(titleID)
```

Arguments

Simulink.ModelAdvisor

titleID
> Title ID or cell array of title IDs of the task to be selected

success
> True (1) if this method succeeds in selecting the specified tasks

Description
Selects a task.

See Also
"deselectTask"

selectTaskAll

Purpose
Select all tasks.

Syntax
```
success = selectTaskAll
```

Arguments

success
> True (1) if this method succeeds in selecting all tasks

Description
Selects all tasks.

See Also
"deselectTaskAll"

setBaselineMode

Purpose
Set the baseline data generation mode for the Model Advisor.

Syntax
```
setBaselineMode(mode)
```

Arguments

mode
> Boolean value indicating setting of Model Advisor's baseline
> mode, either on (true) or off (false)

Description

Sets the Model Advisor's baseline mode to mode. Baseline mode causes the Model Advisor's verify methods to generate baseline comparison data for verifying the results of a Model Advisor run.

See Also

"getBaselineMode", "verifyCheckResult", "verifyHTML"

setCheckResult

Purpose

Set the result for the currently running check.

Syntax

```
success = setCheckResult(result)
```

Arguments

result
>   String or cell array that specifies the result of the currently running task

success
>   True (1) if this method succeeds in setting the check result

Description

Sets the check result for the currently running check. Only the check's callback function can invoke this method.

Note This method is intended for use with custom checks created with the Model Advisor's customization API, an optional feature available with Simulink Verification and Validation (see the online Simulink Verification and Validation documentation for more information).

See Also

"getCheckResult", "setCheckResultData", "setCheckResultStatus"

setCheckResultData

Purpose

Simulink.ModelAdvisor

Set the result data for the currently running check.

Syntax
```
success = setCheckResultData(data)
```

Arguments

data
>   Result data to be set

success
>   True (1) if this method succeeds in setting the result data for the current check

Description
Sets the check result data for the currently running check. Only the check's callback function can invoke this method.

Note This method is intended for use with custom checks created with the Model Advisor's customization API, an optional feature available with Simulink Verification and Validation and Verification (see the online Simulink Verification and Validation documentation for more information).

See Also
"getCheckResultData", "setCheckResult", "setCheckResultStatus"

setCheckResultStatus

Purpose
Set the pass/fail status for the currently running check.

Syntax
```
success = setCheckResultStatus(status)
```

Arguments

status
>   Boolean value that indicates the status of the check that just ran, either pass (`true`) or fail (`false`)

success
>   True (1) if the status was set.

Description
Sets the pass/fail status for the currently running check to `status`.
Only the check's callback function can invoke this method.

Note This method is intended for use with custom checks created with
the Model Advisor's customization API, an optional feature available
with Simulink Verification and Validation (see the online Simulink
Verification and Validation documentation for more information).

See Also
"getCheckResultStatus", "setCheckResult", "setCheckResultStatus"

verifyCheckRan

Purpose
Verify that the Model Advisor has run a set of checks.

Syntax
```
[success, missingChecks, additionalChecks] =
verifyCheckResults(titleIDs)
```

Arguments

titleIDs
>   Cell array of title IDs of checks to verify

success
>   Boolean value specifying whether the checks ran

missingChecks
>   Cell array of title IDs for specified checks that ran

additionalChecks
>   Cell array of title IDs for unspecified checks that ran

Description

Simulink.ModelAdvisor

The output variable success returns `true` if all the checks specified by `titleIDs` have run. If not, `success` returns `false`, `missingChecks` lists specified checks that did not run. The `additionalChecks` argument lists unspecified checks that ran.

See Also
"verifyCheckResultStatus"

verifyCheckResult

Purpose
Generate a baseline Model Advisor check results file or compare the current check results to the baseline check results.

Syntax
```
[success message] = verifyCheckResults(baseline, checkIDs)
```

Arguments

`baseline`
    Pathname of the baseline check results MAT-file

`checkIDs`
    Cell array of check title IDs.

`success`
    Boolean value specifying whether the method succeeded

`message`
    String specifying an error message

Description
If the Model Advisor is in baseline mode (see "setBaselineMode"), this method stores the most recent results of running the checks specified by `checkIDs` in a MAT-file at the location specified by `baseline`. If the method is unable to store the check results at the specified location, it returns `false` in the output variable `success` and the reason for the failure in the output variable `message`. If the Model Advisor is not in baseline mode, this method compares the most recent results of running the checks specified by `checkIDs` with the report specified by `baseline`. If the current results match the baseline results, this method returnstrue as the value of the `success` output variable.

> **Note** You must run the checks specified by checkIDs (see "runCheck")
> before invoking verifyCheckResults.

This method enables you to compare the most recent check results
generated by the Model Advisor with a baseline set of check results. You
can use the method to generate the baseline report as well as perform
current-to-baseline result comparisons. To generate a baseline report,
put the Model Advisor in baseline mode, using "setBaselineMode". Then
invoke this method with the baseline argument set to the location where
you want to store the baseline results. To perform a current-to-baseline
report comparison, first ensure that the Model Advisor is not in baseline
mode (see "getBaselineMode"). Then invoke this method with the path
of the baseline report as the value of the baseline input argument.

See Also
"setBaselineMode", "getBaselineMode", "runCheck",
"verifyCheckResultStatus"

verifyCheckResultStatus

Purpose
Verify that a model has passed or failed a set of checks.

Syntax
```
[success message] = verifyCheckResultsStatus(baseline,
checkIDs)
```

Arguments

baseline
    Array of Boolean variables

checkIDs
    Cell array of check title IDs.

success
    Boolean value specifying whether the method succeeded

message
    String specifying an error message

Simulink.ModelAdvisor

Description

This method compares the pass/fail (`true`/`false`) statuses from the most recent running of the checks specified by `checkIDs` with the Boolean values specified by `status`. If the statuses match the baseline, this method returns `true` as the value of the `success` output variable.

Note You must run the checks specified by `checkIDs` (see "runCheck") before invoking `verifyCheckResultStatus`.

See Also
"runCheck"

verifyHTML

Purpose
Generate a baseline Model Advisor report or compare the current report to a baseline report.

Syntax
```
[success message] = verifyHTML(baseline)
```

Arguments

`baseline`
    Pathname of a Model Advisor report

`success`
    Boolean value specifying whether the method succeeded

`message`
    String specifying an error message

Description
If the Model Advisor is in baseline mode (see "setBaselineMode"), this method stores the report most recently generated by the Model Advisor at the location specified by `baseline`. If the method is unable to store a copy of the report at the specified location, it returns `false` in the output variable `success` and the reason for the failure in the output variable `message`. If the Model Advisor is not in baseline mode, this

method compares the report most recently generated by the Model Advisor with the report specified by `baseline`. If the current report has exactly the same content as the baseline report, this method returns `true` as the value of the `success` output variable.

This method enables you to compare a report generated by the Model Advisor with a baseline report to determine if they differ. You can use the method to generate the baseline report as well as perform current-to-baseline report comparisons. To generate a baseline report, put the Model Advisor in baseline mode. Then invoke this method with the baseline argument set to the location where you want to store the baseline report. To perform a current-to-baseline report comparison, first ensure that the Model Advisor is not in baseline mode (see "getBaselineMode"). The invoke this method with the path of the baseline report as the value of the `baseline` input argument.

See Also
"setBaselineMode", "getBaselineMode", "verifyCheckResult"

Simulink.ModelDataLogs

Purpose   Container for a model's signal data logs

Description Simulink creates instances of this class to contain signal logs that it creates while simulating a model (see "Logging Signals"). In particular, Simulink creates an instance of this class for a top-level model and for each model referenced by the top-level model that contains signals to be logged. Simulink assigns the `ModelDataLogs` object for the top-level model to a variable in the MATLAB workspace. The name of the variable is the name specified in the **Signal logging name** field on the **Data Import/Export** pane of the model's **Configuration Parameters** dialog box. The default value is `logsout`.

A `ModelDataLogs` object has a variable number of properties. The first property, named `Name`, specifies the name of the model whose signal data the object contains or, if the model is a referenced model, the name of the Model block that references the model. The remaining properties reference objects that contain signal data logged during simulation of the model. The objects may be instances of any of the following types of objects:

- `Simulink.Timeseries`

   Log for a signal in this model.

- `Simulink.TsArray`

   Container for the logs of the elements of a root-level composite signal (e.g., a Mux or Bus Creator signal) in this model.

- `Simulink.ModelDataLogs`

   Container for the logs of a model referenced by this model.

- `Simulink.SubsysDataLogs`

   Container for the signal logs of a subsystem of this model.

- `Simulink.ScopeDataLogs`

   Container for data displayed on Scope signal viewers (see "The Signal & Scope Manager" in "Using Simulink").

The names of the properties identify the data being logged as follows:

- For signal data logs, the name of the signal

- For a subsystem or model log container, the name of the subsystem or model, respectively

- For a scope viewer data log, the name specified on the viewer's parameter dialog box

---

Note If a name contains spaces, the `ModelDataLogs` objects specifies its name as (`'name'`) where *name* is the actual name, e.g., (`'Brake Subsystem'`).

Consider, for example, the following model.

Simulink.ModelDataLogs

As indicated by the testpoint icons, this model specifies that Simulink should log the signals named step and scope in the model's root system and the signal named clk in the subsystem named Delayed Out. After simulation of this model, the MATLAB workspace contains the following variable:

```
>> logsout
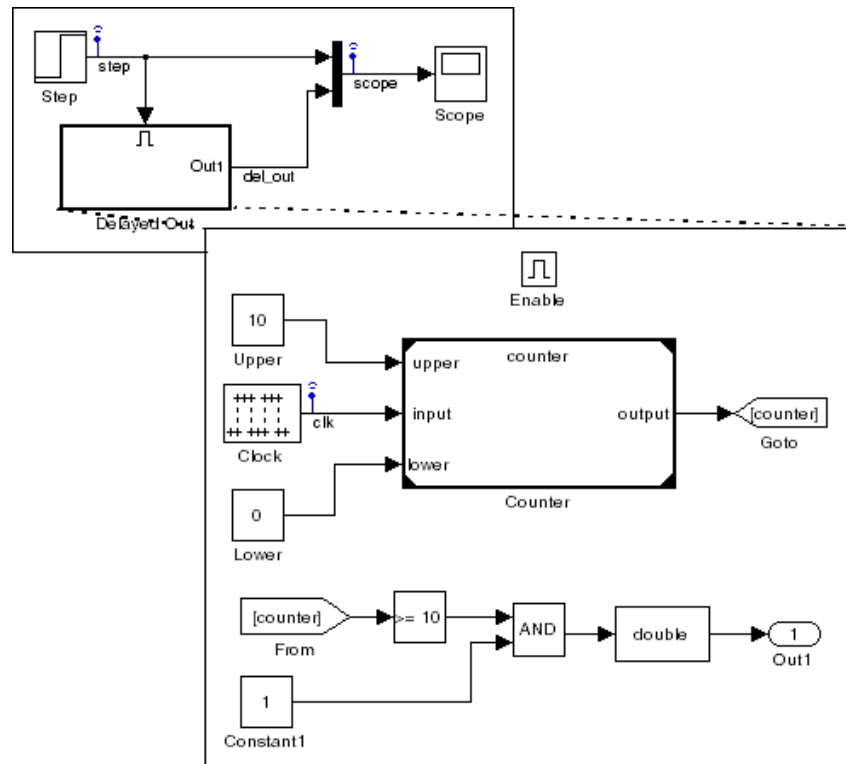
logsout =

Simulink.ModelDataLogs (siglgex):
  Name                    Elements  Simulink Class
```

```
scope                    2      TsArray
step                     1      Timeseries
('Delayed Out')          2      SubsysDataLogs
```

The `logsout` variable contains the signal data logged during the
simulation. You can use fully qualified object names or the Simulink
`unpack` command to access the signal data stored in `logsout`. For
example, to access the amplitudes of the `clk` signal in the Delayed Out
subsystem, enter

```
>> data = logsout.('Delayed Out').clk;
```

or

```
>> logsout.unpack('all');
>> data = clk;
```

Note, you can use a custom logging name or signal name when logging a
signal. If you choose to use the signal name, and that signal name is a
multiline one, as shown in the following:

```
(fixPt)
temp (degC)
```

include an `sprintf('\n')` between the two lines of the signal name
when accessing the logged data. For example,

```
logsout.('Boiler Plant model').('digital thermometer'). ...
(['(fixPt)' sprintf('\n') 'temp (degC)'])
```

See Also   Simulink.Timeseries, Simulink.TsArray,
Simulink.SubsysDataLogs, Simulink.ScopeDataLogs,
unpack

Simulink.ModelWorkspace

Purpose   Describe a model workspace.

Description   Instances of this class describe model workspaces. Simulink creates an instance of this class for each model that you open during a Simulink session. See "Working with Model Workspaces" in "Using Simulink" for more information.

Property Summary

Name	Access	Description
DataSource	RW	Specifies the source used to initialize this workspace. Valid values are • `'MDL-File'` • `'MAT-File'` • `'M-Code'`
FileName	RW	Specifies the name of the MAT-file used to initialize this workspace. Simulink ignores this property if `DataSource` is not `'MAT-File'`.
MCode	RW	A string specifying M code used to initialize this workspace. Simulink ignores this property if `DataSource` is not `'M-Code'`.

Method Summary

Name	Description
"assignin"	Assign a value to a variable in the model's workspace.
"clear"	Clear the model's workspace.
"evalin"	Evaluate an expression in the model's workspace.

Name	Description
"reload"	Reload the model workspace from the workspace's data source.
"save"	Save the model's workspace to a specified MAT-file.
"saveToSource"	Save the workspace to the MAT-file that the workspace designates as its data source.
"whos"	List the variables in the model workspace.

Methods

assignin

Purpose

Assign a value to a variable in the model's workspace.

Syntax

```
assignin('varname', varvalue)
```

Arguments

varname

Name of the variable to be assigned a value.

varvalue

Value to be assigned the variable.

Description

This method assigns the value specified by varvalue to the variable whose name is varname.

See also

"evalin"

clear

Purpose

Clear the model's workspace.

Syntax

Simulink.ModelWorkspace

```
clear
```

Description

This method empties the workspace of its variables.

```
evalin
```

Purpose

Evaluate an expression in the model's workspace.

Syntax

```
evalin('expression')
```

Arguments

```
expression
```
    A MATLAB expression to be evaluated.

Description

This method evaluates expression in the model workspace.

See also

"assignin"

```
reload
```

Purpose

Reload the model workspace from the workspace's data source.

Syntax

```
reload
```

Description

This method reloads the model workspace from the data source specified by its DataSource parameter.

See also

"saveToSource"

```
save
```

Purpose
Save the model's workspace to a specified MAT-file.

Syntax
```
save('filename')
```

Arguments

```
filename
```
     Name of a MAT-file.

Description
This method saves the model's workspace to the MAT-file specified by
`filename`.

Note This method allows you to save the workspace to a file other than
the file specified by the workspace's `FileName` property. If you want to
save the model workspace to the file specified by the file's `FileName`
property, it is simpler to use the workspace's `saveToSource` method.

Example

```
hws = get_param('mymodel','modelworkspace')
hws.DataSource = 'MAT-File';
hws.FileName = 'workspace';
hws.assignin('roll', 30);
hws.saveToSource;
hws.assignin('roll', 40);
hws.save('workspace_test.mat');
```

See also
"reload", "saveToSource"

saveToSource

Purpose
Save the workspace to the MAT-file that it designates as its data source.

Syntax
saveToSource

Description
This method saves the model workspace designated by its `FileName` property.

Example

```
hws = get_param('mymodel','modelworkspace')
hws.DataSource = 'MAT-File';
hws.FileName = 'params';
hws.assignin('roll', 30);
hws.saveToSource;
```

See also
"save", "reload"

---

whos

Purpose
List the variables in the model workspace.

Syntax
whos

Description
This method lists the variables in the model's workspace. The listing includes the size and class of the variables.

Example

```
>> hws = get_param('mymodel','modelworkspace');
>> hws.assignin('k', 2);
>> hws.whos
```

```
Name      Size                    Bytes  Class

k         1x1                         8  double array
```

Simulink.MSFcnRunTimeBlock

Purpose   Get run-time information about a Level-2 M-file S-function block

Description This class allows a Level-2 M-file S-function or other M program to
obtain information from Simulink and provide information to Simulink
about a Level-2 M-file S-function block. Simulink creates an instance
of this class for each Level-2 M-file S-function block in a model.
Simulink passes the object to the callback methods of Level-2 M-File
S-Functions when it updates or simulates a model, allowing the callback
methods to get and provide block-related information to Simulink. See
"Writing Level-2 M-File S-Functions" in "Writing S-Functions" for more
information.

You can also use instances of this class in M-file programs to
obtain information about Level-2 M-File S-Function blocks during a
simulation. See "Accessing Block Data During Simulation" in "Using
Simulink" for more information.

Parent Class   Simulink.RunTimeBlock

Derived Classes   None

Property Summary

Name	Description
"DialogPrmsTunable"	Specifies which of the S-function's dialog parameters are tunable.
"NextTimeHit"	Time of the next sample hit for variable sample time S-functions.

Method Summary

Name	Description
"AutoRegRuntimePrms"	Register this block's dialog parameters as run-time parameters.
"AutoUpdateRuntimePrms"	Update this block's run-time parameters.
"IsDoingConstantOutput"	Determine whether the current simulation stage is the constant sample time stage.
"IsMajorTimeStep"	Determine whether the current simulation time step is a major time step.
"IsSampleHit"	Determine whether the current simulation time is one at which a task handled by this block is active.
"IsSpecialSampleHit"	Determine whether the current simulation time is one at which multiple tasks handled by this block are active.
"RegBlockMethod"	Register a callback method for this block.
"RegisterDataTypeFxpBinaryPoint"	Register fixed-point data type with binary point-only scaling.

Simulink.MSFcnRunTimeBlock

Name	Description
"RegisterDataTypeFxpFSlopeFixExpBias"	Register fixed-point data type with [Slope Bias] scaling specified in terms of fractional slope, fixed exponent, and bias.
"RegisterDataTypeFxpSlopeBias"	Register data type with [Slope Bias] scaling.
"SetAccelRunOnTLC"	Specify whether to use this block's TLC file to generate the simulation target for the model that uses it.
"SetPreCompPortInfoToDefaults"	Set compiled attributes of this block's ports to default values.
"SetPreCompPortInfoToDynamic"	Set precompiled attributes of this block's ports to be inherited.
"SetSimViewingDevice"	Specify whether block is a viewer.
"WriteRTWParam"	Write custom parameter information to Real-Time Workshop file.

Properties

`DialogPrmsTunable`

Description

Specifies whether a dialog parameter of the S-function is tunable.
Tunable parameters are registered as run-time parameters when you

call the "AutoRegRuntimePrms" method. Note that SimOnlyTunable parameters are not registered as run-time parameters.

Data Type
array

Access
RW

`NextTimeHit`

Description
Time of the next sample hit for variable sample-time S-functions.

Data Type
double

Access
RW

Methods

`AutoRegRuntimePrms`

Purpose
Register a block's tunable dialog parameters as run-time parameters.

Syntax
`AutoRegRuntimePrms;`

Description
Register this block's tunable dialog parameters as run-time parameters.

`AutoUpdateRuntimePrms`

Purpose
Update a block's run-time parameters.

Syntax
`AutoRegRuntimePrms;`

Description
Automatically update the values of the run-time parameters during a call to `mdlProcessParameters`.

IsDoingConstantOutput

Purpose
Determine whether this is in the constant sample time stage of a simulation.

Syntax
bVal = IsDoingConstantOutput;

Description
Returns true if this is the constant sample time stage of a simulation, i.e., the stage at the beginning of a simulation where Simulink computes the values of block outputs that cannot change during the simulation (see "Constant Sample Time" in "Using Simulink"). Use this method in the mdlOutputs method of an S-function with port-based sample times to avoid unnecessarily computing the outputs of ports that have constant sample time, i.e., [inf, 0].

```
function Outputs(block)
.
.
  if block.IsDoingConstantOutput
    ts = block.OutputPort(1).SampleTime;
    if ts(1) == Inf
    %% Compute port's output.
    end
  end
.
.
%% end of Outputs
```

See "Specifying Port-Based Sample Times" in "Writing S-Functions" for more information.

IsMajorTimeStep

Purpose.
Determine whether current time step is a major or a minor time step.

Syntax

```
bVal = IsMajorTimeStep;
```

Description

Returns true if the current time step is a major time step; false, if it is
a minor time step. This method can be called only from `mdlOutputs`
and `mdlUpdate`.

`IsSampleHit`

Purpose

Determine whether the current simulation time is one at which a task
handled by this block is active.

Syntax

```
bVal = IsSampleHit(stIdx);
```

Arguments

`stIdx`
    Index of sample time to be queried.

Description

Use in Outputs or Update block methods when the M-file S-function has
multiple sample times to determine whether a sample hit has occurred
at `stIdx` (similar to `ssIsSampleHit` for C-Mex S-functions.)

`IsSpecialSampleHit`

Purpose

Determine whether the current simulation time is one at which multiple
tasks implemented by this block are active.

Syntax

```
bVal = IsSpecialSampleHit(stIdx1,stIdx1);
```

Arguments

`stIdx1`
    Index of sample time of first task to be queried.

Simulink.MSFcnRunTimeBlock

stIdx2
>   Index of sample time of second task to be queried.

Description
Use in Outputs or Update block methods to ensure the validity of data shared by multiple tasks running at different rates. Returns true if a sample hit has occurred at `stIdx1` and a sample hit has also occurred at `stIdx2` in the same time step (similar to `ssIsSpecialSampleHit` for C-Mex S-functions).

RegBlockMethod

Purpose
Register a block callback method.

Syntax
`RegBlockMethod(methName, methHandle);`

Arguments

methName
>   Name of method to be registered.

methHandle
>   MATLAB function handle of the callback method to be registered.

Description
Registers the block callback method specified by `methName` and `methHandle`. Use this method in a Level-2 M-file S-function to specify the block callback methods that the S-function implements.

RegisterDataTypeFxpBinaryPoint

Purpose
Register fixed-point data type with binary point-only scaling.

Syntax
```
dtID = RegisterDataTypeFxpBinaryPoint(isSigned,
wordLength, fractionalSlope, fixedExponent, bias,
obeyDataTypeOverride);
```

Arguments

isSigned
> `true` if the data type is signed.
>
> `false` if the data type is unsigned.

wordLength
> Total number of bits in the data type, including any sign bit.

fractionalLength
> Number of bits in the data type to the right of the binary point.

obeyDataTypeOverride
> `true` indicates that the **Data Type Override** setting for the subsystem is to be obeyed. Depending on the value of **Data Type Override**, the resulting data type could be `True Doubles`, `True Singles`, `ScaledDouble`, or the fixed-point data type specified by the other arguments of the function.
>
> `false` indicates that the **Data Type Override** setting is to be ignored.

Description

This method registers a fixed-point data type with Simulink and returns a data type ID. The data type ID can be used to specify the data types of input and output ports, run-time parameters, and DWork states. It can also be used with all the standard data type access methods defined for instances of this class, such as "DatatypeSize".

Use this function if you want to register a fixed-point data type with binary point-only scaling. Alternatively, you can use one of the other fixed-point registration functions:

- Use "RegisterDataTypeFxpFSlopeFixExpBias" to register a data type with [Slope Bias] scaling by specifying the word length, fractional slope, fixed exponent, and bias.

- Use "RegisterDataTypeFxpSlopeBias" to register a data type with [Slope Bias] scaling.

Simulink.MSFcnRunTimeBlock

If the registered data type is not one of the Simulink built-in data types, a Simulink Fixed Point license is checked out.

`RegisterDataTypeFxpFSlopeFixExpBias`

Purpose
Register fixed-point data type with [Slope Bias] scaling specified in terms of fractional slope, fixed exponent, and bias

Syntax
```
dtID = RegisterDataTypeFxpFSlopeFixExpBias(isSigned,
wordLength, fractionalSlope, fixedExponent, bias,
obeyDataTypeOverride);
```

Arguments

isSigned
> `true` if the data type is signed.
>
> `false` if the data type is unsigned.

wordLength
> Total number of bits in the data type, including any sign bit.

fractionalSlope
> Fractional slope of the data type.

fixedExponent
> Exponent of the slope of the data type.

bias
> Bias of the scaling of the data type.

obeyDataTypeOverride
> `true` indicates that the **Data Type Override** setting for the subsystem is to be obeyed. Depending on the value of **Data Type Override**, the resulting data type could be `True Doubles`, `True Singles`, `ScaledDouble`, or the fixed-point data type specified by the other arguments of the function.

false indicates that the **Data Type Override** setting is to be ignored.

Description

This method registers a fixed-point data type with Simulink and returns a data type ID. The data type ID can be used to specify the data types of input and output ports, run-time parameters, and DWork states. It can also be used with all the standard data type access methods defined for instances of this class, such as "DatatypeSize".

Use this function if you want to register a fixed-point data type by specifying the word length, fractional slope, fixed exponent, and bias. Alternatively, you can use one of the other fixed-point registration functions:

- Use "RegisterDataTypeFxpBinaryPoint" to register a data type with binary point-only scaling.

- Use "RegisterDataTypeFxpSlopeBias" to register a data type with [Slope Bias] scaling.

If the registered data type is not one of the Simulink built-in data types, a Simulink Fixed Point license is checked out.

RegisterDataTypeFxpSlopeBias

Purpose

Register data type with [Slope Bias] scaling.

Syntax

```
dtID = RegisterDataTypeFxpSlopeBias(isSigned, wordLength,
totalSlope, bias, obeyDataTypeOverride);
```

Arguments

isSigned
     true if the data type is signed.

     false if the data type is unsigned.

wordLength
    Total number of bits in the data type, including any sign bit.

totalSlope
    Total slope of the scaling of the data type.

bias
    Bias of the scaling of the data type.

obeyDataTypeOverride
    `true` indicates that the **Data Type Override** setting for the
    subsystem is to be obeyed. Depending on the value of **Data Type
    Override**, the resulting data type could be `True Doubles`, `True
    Singles`, `ScaledDouble`, or the fixed-point data type specified by
    the other arguments of the function.

    `false` indicates that the **Data Type Override** setting is to be
    ignored.

Description

This method registers a fixed-point data type with Simulink and returns
a data type ID. The data type ID can be used to specify the data types of
input and output ports, run-time parameters, and DWork states. It can
also be used with all the standard data type access methods defined for
instances of this class, such as "DatatypeSize" on page 9-109.

Use this function if you want to register a fixed-point data type
with [Slope Bias] scaling. Alternatively, you can use one of the other
fixed-point registration functions:

- Use "RegisterDataTypeFxpBinaryPoint" to register a data type with
  binary point-only scaling.

- Use "RegisterDataTypeFxpFSlopeFixExpBias" to register a data type
  by specifying the word length, fractional slope, fixed exponent, and
  bias

If the registered data type is not one of the Simulink built-in data types,
a Simulink Fixed Point license is checked out.

SetAccelRunOnTLC

Purpose
Specify whether to use block's TLC file to generate code for the Simulink accelerator.

Syntax
SetAccelRunOnTLC(bVal);

Arguments

bVal
> May be `'true'` (use TLC file) or `'false'` (run block in interpreted mode).

Description
Specify if the block should use its TLC file to generate code that runs with the accelerator. If this option is `'false'`, the block runs in interpreted mode.

SetPreCompPortInfoToDefaults

Purpose
Set compiled attributes of this block to default values.

Syntax
SetPreCompPortInfoToDefaults;

Description
Initialize the compiled information (dimensions, data type, complexity, and sampling mode) of this block's ports to have default attributes (double, real, sample-based scalars).

SetPreCompPortInfoToDynamic

Purpose
Set compiled attributes of this block to be inherited.

Syntax
SetPreCompPortInfoToDefaults;

Simulink.MSFcnRunTimeBlock

Description
Initialize the compiled information (dimensions, data type, complexity, and sampling mode) of the block's ports to be inherited.

`SetSimViewingDevice`

Purpose
Specify whether this block is a viewer.

Syntax
`SetSimViewingDevice(bVal);`

Arguments

`bVal`
> May be `'true'` (is a viewer) or `'false'` (is not a viewer).

Description
Specify if the block is a viewer/scope. If this flag is specified, the block will be used only during simulation and automatically stubbed out in generated code.

`WriteRTWParam`

Purpose
Write a custom parameter to the Real-Time Workshop information file used for code generation.

Syntax
`WriteRTWParam(pType, pName, pVal)`

Arguments

`pType`
> Type of the parameter to be written. Valid values are `'string'` and `'matrix'`.

`pName`
> Name of the parameter to be written.

pVal
    Value of the parameter to be written.

Description

Use in the `mdlRTW` method of the M-file S-function to write out custom parameters. These parameters are generally settings used to determine how code should be generated in the TLC file for the S-function.

Simulink.NumericType

Purpose　　　Specify a data type

Description　　This class lets you specify a data type. To do this, create an instance
of this class in the MATLAB workspace and set its properties to the
properties of the custom data type. Then assign this data type to all
signals and parameters of your model that you want to conform to the
data type. Assigning the data type in this way allows you to change the
data types of the signals and parameters in your model by changing the
properties of the object that describe them. You do not have to change
the model itself.

**Property
Dialog
Box**

Data type mode
　　　Data type of this numeric type. The options are

Option	Description
Boolean	Same as the MATLAB `boolean` type.
Double	Same as the MATLAB `double` type.
Single	Same as the MATLAB `single` type.
Fixed-point: unspecified scaling	A fixed-point data type with unspecified scaling.

Option	Description
Fixed-point: binary point scaling	A fixed-point data type with binary-point scaling.
Fixed-point: slope and bias scaling	A fixed-point data type with slope and bias scaling.

Selecting a category causes Simulink to disable other controls on the dialog box (see below) that apply to the category and to disable controls that do not apply. Selecting a fixed-point category may, depending on the other dialog box options that you select, cause the model to run only on systems that have a Simulink Fixed Point option installed.

Is alias

If this option is selected, Simulink uses the name of the workspace variable that references this object as the name of the data type. Otherwise, Simulink uses the category of the data type as its name, or, if the category is a fixed-point category, Simulink generates a name that encodes the type's properties, using the encoding specified by the Simulink Fixed Point product.

Header file

Name of a user-supplied C header file that defines a data type having the same name as this numeric type (i.e., as the MATLAB variable that references this object). If this field is not empty, code generated from this model defines the numeric type by including the specified header file. If this field is empty, the generated code defines the numeric type itself.

Simulink.NumericType

Description

    Description of this data type. This field is intended for use in documenting this data type. Simulink ignores it.

Signed

    Specifies whether the data type is signed or unsigned. This option is enabled only for fixed-point data type categories.

Word-Length

    Word length in bits of the fixed-point data type. This option is enabled only for fixed-point data type categories.

Fraction length
> Number of bits to the right of the binary point. This option is enabled only if the data type category is `Fixed-point:   binary point scaling`.

Slope
> Slope for slope and bias scaling. This option is enabled only if the data type category is `Fixed-point:   slope and bias scaling`.

Bias
> Bias for slope and bias scaling. This option is enabled only if the data type category is `Fixed-point:   slope and bias scaling`.

Properties

Name	Access	Description
Bias	RW	Bias used for slope and bias scaling of a fixed-point data type. This field is intended for use by the Simulink Fixed Point product. (Bias)

Simulink.NumericType

Name	Access	Description
`DataTypeMode`	RW	String that specifies the data type of this numeric type. Valid values are `'Double'`, `'Boolean'`, `'Single'`, `'Fixed-point:  unspecified scaling'`, `'Fixed-point:  binary point scaling'`, and `'Fixed-point: slope and bias scaling'`. (Data type mode)
`Description`	RW	Description of this data type. (Description)
`FixedExponent`	RW	Exponent used for binary point scaling. This property equals `-FractionLength`. Setting this property causes Simulink to set the `FractionLength` and `Slope` properties accordingly, and vice versa. This property appears only if the data type category is `Fixed-point:  binary point scaling` or `Fixed-point:  slope and bias scaling`.
`FractionLength`	RW	Integer that specifies the size in bits of the fractional portion of the fixed-point number. This property equals `-FixedExponent`. Setting this property causes Simulink to set the `FixedExponent` property accordingly, and vice versa. This field is intended for use by the Simulink Fixed Point product. (Fraction length)
`IsAlias`	RW	Integer that specifies whether to use the name of this object as the name of the data type that it specifies. Valid values are `1` (yes) or `0` (no). (Is alias)
`Signed`	RW	Integer that specifies whether this data type is signed or unsigned. Valid values are `1` (yes) or `0` (no). (Signed)

Name	Access	Description
Slope	RW	Slope for slope and bias scaling of fixed-point numbers. This property equals SlopeAdjustmentFactor * 2^FixedExponent. If SlopeAdjustmentFactor is 1.0, Simulink displays the value of this field as 2^SlopeAdjustmentFactor. Otherwise, it displays it as a numeric value. Setting this property causes Simulink to set the FixedExponent and SlopeAdjustmentFactor properties accordingly, and vice versa. This property appears only if Category is Fixed-point: slope and bias scaling. (Slope)
SlopeAdjustmentFactor	RW	Slope for slope and bias scaling of fixed-point numbers. Setting this property causes Simulink to adjust the Slope property accordingly, and vice versa. This property appears only if Category is Fixed-point: slope and bias scaling.
WordLength	RW	Integer that specifies the word size of this data type. This field is intended for use by the Simulink Fixed Point product. This property appears only if Category is Fixed-point (Word Length).

Simulink.Parameter

Purpose   Specify the value, value range, data type, and other properties of a block parameter

Description   This class enables you to create workspace objects that you can then use as the values of block parameters, e.g., the value of a Gain block's Gain parameter. The advantage? Parameter objects let you specify not only the value of a parameter but also other information about the parameter, such as the parameter's purpose, its dimensions, its minimum and maximum values, etc. Some Simulink products use this information. For example, Simulink and Real-Time Workshop use information specified by Simulink.Parameter objects to determine whether the parameter is tunable (see "Working with Tunable Parameters" in Using Simulink).

Property Dialog Box

Value

Value of the parameter. You can use MATLAB expressions to specify the numeric type, dimensions, and data type of the parameter (see "Data Types Supported by Simulink"). You can also specify fixed-point values for block parameters (see "Specifying Fixed-Point Values Directly" in the Simulink Fixed

Point documentation). The following examples illustrate this syntax.

Expression	Description
single(1.0)	Specifies a single-precision value of 1.0
int8(2)	Specifies an 8-bit integer of value 2
int32(3+2i)	Specifies a complex value whose real and imaginary parts are 32-bit integers
fi(2.3,true,16,3)	Specifies a signed fixed-point numeric object having a value of 2.3, a word length of 16 bits, and a fraction length of 3.

Note If you specify a typed expression as the parameter object's **Value** property, it overrides the current setting of the **Data type** property.

Data type

Data type of the parameter. You can either select a data type from the adjacent pulldown list or enter a string. If you select auto (the default), the block that references the parameter object determines the data type of the variable used to represent this parameter in code generated from the model. If you enter a string, it must evaluate to one of the following:

- A built-in data type supported by Simulink (see "Data Types Supported by Simulink").

- A Simulink.NumericType object

- A Simulink.AliasType object

Simulink.Parameter

> **Note** If you specify a parameter object's data type using the **Data type** property, it overrides any typed expression in the **Value** property and changes the value to be untyped.

Units

  Measurement units in which this value is expressed, e.g., inches. This field is intended for use in documenting this parameter. Simulink ignores it.

Dimensions

  Dimensions of the parameter. Simulink determines the dimensions from the entry in the **Value** field of this parameter. You cannot set this field yourself.

Complexity

  Numeric type (i.e., real or complex) of the parameter. Simulink determines the numeric type of this parameter from the entry in the **Value** field of this parameter. You cannot set this field yourself.

Minimum

  Minimum value that the parameter can have. Simulink generates a warning if you assign a value to the parameter that is less than the minimum value. When updating the diagram or starting a simulation, Simulink generates an error if the parameter value violates its minimum value.

Maximum

  Maximum value that the parameter can have. Simulink generates a warning if you assign a value to the parameter that is greater than the maximum value. When updating the diagram or starting a simulation, Simulink generates an error if the parameter violates its maximum value.

Storage class

  Storage class of this parameter. Simulink code generation products use this property to allocate memory for this parameter

in generate code. See "Storage Classes of Tunable Parameters" in "Real-Time Workshop User's Guide" for more information.

Alias
Alternate name for this parameter. Simulink ignores this setting.

Description
Description of this parameter. This field is intended for use in documenting this parameter. Simulink ignores it.

Properties

Name	Access	Description
Value	RW	Value of this parameter. (Value)
DataType	RW	String specifying the data type of this parameter. (Data type)
Dimensions	RO	Vector specifying the dimensions of this parameter. (Dimensions)
Complexity	RO	String specifying the numeric type of this parameter. Valid values are 'real' or 'complex'. (Complexity)
Min	RW	Minimum value that this parameter can have. (Minimum)
Max	RW	Maximum value that this parameter can have. (Maximum)
DocUnits	RW	Measurement units in which this parameter's value is expressed. (Units)

Simulink.Parameter

Name	Access	Description
RTWInfo	RW	Information used by Real-Time Workshop for generating code for this parameter. The value of this property is an object of `Simulink.ParamRTWInfo` class.
Description	RW	String that describes this parameter. This property is intended for user use. Simulink itself does not use it. (Description)

Purpose   Specify information needed to generate code for a parameter

Description   Simulink creates an instance of this class for each instance of a
                   `Simulink.Parameter` object that it creates. Simulink uses the
                   `Simulink.ParamRTWInfo` object to store information needed to generate
                   code for the parameter specified by the `Simulink.Parameter` object.

                   You can set the properties of an instance of this class via the `RTWInfo`
                   property or the property dialog box of the `Simulink.Parameter` object
                   that uses it. For example, the following MATLAB expression sets the
                   `StorageClass` property of a `Simulink.ParamRTWInfo` object used by a
                   parameter object name `gain`.

                       gain.RTWInfo.StorageClass = 'ExportedGlobal';

**Property
Dialog
Box**   Use the `Simulink.Parameter` property dialog box to set the
                   `StorageClass` and `Alias` properties of objects of this class.

Properties

Name	Description
Alias	Alternate name for this parameter.
CustomAttributes	Custom storage class attributes of this parameter. See "Custom Storage Classes" in the Real-Time Workshop Embedded Coder documentation for more information.
CustomStorageClass	Custom storage class of this parameter.
StorageClass	Storage class of this parameter. See "Storage Classes of Tunable Parameters" in the Real-Time Workshop documentation for more information.

Simulink.RunTimeBlock

Purpose	Allow Level-2 M-file S-function and other M-file programs to get information about a block while a simulation running.
Description	This class allows a Level-2 M-file S-function or other M program to obtain information about a block. Simulink creates an instance of this class or a derived class for each block in a model. Simulink passes the object to the callback methods of Level-2 M-file S-functions when it updates or simulates a model, allowing the callback methods to get block-related information from and provide such information to Simulink. See "Writing Level-2 M-File S-Functions" in Writing S-Functions for more information. You can also use instances of this class in M-file programs to obtain information about blocks during a simulation. See "Accessing Block Data During Simulation" in Using Simulink for more information.
Parent Class	None
Derived Classes	`Simulink.MSFcnRunTimeBlock`

Property Summary

Name	Description
"BlockHandle"	Block's handle.
"CurrentTime"	Current simulation time.
"NumDworks"	Number of discrete work vectors used by the block.
"NumOutputPorts"	Number of block output ports.
"NumContStates"	Number of block's continuous states.
"NumDiscStates"	Number of block's discrete states
"NumDlgParams"	Number of parameters that can be entered on S-function block's dialog box.

Name	Description
"NumInputPorts"	Number of block's input ports.
"NumRuntimePrms"	Number of run-time parameters used by block.
"SampleTimes"	Sample times at which block produces outputs.

Method Summary

Name	Description
"ContStates"	Get a block's continuous states.
"DataTypeIsFixedPoint"	Determine whether a data type is fixed point.
"DatatypeName"	Get name of a data type supported by this block.
"DatatypeSize"	Get size of a data type supported by this block.
"Derivatives"	Get a block's continuous state derivatives.
"DialogPrm"	Get a parameter entered on an S-function block's dialog box.
"Dwork"	Get one of a block's Dwork vectors.
"FixedPointNumericType"	Determine the properties of a fixed-point data type.
"InputPort"	Get one of a block's input ports.
"OutputPort"	Get one of a block's output ports.
"RuntimePrm"	Get one of the run-time parameters used by a block.

Simulink.RunTimeBlock

Properties

BlockHandle

Description
Block's handle.

Access
RO

CurrentTime

Description
Current simulation time.

Access
RO

NumDworks

Description
Number of data work vectors.

Access
RW

See Also
ssGetNumDWork

NumOutputPorts

Description
Number of output ports.

Access
RW

See Also
ssGetNumOutputPorts

NumContStates

Description

Number of continuous states.

Access
RW

See Also
ssGetNumContStates

NumDiscStates

Description
Number of discrete states. In an M-file S-function, you need to use
Dworks to setup discrete states.

Access
RW

See Also
ssGetNumDiscStates

NumDlgParams

Description
Number of parameters declared on the block's dialog. In the case
of the S-function, it returns the number of parameters listed as a
comma-separated list in the **S-function parameters** dialog field.

Access
RW

See Also
ssGetNumSFcnParams

NumInputPorts

Description
Number of input ports.

Access
RW

See Also
ssGetNumInputPorts

Simulink.RunTimeBlock

NumRuntimePrms

Description
Number of run-time parameters used by this block. See "Run-Time Parameters" for more information.

Access
RW

See Also
ssGetNumSFcnParams

SampleTimes

Description
Blocks's sample times.

Access
RW for M-file S-functions, RO for all other blocks.

Methods

ContStates

Purpose
Get a block's continuous states.

Syntax
states = ContStates();

Description
Get vector of continuous states.

See Also
ssGetContStates

DataTypeIsFixedPoint

Purpose
Determine whether a data type is fixed point.

Syntax
bVal = DataTypeIsFixedPoint(dtID);

Arguments

dtID
> Integer value specifying the ID of a data type.

Description
Returns `true` if the specified data type is a fixed-point data type.

DatatypeName

Purpose
Get the name of a data type.

Syntax
`name = DatatypeName(dtID);`

Arguments

dtID
> Integer value specifying ID of a data type.

Description
Returns the name of the data type specified by `dtID`.

See Also
"DatatypeSize"

DatatypeSize

Purpose
Get the size of a data type.

Syntax
`size = DatatypeSize(dtID);`

Arguments

dtID
> Integer value specifying the ID of a data type.

Description

Simulink.RunTimeBlock

Returns the size of the data type specified by `dtID`.

See Also
"DatatypeName"

`Derivatives`

Purpose
Get derivatives of a block's continuous states.

Syntax
`derivs = Derivatives();`

Description
Get vector of state derivatives.

See Also
`ssGetdX`

`DialogPrm`

Purpose
Get an S-function's dialog parameters.

Syntax
`param = DialogPrm(pIdx);`

Arguments

`pIdx`
   Integer value specifying the index of the parameter to be returned.

Description
Get the specified dialog parameter. In the case of the S-function, each `DialogPrm` corresponds to one of the elements in the comma-separated list of parameters in the **S-function parameters** dialog field.

See Also
`ssGetSFcnParam`, "RuntimePrm"

Dwork

Purpose
Get one of a block's Dwork vectors.

Syntax
```
dworkObj = Dwork(dwIdx);
```

Arguments

dwIdx

   Integer value specifying the index of a work vector.

Description
Get information about the Dwork vector specified by `dwIdx` where `dwIdx` is the index number of the work vector. This method returns an object of type `Simulink.BlockCompDworkData`.

See Also
`ssGetDWork`

FixedPointNumericType

Purpose
Get the properties of a fixed-point data type.

Syntax
```
eno = FixedPointNumericType(dtID);
```

Arguments

dtID

   Integer value specifying the ID of a fixed-point data type.

Description
Returns an object of `Embedded.Numeric` class that contains the attributes of the specified fixed-point data type.

> **Note** `Embedded.Numeric` is also the class of the `numerictype` objects created by the Fixed-Point Toolbox. For information on the properties defined by `Embedded.Numeric` class, see `numerictype` Object Properties in the "Property Reference" in the "Fixed-Point Toolbox User's Guide".

`InputPort`

Purpose
Get an input port of a block.

Syntax
`port = InputPort(pIdx);`

Arguments

`pIdx`
> Integer value specifying the index of an input port.

Description
Get the input port specified by `pIdx`, where `pIdx` is the index number of the input port. For example,

```
port = rto.InputPort(1)
```

returns the first input port of the block represented by the run-time object `rto`.

This method returns an object of type `Simulink.BlockPreCompInputPortData` or `Simulink.BlockCompInputPortData`, depending on whether the model that contains the port is uncompiled or compiled. You can use this object to get and set the input port's uncompiled or compiled properties, respectively.

See Also
`ssGetInputPortSignalPtrs`, `Simulink.BlockPreCompInputPortData`, `Simulink.BlockCompInputPortData`, "OutputPort"

OutputPort

Purpose
Get an output port of a block.

Syntax
port = OutputPort(pIdx);

Arguments

pIdx
>   Integer value specifying the index of an output port.

Description
Get the output port specified by pIdx, where pIdx is the index number of the output port. For example,

    port = rto.InputPort(1)

returns the first output port of the block represented by the run-time object rto.

This method returns an object of type Simulink.BlockPreCompOutputPortData or Simulink.BlockCompOutputPortData, depending on whether the model that contains the port is uncompiled or compiled, respectively. You can use this object to get and set the output port's uncompiled or compiled properties, respectively.

See Also
ssGetInputPortSignalPtrs,
Simulink.BlockPreCompOutputPortData,
Simulink.BlockCompOutputPortData

RuntimePrm

Purpose
Get an S-function's run-time parameters.

Syntax

Simulink.RunTimeBlock

```
param = RuntimePrm(pIdx);
```

Arguments

pIdx
>   Integer value specifying the index of a run-time parameter.

Description

Get the run-time parameter whose index is `pIdx`.

See Also

ssGetRunTimeParamInfo

Purpose   Log data displayed by a Scope viewer.

Description   Simulink creates instances of this class to log data displayed on Scope viewers (see "The Signal & Scope Manager" in Using Simulink). In particular, if you have enabled data logging for a model, Simulink creates an instance of this class for each scope viewer enabled for logging in the model and assigns it to a property of the model's `Simulink.ModelDataLogs` object. The instance created for each viewer has a Name property whose value is the name specified on the History pane of the viewer's parameter dialog box (see Scope for more information). The instance also has an axes property for each of the scope's axes labeled `Axes1`, `Axes2`, etc. The value of each axes property is itself a `Simulink.ScopeDataLogs` object that contains `Simulink.Timeseries` objects, one for each signal displayed on the axes. The time series objects contain the signal data displayed on the axes.

Consider, for example, the following model.

This model displays signals `out1` and `out2` on a single scope viewer that has only one set of axes.

Simulink.ScopeDataLogs

The model enables data logging for the scope viewer under the variable name ScopeData and for the model as a whole under the default variable name logsout.

Scope viewer dialog specifies that
Simulink log scope data to the workspace
under the logging name ScopeData.

Simulink.ScopeDataLogs

After simulation of the model, the MATLAB workspace contains a `Simulink.ModelDataLogs` object named `logsout` containing a `Simulink.ScopeDataLogs` object that in turn contains a `Simulink.ScopeDataLogs` object that contains `Simulink.Timeseries` objects that contain the times series data for signals `out1` and `out 2`.

You can use Simulink data object dot notation to access the data, e.g.,

```
>> logsout.ScopeData.axes1
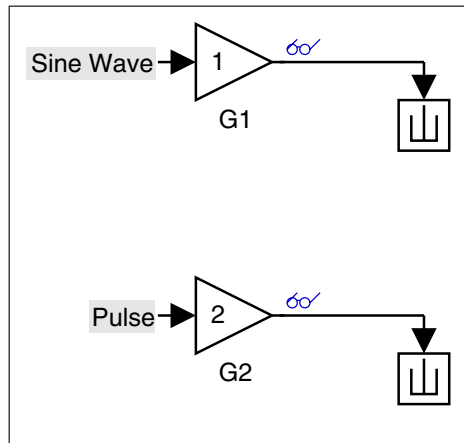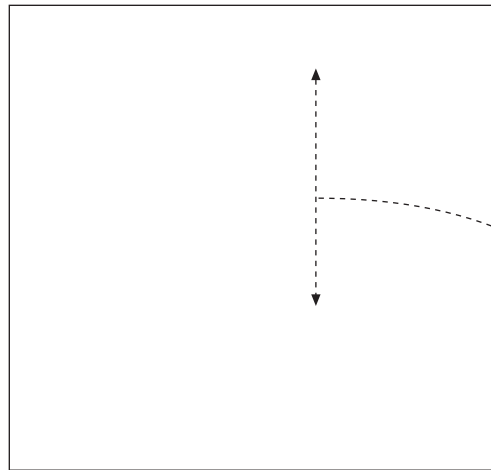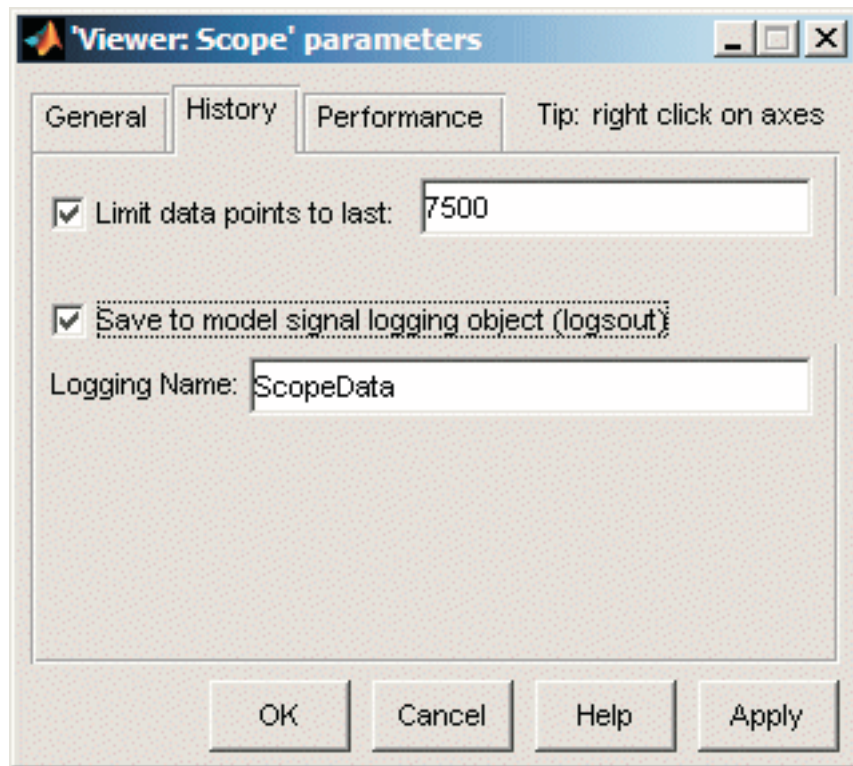
ans =

Simulink.ScopeDataLogs (axes1):
  Name                  Elements  Simulink Class

  out1                      1       Timeseries
  out2                      1       Timeseries
```

Purpose   Specify the attributes of a signal

Description   Objects of this class allow you to specify the attributes that a signal or
                       discrete state should have, e.g., its data type, numeric type, dimensions,
                       and so on. You do this by giving the signal or discrete state the same
                       name as the base (MATLAB) workspace variable that references the
                       `Simulink.Signal` object. You can use signal objects both for specifying
                       and checking signal properties.

Using Signal Objects to Specify Signal Properties

You can use signal objects to assign values to properties left unassigned
by signal sources, i.e., that are assigned a value of `-1` (inherited) or
`auto`. To do this for a particular signal, create a signal object that has
the same name as the signal and set the properties of the object that
correspond to the properties left unspecified by the signal source.

You can also use a `Signal Specification` block to specify properties
left unspecified by a signal source. The advantage of using signal objects
is that it allows you to change signal property values without having to
edit the model and it simplifies the model's diagram. The advantage of
a Signal Specification block is that it displays the values assigned to the
signal's properties on the block diagram itself.

Simulink.Signal

The following model illustrates the respective advantages of the two ways of assigning attributes to a signal.

In this example, the signal object named s1 specifies the sample time and data type of the signal emitted by input port In1 and a Signal Specification block specifies the sample time and data type of the signal emitted by input port In2. As this example illustrates, you have to display the signal object in the Model Explorer to determine many of its properties whereas the Signal Specification block displays the property values on the diagram itself. On the other hand, the use of a signal object to specify the sample time and data type properties of signal s1 allows you to change the sample time or data type without having to edit the model. For example, you could use the Model Explorer, the MATLAB command line, or an M-file program to change these properties.

Using Signal Objects to Check Signal Properties

You can use signal objects to ensure that signal sources assign desired properties to a signal or state. To do this, create a signal object that has the same name as the signal or state to be validated and that specifies the desired properties. Then, whenever you update the diagram containing the signal or state, Simulink checks the properties of the signal specified by the signal's or state's source against the properties specified by the signal object. For most properties, if the source specifies a value other than inherited or auto for the property and the values specified by the source and the signal object differ, Simulink displays an error message. This enables you to quickly determine whether the actual attributes of your model's signals are the attributes you intend them to have.

Simulink.Signal

Property Dialog Box

Simulink.Signal: sd1

Data type:	auto ▼	Units:
Dimensions:	-1	Complexity: auto ▼
Sample time:	-1	Sample mode: auto ▼
Minimum:	-Inf	Maximum: Inf
Initial value:	0	

Code generation options

Storage class: Auto ▼

Alias:

Description:

Revert | Help | Apply

Data type

Data type of the signal. The default entry, auto, specifies that Simulink should determine the data type. Use the adjacent pull-down list to specify built-in data types (e.g., uint8). To specify a custom data type, enter a MATLAB expression that specifies the type, e.g., a base workspace variable that references a Simulink.NumericType object.

Units

Measurement units in which the value of this signal is expressed, e.g., inches. This field is intended for use in documenting this signal. Simulink ignores it.

Dimensions

Dimensions of this signal. Valid values are -1 (the default) specifying any dimensions, N specifying a vector signal of size N, or [M N] specifying an MxN matrix signal.

Complexity

Numeric type of the signal. Valid values are auto (determined by Simulink), real, or complex.

Sample time

> Rate at which the value of this signal should be computed. See "Specifying Sample Time" in Using Simulink for information on how to specify the sample time.

Sample mode

> Sample mode of this signal. Simulink ignores the setting of this field.

Minimum

> Minimum value that the signal can have. When updating the diagram or starting a simulation, Simulink generates an error if the signal's initial value is less than the minimum value and its storage class is other than `Auto` or `SimulinkGlobal`.

Maximum

> Maximum value that the signal can have. When updating the diagram or starting a simulation, Simulink generates an error if the signal's initial value is greater than the maximum value and its storage class is other than `Auto` or `SimulinkGlobal`.

Initial value

> Signal or state value before a simulation takes its first time step. You can specify any MATLAB string expression that evaluates to a `double` numeric scalar value or array.
>
> Valid:

```
1.5
[1 2 3]
1+0.5

foo = 1.5;
s1.InitialValue = 'foo';
```

> Invalid:

```
uint(1)
foo = '1.5';
s1.InitialValue = 'foo';
```

Simulink.Signal

If necessary, Simulink converts the initial value to ensure type, complexity, and dimension consistency with the corresponding block parameter value. If you specify an invalid value or expression, an error message appears when you update the model.

Initial value settings for signal objects that represent the following signals and states override the corresponding block parameter initial values if undefined (specified as []):

- Output signals of conditionally executed subsystems and Merge blocks
- Block states

Storage class
Storage class of this signal. See "Storage Classes of Tunable Parameters" in the Real-Time Workshop User's Guide for more information.

Alias
Alternate name for this signal. Simulink ignores this setting.

Description
Description of this signal. This field is intended for use in documenting this signal.

Properties

Name	Access	Description
DataType	RW	String specifying the data type of this signal. (Data type)
Dimensions	RW	Scalar or vector specifying the dimensions of this signal. (Dimensions)
Complexity	RW	String specifying the numeric type of this signal. Valid values are 'auto', 'real', or 'complex'. (Complexity)
Min	RW	Minimum value that this signal can have. (Minimum)

Name	Access	Description
Max	RW	Maximum value that this signal can have. (Maximum)
DocUnits	RW	Measurement units in which this signal's value is expressed. (Units)
RTWInfo	RW	Information used by Real-Time Workshop for generating code for this signal. The value of this property is an object of Simulink.ParamRTWInfo class.
SampleTime	RW	Rate at which this signal should be updated. (Sample time)
Sampling Mode	RW	Sampling mode of this signal. (Sample mode)

Simulink.StructElement

Purpose	Describe an element of a data structure
Description	Objects of this class describe elements of structures described by objects of the Simulink.StructType class.
Property Dialog Box	

Name
> Name of the element.

Dimensions
> A vector specifying the dimensions of the element.

Data type
> Name of the data type of this element.

Complexity
> Numeric type (i.e., real or complex) of this element.

Properties

Name	Access	Description
Name	RW	String specifying the name of this element. (Name)
Dimensions	RW	A vector specifying the dimensions of this element. (Dimensions)
DataType	RW	String that specifies the name of the data type of this element. (Data type)
Complexity	RW	String that specifies the numeric type ('real' or 'complex') of this element. (Complexity)

See Also   Simulink.StructType

Simulink.StructType

Purpose   Describe a data structure used as the value of a signal or parameter

Description   An object of this class describes a signal whose values are data structures (i.e., aggregates of data of different types as opposed to arrays of values of the same type). This class is intended to support development and use of custom blocks (e.g., S-Function blocks) that accept or output data structures. The class allows users of such blocks to determine the structure of the signals connected to them.

You can use either the Model Explorer or the MATLAB command line to create an instance of this class. To define the elements of a structure, create an array of instances of Simulink.StructElement at the MATLAB command line and assign the array as the value of the structure's Elements property. For example, the following commands define a structure that contains a floating point and an integer element.

```
v = Simulink.StructElement;
v.Name = 'v';
v.DataType = 'single';
n = Simulink.StructElement;
n.Name = 'n';
n.DataType = 'uint8';

s = Simulink.StructType;
s.Elements = [v n];
```

You can use a structure type object to specify the data type of Inport and Signal Specification blocks. To do this, enter the name of the variable that references the structure type object as the data type in the block's parameter dialog box.

The Simulink S-function API lets you create S-functions capable of generating and manipulating signal structures (see the simstruct.h header file for more information). You can connect signal structures created by S-function blocks to any standard Simulink block that accepts any data type. This includes virtual blocks and the Switch block configured to require the same data type on all its data inputs.

Property Dialog Box

Struct elements

> Table that displays the properties of the structure's elements. You cannot edit this table. To add or delete this structure's elements or change the properties of elements, you must use MATLAB commands, e.g.,

```
state.Elements(1).DataType = 'double';
```

Header file

> Name of a C header file that declares this structure. This field is intended for use by Real-Time Workshop. Simulink ignores it.

Description

> Description of this structure. This field is intended for you to use to document this structure. Simulink itself does not use this field.

Simulink.StructType

Properties

Name	Access	Description
Elements	RW	An array of Simulink.StructElement objects that define the names, data types, dimensions, and numeric types of the structure's elements. The elements must have unique names. (Struct elements)
Description	RW	String that describes this structure. This property is intended for user use. Simulink itself does not use it. (Description)
HeaderFile	RW	String that specifies the name of a C header file that declares this structure. (Header file)

See Also   Simulink.StructElement

Purpose   Log signals in a subsystem

Description   Simulink creates instances of this class to contain logs for signals belonging to a subsystem (see "Logging Signals" in Using Simulink). Objects of this class have a variable number of properties. The first property, named Name, is the name of the subsystem whose log data this object contains. The remaining properties are signal log or signal log container objects containing the data logged for the subsystem specified by this object's Name property.

Consider, for example, the following model.

After simulation of this model, the MATLAB workspace contains a Simulink.ModelDataLogs object, named logsout, that contains a Simulink.SubsysDataLogs object, named Gain, that contains the log data for signals a and g in the subsystem named Gain.

```
>> logsout.Gain
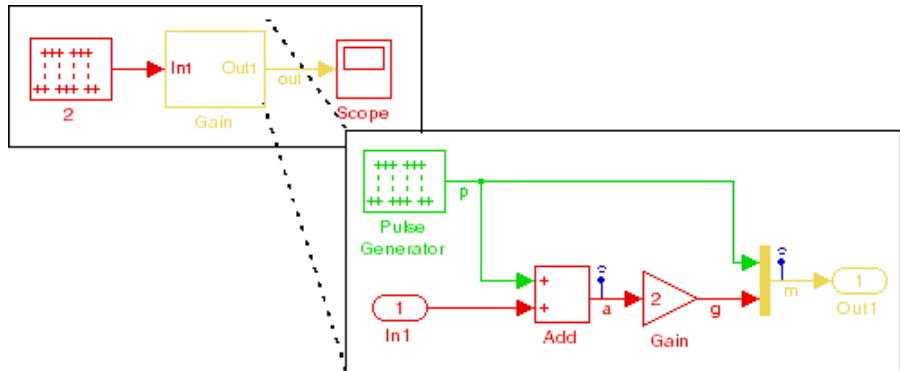
ans =

Simulink.SubsysDataLogs (Gain):
  Name                    Elements  Simulink Class

  a                          1       Timeseries
```

Simulink.SubsysDataLogs

g		2	TsArray

You can use either fully qualified log names or the `unpack` command to access the signal logs contained by a `SubsysDataLogs` object. For example, to access the amplitudes logged for signal a in the preceding example, you could enter the following at the MATLAB command line:

```
>> data = logsout.Gain.a.Data;
```

or

```
>> logsout.unpack('all');
data = a.Data;
```

See Also   Simulink.ModelDataLogs, Simulink.Timeseries, Simulink.TsArray, unpack

Purpose   Provide information about the time data in a `Simulink.Timeseries` object

Description   Simulink creates instances of these objects to describe the time data that it includes in `Simulink.Timeseries` objects.

Properties

Name	Access	Description
Units	RW	The units, e.g., `'seconds'`, in which the time series data are expressed in the associated `Simulink.Timeseries` object.
Start	RW	If the associated signal is not in a conditionally executed subsystem, this field contains the simulation time of the first signal value recorded in the associated `Simulink.Timeseries` object. If the signal is in a conditionally executed subsystem, this field contains an array of times when the system became active.
End	RW	If the associated signal is not in a conditionally executed subsystem, this field contains the simulation time of the last signal value recorded in the associated `Simulink.Timeseries` object. If the signal is in a conditionally executed subsystem, this field contains an array of times when the system became inactive.

Simulink.TimeInfo

Name	Access	Description
Increment	RW	The interval between simulation times at which signal data is logged in the associated `Simulink.Timeseries` object.
Length	W	The number of signal samples recorded in the associated `Simulink.Timeseries` object, i.e., the length of the arrays referenced by the object's `Time` and `Data` properties.

See Also   `Simulink.Timeseries`

Simulink.Timeseries

Purpose   Log signal data

Description   Simulink creates instances of this class to store signal data that it logs
while simulating a model (see "Logging Signals" in Using Simulink).

Note The MATLAB Time Series Tools can import and manipulate
instances of this class. See Using Time Series Tools in the MATLAB
Data Analysis documentation for further details.

Properties

Name	Access	Description
Name	RW	Name of this signal log.
BlockPath	RW	Path of the block that output the signal logged in this signal log.
PortIndex	RW	Index of the output port that emitted the signal logged in this signal log.
SignalName	RW	Name of the signal logged in this signal log.
ParentName	RW	Name of the parent of the signal recorded in this log, if the signal is an element of a composite signal; otherwise, the same as SignalName.
TimeInfo	RW	An object of Simulink.TimeInfo class that describes the time data in this log.
Time	RW	An array containing the simulation times at which signal data was logged.
Data	RW	An array containing the signal data.

See Also   Simulink.ModelDataLogs, Simulink.TimeInfo, unpack

Simulink.TsArray

Purpose　　　Log composite virtual signals

Description　　Simulink creates instances of this class to contain the data that it logs for a composite virtual signal, e.g., the output of a Mux or of a virtual Bus Creator block (see "Logging Signals"). Objects of the `Simulink.TsArray` class have a variable number of properties. The first property, called `Name`, specifies the log name of the composite signal. The remaining properties reference logs for the elements of the composite signal, i.e., `Simulink.Timeseries` objects for elementary signals and `Simulink.TSArray` objects for elements that are themselves composite signals, e.g., a bus. The name of each property is the log name of the corresponding signal.

Consider, for example, the following model.

This model specifies that Simulink should log the values of the composite signal b2 during simulation. After simulation of this model, the MATLAB workspace contains a `Simulink.ModelDataLogs` object, named `logsout`, that contains a `Simulink.TsArray` object, named b2, that contains the logs for the elements of b2, i.e., for the elementary signal x1 and the bus signal b1. Entering the fully qualified name of the `Simulink.TsArray` object, i.e., `logsout.b2`, at the MATLAB command line reveals the structure of the signal log for this model.

```
>> logsout.b2
Simulink.TsArray (untitled/Bus Creator1):
```

```
Name                  Elements    Simulink Class
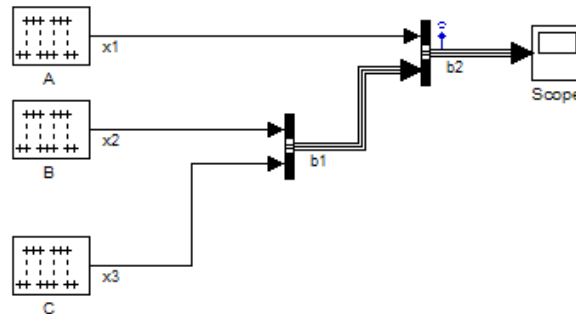
x1                        1       Timeseries
b1                        2       TsArray
```

You can use either fully qualified log names or the unpack command to access the signal logs contained by a Simulink.TsArray object. For example, to access the amplitudes logged for signal x1 in the preceding example, you could enter the following at the MATLAB command line:

```
>> data = logsout.b2.x1.Data;
```

or

```
>> logsout.unpack('all');
data = x1.Data;
```

See Also   Simulink.ModelDataLogs, Simulink.Timeseries, unpack

10

Model and Block Parameters

The following sections list parameters that you can set for Simulink models and blocks, using the `set_param` command.

Model Parameters

This table lists and describes parameters that describe a model. The parameters appear in the order they are defined in the model file, as described in Chapter 11, "Model File Format". The table also includes model callback parameters (see "Using Callback Functions"). The **Description** column indicates where you can set the value on the **Configuration Parameters** dialog box. Examples showing how to change parameters follow the table (see "Examples of Setting Model Parameters" on page 10-54).

Parameter values must be specified as quoted strings. The string contents depend on the parameter and can be numeric (scalar, vector, or matrix), a variable name, a filename, or a particular value. The **Values** column shows the type of value required, the possible values (separated with a vertical line), and the default value, enclosed in braces.

Model Parameters

Parameter	Description	Values
AbsTol	Absolute error tolerance. Setting for the **Absolute tolerance** on the **Solver** pane of the **Configuration Parameters** dialog box.	string {'auto'}
AccelMakeCommand	Program that builds the Simulink Accelerator target for this model.	string {'make_rtw'}
AccelSystemTargetFile	TLC file used to build the Simulink Accelerator target for this model.	string {'accel.tlc'}
AccelTemplateMakefile	Template for the makefile used to build the Simulink Accelerator target for this model.	string {'accel_default_tmf'}
AlgebraicLoopMsg	Specifies diagnostic action to take when there is an algebraic loop. Set by the **Algebraic loop** option on the **Diagnostics** pane of the **Configuration Parameters** dialog box.	'none'	{'warning'}	'error'

Model Parameters (Continued)

Parameter	Description	Values
`AnalyticLinearization`	For internal use.	
`ArrayBoundsChecking`	Setting for the **Array bounds exceeded** diagnostic on the **Diagnostics Data Validity** pane of the **Configuration Parameters** dialog box.	`{'none'}` | `'warning'` | `'error'`
`ArtificialAlgebraic LoopMsg`	Setting for the **Minimize algebraic loop** diagnostic on the **Diagnostics** pane of the **Configuration Parameters** dialog box.	`'none'` | `{'warning'}` | `'error'`
`AssertControl`	See `AssertionControl` parameter for more information.	
`AssertionControl`	Setting for the **Model Verification block enabling** control on the **Diagnostics Data Validity** pane of the **Configuration Parameters** dialog box.	`{'UseLocalSettings'}` | `'EnableAll'` | `'DisableAll'`
`BlockDescription StringDataTip`	Specifies whether to display the user description string for a block as a data tip. Set by the **User Description String** command on the model editor's **View->Block Data Tips Options** menu.	`'on'` | `{'off'}`
`BlockDiagramType`	Type of block diagram (read only).	`'model'` | `'library'`
`BlockNameDataTip`	Specifies whether to display the block name as a data tip. Set by the **Block Name** command on the model editor's **View->Block Data Tips Options** menu.	`'on'` | `{'off'}`

Model Parameters (Continued)

Parameter	Description	Values
`BlockParametersData Tip`	Specifies whether to display the block parameter as a data tip. Set by the **Parameter Names and Values** command on the model editor's **View->Block Data Tips Options** menu.	`'on' | {'off'}`
`BlockPriority ViolationMsg`	Setting for the **Block priority violation** diagnostic on the **Diagnostics** pane of the **Configuration Parameters** dialog box.	`'none' | {'warning'} | 'error'`
`BlockReduction`	Enables block reduction optimization. Set by the **Block reduction optimization** option on the **Optimization** pane of the **Configuration Parameters** dialog box.	`{'on'} | 'off'`
`BlockReductionOpt`	See `BlockReduction` parameter for more information.	
`Blocks`	Names of the blocks that this model contains.	`cell array {{}}`
`BooleanDataType`	Enable Boolean mode. Set by the **Implement logic signals as boolean data (vs. double)** option on the **Optimization** pane of the **Configuration Parameters** dialog box.	`{'on'} | 'off'`
`Browser`	Deprecated.	
`BrowserHandle`	Deprecated.	

Model Parameters (Continued)

Parameter	Description	Values
BrowserLookUnder Masks	Show masked subsystems in the Model Browser. Set by the **Show Masked Subsystems** command on the model editor's **View->Model Browser Options** menu.	'on' | {'off'}
BrowserShowLibraryLinks	Show library links in the Model Browser. Set by the **Show Library Links** command on the model editor's **View->Model Browser Options** menu.	'on' | {'off'}
BusObjectLabelMismatch	Set by the **Element name mismatch** option on the **Connectivity** panel of the **Diagnostics** pane of the **Configuration Parameters** dialog box.	{'none'} | 'warning'| 'error'
BufferReusableBoundary	For internal use.	
BufferReuse	Enable reuse of block I/O buffers. Set by the **Reuse block outputs** option on the **Optimization** pane of the **Configuration Parameters** dialog box.	{'on'} | 'off'
CheckExecutionContext RuntimeOutputMsg	Set by the **Check runtime output of execution context** option on the **Compatibility Diagnostics** pane of the **Configuration Parameters** dialog box.	{'on'} | 'off'
CheckExecutionContext PreStartOutputMsg	Set by the **Check preactivation output of execution context** option on the **Compatibility Diagnostics** pane of the **Configuration Parameters** dialog box.	{'on'} | 'off'
CheckForMatrix Singularity	See CheckMatrixSingularityMsg parameter for more information.	

Model Parameters (Continued)

Parameter	Description	Values
CheckMatrix SingularityMsg	Set by the **Division by singular matrix** option on the **Data Validity** pane of the **Configuration Parameters** dialog box.	{'none'} | 'warning' | 'error'
CheckModelReference TargetMessage	Message behavior when the **Never rebuild targets diagnostic** is set to never in the **Model Referencing** pane of the **Configuration Parameters** dialog box.	'none' | 'warning' | {'error'}
CheckSSInitial OutputMsg	Enable checking for undefined initial subsystem output. Set by the **Check undefined subsystem initial output** option on the **Compatibility Diagnostics** pane of the **Configuration Parameters** dialog box.	{'on'} | 'off'
CloseFcn	Close callback. Created on the **Callbacks** pane of the Model Properties dialog box. See "Creating Model Callback Functions" in the Using Simulink documentation for further information.	command or variable
ConditionallyExecute Inputs	Enable conditional input branch execution optimization. Set by the **Conditional input branch execution** control on the **Optimization** pane of the **Configuration Parameters** dialog box.	{'on'} | 'off'

Model Parameters (Continued)

Parameter	Description	Values
`ConfigurationManager`	Configuration manager for this model.	string {`'None'`}
`ConsecutiveZCsStep RelTol`	Relative tolerance associated with the time difference between zero crossing events. Set by the **Consecutive zero crossings relative tolerance** option on the **Solver** pane of the **Configuration Parameters** dialog box.	string {`'10*128*eps'`}
`ConsistencyChecking`	Consistency checking. Set by the **Solver data inconsistency** option on the **Diagnostics** pane of the **Configuration Parameters** dialog box.	{`'none'`} | `'warning'` | `'error'`
`CovCompData`	If `CovHTMLOptions` is set to off, and `CovCumulativeReport` is set to on, this parameter specifies cvdata objects containing additional model coverage data to include in the model coverage report. Specified by the **Additional data to include in report (cvdata objects)** field in the **Report** pane of the **Coverage Settings** dialog box.	string

Model Parameters (Continued)

Parameter	Description	Values
CovCumulativeReport	If CovHTMLReporting is set to on, this parameter allows the CovCumulativeReport and CovCompData parameters to specify the number of coverage results displayed in the model coverage report. If set to on, display the coverage results for the last simulation in the report. If set to off, display the coverage results from successive simulations in the report. Set by the radial buttons **Cumulative runs** (on)/**Last runs** (off) in the **Report** pane of the **Coverage Settings** dialog box.	'on' | {'off'}
CovCumulativeVarName	If covSaveCumulativeToWorkSpace Var is set to on, model coverage saves the results of successive simulations in the workspace variable specified by this property. Entered in the field below the selected **Save cumulative results in workspace variable** check box on the **Results** pane of the **Coverage Settings** dialog box.	string {'covCumulativeData'}

Model Parameters (Continued)

Parameter	Description	Values
CovHTMLOptions	If CovHTMLReporting is set to on, use this parameter to select from a set of display options for the resulting model coverage report. In the **Report** pane of the **Coverage Settings** dialog box, select **Settings** to receive a dialog box for selecting these options.	String of appended character sets separated by a space. HTML options are enabled or disabled through a value of 1 or 0, respectively, in the following character sets (default values shown): • '-aTS=1' Include each test in the model summary • '-bRG=1' Produce bar graphs in the model summary • '-bTC=0' Use two color bar graphs (red, blue) • '-hTR=0' Display hit/count ratio in the model summary • '-nFC=0' Do not report fully covered model objects • '-scm=1' Include cyclomatic complexity numbers in summary • '-bcm=1' Include cyclomatic complexity numbers in block details

Model Parameters (Continued)

Parameter	Description	Values
CovHtmlReporting	Set to on to tell Simulink to create an HTML report containing the coverage data in the MATLAB Help browser at the end of the simulation. Set by the **Generate HTML report** check box on the **Report** pane of the **Coverage Settings** dialog box.	{'on'} | 'off'

Model Parameters (Continued)

Parameter	Description	Values

CovMetricSettings	Selects coverage metrics for coverage report. Coverage metrics are enabled by selecting the check boxes for individual coverages in the **Coverage Metrics** section of the **Coverage** pane of the **Coverage Settings** dialog box. Options 's' and 'w' are enabled by selecting the check boxes **Treat Simulink logic blocks as short-circuited** and **Warn when unsupported blocks exist in model**, respectively, in the **Options** pane of the **Coverage Settings** dialog box. Option 'e' is disabled by selecting the check box **Display coverage results using model coloring** in the **Results** pane of the **Coverage Settings** dialog box.	string {'dw'}
		
		Each order-independent character in the string enables a coverage metric or option as follows:
		
		• 'd'
		
		  Enable decision coverage
		
		• 'c'
		
		  Enable condition coverage
		
		• 'm'
		
		  Enable MCDC coverage
		
		• 't'
		
		  Enable lookup table coverage
		
		• 'r'
		
		  Enable signal range coverage
		
		• 's'
		
		  Treat Simulink logic blocks as short-circuited
		
		• 'w'
		
		  Warn when unsupported blocks exist in model
		
		• 'e'
		
		  Eliminate model coloring for coverage results

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Model Parameters (Continued)

Parameter	Description	Values
CovNameIncrementing	If CovSaveSingleToWorkspaceVar is set to on, setting this parameter to on tells Model Coverage to increment the workspace variable specified in CovSaveName to store the results succeeding simulations. Entered in the **Increment variable name with each simulation** check box below the selected **Save last run in workspace variable** check box on the **Results** pane of the **Coverage Settings** dialog box.	'on' | {'off'}
CovPath	Model path of the subsystem for which Simulink gathers and reports coverage data. Set by browsing for the path in **Coverage Instrumentation Path** on the **Coverage** pane of the **Coverage Settings** dialog box.	string {'/'}
CovReportOnPause	Specifies that when you pause during simulation the model coverage report appears in updated form with coverage results up to the current pause or stop time. Set by selecting the **Update results on pause** check box on the **Results** pane of the **Coverage Settings** dialog box.	{'on'} | 'off'

Model Parameters (Continued)

Parameter	Description	Values
covSaveCumulativeTo WorkspaceVar	If set to on, causes Model Coverage to accumulate and save the results of successive simulations in the workspace variable in `CovCumulativeVarName`. Set by selecting the **Save cumulative results in workspace variable** check box on the **Results** pane of the **Coverage Settings** dialog box.	`{'on'}	'off'`
CovSaveName	If `CovSaveSingleToWorkspaceVar` is set to on, Model Coverage saves the results of the last simulation run in the workspace variable specified by this property. Entered in the field below the selected **Save last run in workspace variable** check box on the **Results** pane of the **Coverage Settings** dialog box.	string `{'covdata'}`
CovSaveSingleTo WorkspaceVar	If enabled, tells Model Coverage to save the results of the last simulation run in the workspace variable specified by the `CovSaveName` property. Set by selecting the **Save last run in workspace variable** check box on the **Results** pane of the **Coverage Settings** dialog box.	`{'on'}	'off'`
Created	Date and time model was created.	string
Creator	Name of model creator.	string `{''}`
CurrentBlock	For internal use.	
CurrentOutputPort	For internal use.	

Model Parameters (Continued)

Parameter	Description	Values
DataTypeOverride	Specifies data type used to override fixed-point data types. Set by the **Data type override** control on the **Fixed-Point Settings** dialog box.	{'UseLocalSettings'} | 'ScaledDoubles' | 'TrueDoubles' | 'TrueSingles' | 'ForceOff'
Decimation	Decimation factor. Set by the **Decimation** field on the **Data Import/Export** pane of the **Configuration Parameters** dialog box.	string {'1'}
DeleteChildFcn	Delete child callback.	string {''}
Description	Description of this model. Set by the Description pane of theModel Properties dialog box.	string
Dirty	If the parameter is on, the model has unsaved changes.	'on' | {'off'}
DiscreteInherit ContinuousMsg	Specifies diagnostic action to take when a Unit Delay block inherits a continuous sample time. Set by the **Discrete used as continuous** control on the **Sample Time Diagnostics** pane of the **Configuration Parameters** dialog box.	'none' | {'warning'} | 'error'
DisplayBdSearch Results	For internal use.	
DisplayBlockIO	For internal use.	
DisplayCallgraph Dominators	For internal use	
DisplayCompileStats	For internal use.	
DisplayCondInputTree	For internal use.	

Model Parameters (Continued)

Parameter	Description	Values
DisplayCondStIdTree	For internal use.	
DisplayError Directions	For internal use.	
DisplayInvisible Sources	For internal use.	
DisplaySortedLists	For internal use.	
DisplayVectorAnd FunctionCounts	For internal use.	
DisplayVect PropagationResults	For internal use.	
Echo	For internal use.	
EnableOverflow Detection	For internal use.	
ExecutionContextIcon	Toggles display of execution context icons on this model's block diagram.	'on' | {'off'}
ExpressionFolding	Enables expression folding. Set by the **Eliminate superfluous temporary variables** option on the **Optimization** pane of the **Configuration Parameters** dialog box.	{'on'} | 'off'
ExternalInput	Names of MATLAB workspace variables used to designate data and times to be loaded from the workspace. Set by the **Input** option on the **Data Import/Export** pane of the **Configuration Parameters** dialog box.	scalar or vector {'[t, u]'}

Model Parameters (Continued)

Parameter	Description	Values
ExtMode...	Parameters whose names start with ExtMode apply to Simulink External Mode. See External Mode in the Real-Time Workshop User's Guide for more information.	
ExtrapolationOrder	Extrapolation order of the ode14x implicit fixed-step solver. Set by the **Extrapolation order** control on the **Solver** pane of the **Configuration Parameters** dialog box.	1 | 2 | 3 | {4}
FcnCallInpInside ContextMsg	Specifies diagnostic action to take when Simulink has to compute any of a function-call subsystem's inputs directly or indirectly during execution of a call to a function-call subsystem. Set by the **Context-dependent inputs** control on the **Connectivity Diagnostics** pane of the **Configuration Parameters** dialog box.	{'Use local settings'} | 'Enable All' | 'Disable All'
FileName	For internal use.	
FinalStateName	Names of final states to be saved to the workspace. Set by the **Final states** option on the **Data Import/Export** pane of the **Configuration Parameters** dialog box.	string {'xFinal'}
FixedStep	Fixed step size. Set by the **Fixed step size (fundamental sample time)** field on the **Solver** pane of the **Configuration Parameters** dialog box.	string {'auto'}
FixPtInfo	For internal use.	

Model Parameters (Continued)

Parameter	Description	Values
`FollowLinksWhen OpeningFromGotoBlocks`	Specifies whether to search for Goto tags in libraries referenced by the model when opening the From block dialog box.	`'on'` | `{'off'}`
`ForceArrayBounds Checking`	For internal use.	
`ForceConsistency Checking`	For internal use.	
`ForceModelCoverage`	For internal use.	
`ForwardingTable`	Specifies the forwarding table for this library. See "Forwarding Tables" in Using Simulink for more information.	`{{'old_path_1', 'new_path_1'} ... {'old_path_n', 'new_path_n'}}`
`ForwardingTable String`	For internal use.	
`GridSpacing`	Spacing of model editor grid in pixels.	`integer {20}`
`Handle`	Handle of this model's block diagram.	`double`
`HiliteAncestors`	For internal use.	
`HiliteFcnCallInp InsideContext`	Enables highlighting of Function-Call Subsystems when one or more inputs depend on source blocks that appear in their own calling context.	`'on'` | `{'off'}`
`IgnoreBidirectional Lines`	For internal use.	
`InheritedTsInSrcMsg`	Message behavior when the sample time is inherited. Set by the **Source block specifies -1 sample time** control on the **Sample Time Diagnostics** pane of the **Configuration Parameters** dialog box.	`'none'` | `{'warning'}` | `'error'`

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Model Parameters (Continued)

Parameter	Description	Values
InitFcn	Function that is called when this model is first compiled for simulation.	string {''}
InitialState	Initial state name or values. Set by the **Initial state** field on the **Data Import/Export** pane of the **Configuration Parameters** dialog box.	variable or vector {'xInitial'}
InitialStep	Initial step size. Set by the **Initial step size** field on the **Solver** pane of the **Configuration Parameters** dialog box.	string {'auto'}
InlineParams	Enable inline of parameters in generated code. Set by the **Inline parameters** check box on the **Optimization** pane of the **Configuration Parameters** dialog box.	'on' | {'off'}
InspectSignalLogs	Enable Simulink to display logged signals in the MATLAB **Time Series Tools** viewer at the end of a simulation or whenever you pause the simulation. Set by the **Inspect signal logs when simulation is paused/stopped** check box on the **Data Import/Export** pane of the **Configuration Parameters** dialog box.	'on' | {'off'}
Int32ToFloatConvMsg	Message behavior when a 32-bit integer is converted to a single-precision float. Set by the **32-bit integer to single precision float conversion** control on the **Type Conversion** pane of the **Configuration Parameters** dialog box.	'none' | {'warning'}

Model Parameters (Continued)

Parameter	Description	Values
IntegerOverflowMsg	Message behavior when there is an integer overflow. Set by the **Data overflow** control on the **Diagnostics Data Validity** pane of the **Configuration Parameters** dialog box.	'none' | {'warning'} | 'error'
InvalidFcnCallConnMsg	Message behavior when there is an invalid function call connection. Set by the **Invalid function call connection** control on the **Connectivity Diagnostics** pane of the **Configuration Parameters** dialog box.	'none' | 'warning' | {'error'}
Jacobian	For internal use.	
LastModifiedBy	Name used for version control.	string
LastModifiedDate	Date used for version control.	string
LibraryLinkDisplay	Shows which blocks in the model are linked or have disabled or modified links. Set by the **Library Link Display** option under the **Format** menu.	{'none'} | 'user' | 'all'
LibraryType	For internal use.	{'none'} | 'BlockLibrary' | 'IOLibrary'

Model Parameters (Continued)

Parameter	Description	Values
LimitDataPoints	Limit output. Set by the **Limit data points to last** check box on the **Data Import/Export** pane of the **Configuration Parameters** dialog box.	{'on'} | 'off'
LinearizationMsg	For internal use.	
Lines	For internal use.	
LoadExternalInput	Load input from workspace. Set by the **Input** check box on the **Data Import/Export** pane of the **Configuration Parameters** dialog box.	'on' | {'off'}
LoadInitialState	Load initial state from workspace. Set by the **Initial state** check box on the **Data Import/Export** pane of the **Configuration Parameters** dialog box.	'on' | {'off'}
Location	For internal use.	
Lock	Lock/unlock a block library. Setting this parameter on prevents a user from inadvertently changing a library.	'on' | {'off'}
MaxConsecutiveMinStep	Maximum number of minimum step size violations allowed during simulation. Set by the **Number of consecutive min step size violations allowed** control on the **Solver** pane of the **Configuration Parameters** dialog box. This option is displayed when the solver option type is Variable-step and the solver is an ode one.	string {'1'}

Model Parameters (Continued)

Parameter	Description	Values
MaxConsecutiveZCs	Maximum number of consecutive zero crossings allowed during simulation. Set by the **Number of consecutive zero crossings allowed** control on the **Solver** pane of the **Configuration Parameters** dialog box. This option is displayed when the solver option type is `Variable-step` and the solver is an ode one.	string {'1000'}
MaxConsecutiveZCsMsg	Specifies diagnostic action to take when Simulink detects the maximum number of consecutive zero crossings allowed. Set by the **Consecutive zero crossings violation** control on the **Diagnostics** pane of the **Configuration Parameters** dialog box. This option is displayed when the solver option type is `Variable-step` and the solver is an ode one.	'warning' | {'error'}
MaxDataPoints	Maximum number of output data points to save. Set by the **Limit data points to last** field on the **Data Import/Export** pane of the **Configuration Parameters** dialog box.	string {'1000'}
MaxNumMinSteps	Maximum number of times the solver uses the minimum step size.	string {'-1'}
MaxOrder	Maximum order for `ode15s`. Set by the **Maximum order** option on the **Solver** pane of the **Configuration Parameters** dialog box.	1 | 2 | 3 | 4 | {5}

Model Parameters (Continued)

Parameter	Description	Values
MaxStep	Maximum step size. Set by the **Max step size** field on the **Solver** pane of the **Configuration Parameters** dialog box.	string {'auto'}
MdlSubVersion	For internal use	
MinMaxOverflow ArchiveData	For internal use	
MinMaxOverflow ArchiveMode	Logging type for fixed-point logging. Set by the **Logging type** option in the **Fixed-Point Settings** dialog box.	{'Overwrite'} | 'Merge'
MinMaxOverflow Logging	Setting for fixed-point logging. Set by the **Logging mode** option in the **Fixed-Point Settings** dialog box.	{'UseLocalSettings'} | 'MinMaxAndOverflow' | 'OverflowOnly' | 'ForceOff'
MinStep	Minimum step size for the solver. Set by the **Min step size** field on the **Solver** pane of the **Configuration Parameters** dialog box.	string {'auto'}
MinStepSizeMsg	Message shown when minimum step size is violated. Set by the **Min step size violation** option on the **Diagnostics** pane of the **Configuration Parameters** dialog box.	{'warning'} | 'error'
ModelBrowser Visibility	Show the Model Browser. Set by the **Model Browser** command of the model's **View->Model Browser Options** menu.	'on' | {'off'}

Model Parameters (Continued)

Parameter	Description	Values
`ModelBrowserWidth`	Width of the Model Browser pane in the model window. To display the Model Browser pane, see the `ModelBrowserVisibility` parameter.	integer {200}
`ModelDataFile`	For internal use.	string {''}
`ModelDependencies`	List of model dependencies. Set by the **Model dependencies** field on the **Model Referencing** pane of the **Configuration Parameters** dialog box.	string {''}
`ModelReferenceCS MismatchMessage`	Message shown when there is a model configuration mismatch. Set by the **Model configuration mismatch** option on the **Model Referencing Diagnostics** pane of the **Configuration Parameters** dialog box.	{'none'} | 'warning' | 'error'
`ModelReferenceData LoggingMessage`	Message shown when there is unsupported data logging. Set by the **Unsupported data logging** option on the **Model Referencing Diagnostics** pane of the **Configuration Parameters** dialog box.	'none' | {'warning'} | 'error'
`ModelReferenceExtra NoncontSigs`	Specifies diagnostic action to take when a discrete signal appears to pass through a Model block to the input of a block with continuous states. Set by the **Extraneous discrete derivative signals** control on the **Diagnostics** pane of the **Configuration Parameters** dialog box.	'none' | 'warning' | {'error'}

Model Parameters (Continued)

Parameter	Description	Values
`ModelReferenceIO MismatchMessage`	Message shown when there is a port and parameter mismatch. Set by the **Port and parameter mismatch** option on the **Model Referencing Diagnostics** pane of the **Configuration Parameters** dialog box.	`{'none'}	'warning'	'error'`
`ModelReferenceIOMsg`	Message shown when there is an invalid root Inport/Outport block connection. Set by the **Invalid root Inport/Outport block connection** option on the **Model Referencing Diagnostics** pane of the **Configuration Parameters** dialog box.	`{'none'}	'warning'	'error'`
`ModelReferenceMin AlgLoopOccurrences`	See `ModelrefMinAlgLoopOccurrences` parameter for more information.	
`ModelReferenceNum InstancesAllowed`	Total number of instances allowed per top model. Set by the **Total number of instances allowed per top model** option on the **Model Referencing** pane of the **Configuration Parameters** dialog box.	`'Zero'	'Single'	{'Multi'}`
`ModelReferencePass RootInputsByReference`	See `ModelrefPassRootInputsByReference` parameter for more information.	
`ModelReferenceSim TargetVerbose`	Print detailed information when generating simulation targets for models referenced by a top-level model.	`'on'	{'off'}`
`ModelReferenceSymbol NameMessage`	For internal use.	

Model Parameters (Continued)

Parameter	Description	Values
`ModelReferenceTarget Type`	For internal use.	
`ModelReferenceVersion MismatchMessage`	Message shown when there is a model block version mismatch. Set by the **Model block version mismatch** option on the **Model Referencing Diagnostics** pane of the **Configuration Parameters** dialog box.	`{'none'}` | `'warning'` | `'error'`
`ModelrefMinAlgLoop Occurrences`	Toggles the minimization of algebraic loop occurrences. Set by the **Minimize algebraic loop occurrences** check box on the **Model Referencing** pane of the **Configuration Parameters** dialog box.	`'on'` | `{'off'}`
`ModelrefPassRoot InputsByReference`	Toggles the passing of scalar root inputs by value. Set by the **Pass scalar root inputs by value** check box on the **Model Referencing** pane of the **Configuration Parameters** dialog box.	`{'on'}` | `'off'`
`ModelVersion`	Version number of model.	string `{'1.1'}`
`ModelVersionFormat`	Format of model's version number.	string `{'1.%<AutoIncrement: 0>'}`
`ModelWorkspace`	References this model's model workspace object.	an instance of the `Simulink.ModelWorkspace` class
`ModifiedBy`	Last modifier of this model.	string

Model Parameters (Continued)

Parameter	Description	Values
ModifiedByFormat	Format for the display of last modifier. This is set by the **Last saved by** parameter on the History pane of theModel Properties dialog box. See "Model History Panel" in the Using Simulink documentation for further information. This can also be set by the **Last saved by** on theModel history field on the **History** pane of the **Model Explorer** dialog box.	string {'%<Auto>'}
ModifiedComment	Field for user comments.	string {''}
ModifiedDate	Date of last model modification.	string
ModifiedDateFormat	Format of modified date.	string {'%<Auto>'}
ModifiedHistory	Area for keeping notes about the history of the model. This is set by the History pane of theModel Properties dialog box. See "Model History Panel" in "Using Simulink"the Using Simulink documentation for further information. This can also be set by the **Model history** field on the **History** pane of the **Model Explorer** dialog box.	string {''}

Model Parameters (Continued)

Parameter	Description	Values
MultiTaskDSMMsg	Specifies diagnostic action to take when one task reads data from a Data Store Memory block to which another task writes data. Set by the **Multitask data store** control on the **Diagnostics Data Validity** pane of the **Configuration Parameters** dialog box.	'none' | {'warning'} | 'error'
MultiTaskRateTransMsg	Specifies diagnostic action to take when an invalid rate transition takes place between two blocks operating in single-tasking mode. Set by the **Multitask rate transition** control on the **Sample Time Diagnostics** pane of the **Configuration Parameters** dialog box.	'warning' | {'error'}
Name	Model name.	string
NumberNewton Iterations	Number of Newton's Method iterations performed by the ode14x implicit fixed-step solver. Set by the **Number Newton's iterations** control on the **Solver** pane of the pane of the **Configuration Parameters** dialog box.	integer {1}
ObjectParameters	Names/attributes of model parameters.	structure
Open	For internal use.	
OptimizeBlockIO Storage	Enables signal storage reuse optimization. Set by the **Signal storage reuse** control on the **Optimization** pane of the **Configuration Parameters** dialog box.	{'on'} | 'off'

Model Parameters (Continued)

Parameter	Description	Values
OutputOption	Time step output options for variable-step solvers. Set by the **Output options** option on the **Data Import/Export** pane of the **Configuration Parameters** dialog box.	'AdditionalOutputTimes' | {'RefineOutputTimes'} | 'SpecifiedOutputTimes'
OutputSaveName	Workspace variable to store the model outputs. Set by the **Output** field on the **Data Import/Export** pane of the **Configuration Parameters** dialog box.	variable {'yout'}
OutputTimes	Output times set when **Output options** on the **Data Import/Export** pane of the **Configuration Parameters** dialog box is set to **Produce additional output**. Set by the **Output times** option on the **Data Import/Export** pane of the **Configuration Parameters** dialog box.	string {'[]'}
PaperOrientation	Printing paper orientation.	'portrait' | {'landscape'} | 'rotated'
PaperPosition	Position of diagram on paper.	[left, bottom, width, height]
PaperPositionMode	Paper position mode.	{'auto'} | 'manual' | 'tiled'
PaperSize	Size of PaperType in PaperUnits.	[width height] (read only)

Model Parameters (Continued)

Parameter	Description	Values
PaperType	Printing paper type.	`'usletter' | 'uslegal' | 'a0' | 'a1' | 'a2' | 'a3' | 'a4' | 'a5' | 'b0' | 'b1' | 'b2' | 'b3' | 'b4' | 'b5' | 'arch-A' | 'arch-B' | 'arch-C' | 'arch-D' | 'arch-E' | 'A' | 'B' | 'C' | 'D' | 'E' | 'tabloid'`
PaperUnits	Printing paper size units.	`'normalized' | {'inches'} | 'centimeters' | 'points'`
ParameterArgument Names	List of parameters used as arguments when this model is called as a reference. Set in the **Model arguments (for referencing this model)** field in the **Model Workspace** pane of the **Model Explorer**.	`string {''}`
ParameterDowncastMsg	Specifies diagnostic action to take when a parameter downcast occurs during simulation. Set by the **Detect downcast** control on the **Diagnostics Data Validity** pane of the **Configuration Parameters** dialog box.	`'none' | 'warning' | {'error'}`

Model Parameters (Continued)

Parameter	Description	Values
ParameterOverflowMsg	Specifies diagnostic action to take when a parameter overflow occurs during simulation. Set by the **Detect overflow** control on the **Diagnostics Data Validity** pane of the **Configuration Parameters** dialog box.	'none' | 'warning' | {'error'}
ParameterPooling	Toggles pooling of parameters in Real-Time Workshop generated code.	{'on'} | 'off'
ParameterPrecision LossMsg	Specifies diagnostic action to take when parameter precision loss occurs during simulation. Set by the **Detect precision loss** control on the **Diagnostics Data Validity** pane of the **Configuration Parameters** dialog box.	'none' | {'warning'} | 'error'
ParameterUnderflowMsg	Specifies diagnostic action to take when a parameter underflow occurs during simulation. Set by the **Detect underflow** control on the **Diagnostics Data Validity** pane of the **Configuration Parameters** dialog box.	{'none'} | 'warning' | 'error'
ParamWorkspaceSource	For internal use.	
Parent	Name of the model or subsystem that owns this object. The value of this parameter for a model is an empty string.	string {''}

Model Parameters (Continued)

Parameter	Description	Values
PostLoadFcn	Function invoked just after this model is loaded. Created on the **Callbacks** pane of the Model Properties dialog box. See "Creating Model Callback Functions" in the Using Simulink documentation for further information.	string {''}
PostSaveFcn	Function invoked just after this model is saved to disk.	string {''}
PreLoadFcn	Preload callback. Created on the **Callbacks** pane of the Model Properties dialog box. See "Creating Model Callback Functions" in the Using Simulink documentation for further information.	command or variable {''}
PreSaveFcn	Function invoked just before this model is saved to disk. Created on the **Callbacks** pane of the Model Properties dialog box. See "Creating Model Callback Functions" in the Using Simulink documentation for further information.	string {''}
ProdBitPerChar	Specifies the length in bits of the C char data type supported by the production hardware device type targeted by this model. Set by the **char** control in the **Embedded Hardware** panel of the **Hardware Implementation** pane of the **Configuration Parameters** dialog box.	integer {8}

Model Parameters (Continued)

Parameter	Description	Values
ProdBitPerInt	Specifies the length in bits of the C int data type supported by the production hardware device type targeted by this model. Set by the **int** control in the **Embedded Hardware** panel of the **Hardware Implementation** pane of the **Configuration Parameters** dialog box.	integer {32}
ProdBitPerLong	Specifies the length in bits of the C long data type supported by the production hardware device type targeted by this model. Set by the **long** control in the **Embedded Hardware** panel of the **Hardware Implementation** pane of the **Configuration Parameters** dialog box.	integer {32}
ProdBitPerShort	Specifies the length in bits of the C short data type supported by the production hardware device type targeted by this model. Set by the **short** control in the **Embedded Hardware** panel of the **Hardware Implementation** pane of the **Configuration Parameters** dialog box.	integer {16}
ProdEndianess	Specifies the significance of the first byte of a data word of the target hardware. Set by the **Byte ordering** control in the **Embedded Hardware** panel of the **Hardware Implementation** pane of the **Configuration Parameters** dialog box.	{'Unspecified'} | 'LittleEndian' | 'BigEndian'

Model Parameters (Continued)

Parameter	Description	Values
ProdEqTarget	Specifies that the hardware used to test the code generated from this model is the same as the production hardware or has the same characteristics. Set by the **None** control in the **Emulation Hardware** panel of the **Hardware Implementation** pane of the **Configuration Parameters** dialog box.	{'on'} | 'off'
ProdHWDeviceType	Predefined hardware device to specify the C language constraints for your microprocessor. Set by the **Device type** option on the **Hardware Implementation** pane of the **Configuration Parameters** dialog box.	string {'32-bit Generic'}
ProdHWWordLengths	Number of bits used for char, short, int, and long, respectively (set by the hardware device type).	string {'8,16,32,32'}
ProdIntDivRoundTo	Specifies how an ANSI C conforming compiler used to compile code for the production hardware targeted by this model rounds the result of dividing one signed integer by another to produce a signed integer quotient. Set by the **Signed integer division rounds to** control in the **Embedded Hardware** panel of the **Hardware Implementation** pane of the **Configuration Parameters** dialog box.	'Floor' | 'Zero' | {'Undefined'}

Model Parameters (Continued)

Parameter	Description	Values
ProdShiftRightIntArith	Specifies whether the C compiler implements a signed integer right shift as an arithmetic right shift. Set by the **Shift right on a signed integer as arithmetic shift** control in the **Embedded Hardware** panel of the **Hardware Implementation** pane of the **Configuration Parameters** dialog box.	{'on'} | 'off'
ProdWordSize	Specifies the word length in bits of the production hardware device type targeted by this model. Set by the **native word size** control in the **Embedded Hardware** panel of the **Hardware Implementation** pane of the **Configuration Parameters** dialog box.	integer {32}
Profile	Enables the simulation profiler for this model.	'on' | {'off'}
ReadBeforeWriteMsg	Specifies diagnostic action to take when the model attempts to read data from a data store before it has stored data at the current time step. Set by the **Detect read before write** control on the **Diagnostics Data Validity** pane of the **Configuration Parameters** dialog box.	{'UseLocalSettings'} | 'DisableAll' | 'EnableAllAsWarning' | 'EnableAllAsError'

Model Parameters (Continued)

Parameter	Description	Values
RecordCoverage	A value of on causes Simulink to gather and report model coverage data during simulation. The format of this report is controlled by the values of the following parameters: CovCompData CovCumulativeReport CovCumulativeVarName CovHTMLOptions CovHTMLReporting CovMetricSettings CovNameIncrementing CovPath CovReportOnPause covSaveCumulativeToWorkSpace Var CovSaveName CovSaveSingleToWorkspaceVar If the value is off, no model coverage data is collected or reported and the preceding coverage report parameters have no effect.	'on' | {'off'}
Refine	Refine factor. Set by the **Refine factor** field on the **Data Import/Export** pane of the **Configuration Parameters** dialog box.	string {'1'}

Model Parameters (Continued)

Parameter	Description	Values
RelTol	Relative error tolerance. Set by the **Relative tolerance** field on the **Solver** pane of the **Configuration Parameters** dialog box.	string {'1e-3'}
ReportName	Name of the associated file for the Report Generator	string {'simulink-default.rpt'}
ReqHilite	Highlights all the blocks in the Simulink diagram that have requirements associated with them. Set by the **Highlight model** command on the **Tools->Requirements** menu.	'on' | {'off'}
RequirementInfo	For internal use.	
RootOutportRequire BusObject	Specifies diagnostic action to take when a bus enters a root model Outport block for which a bus object has not been specified. Set by the **Unspecified bus object at root Outport block** control on the **Connectivity Diagnostics** pane of the **Configuration Parameters** dialog box.	'none' | {'warning'} | 'error'
RTPrefix	Specifies diagnostic action to take when Simulink encounters an object name that begins with rt. Set by the **"rt" prefix for identifiers** control on the **Diagnostics Data Validity** pane of the **Configuration Parameters** dialog box.	'none' | 'warning' | {'error'}
RTW...	See the Real-Time Workshop documentation for more information on parameters whose names begin with RTW.	

Model Parameters (Continued)

Parameter	Description	Values
SampleTimeColors	Set by the Sample Time Colors option under the **Format > Port/Signal Displays** menu.	'on' | {'off'}
SampleTimeConstraint	Set by the Periodic Sample Time Constraint option on the **Configuration Parameters** dialog box. This option is displayed when the solver option type is Fixed-step	{'unconstrained'} | 'STIndependent' | 'Specified'
SavedCharacterEncoding	Specifies the character set used to encode this model. See the slCharacterEncoding command for more information.	string
SaveDefaultBlock Params	For internal use.	
SaveFinalState	Save final states to workspace. Set by the **Final states** check box on the **Data Import/Export** pane of the **Configuration Parameters** dialog box.	'on' | {'off'}
SaveFormat	Format used to save data to the MATLAB workspace. Set by the **Format** option on the **Data Import/Export** pane of the **Configuration Parameters** dialog box.	{'Array'} | 'Structure' | 'StructureWithTime'
SaveOutput	Save simulation output to workspace. Set by the **Output** check box on the **Data Import/Export** pane of the **Configuration Parameters** dialog box.	{'on'} | 'off'

Model Parameters (Continued)

Parameter	Description	Values
SaveState	Save states to workspace. Set by the **States** check box on the **Data Import/Export** pane of the **Configuration Parameters** dialog box.	'on' | {'off'}
SaveTime	Save simulation time to workspace. Set by the **Time** check box on the **Data Import/Export** pane of the **Configuration Parameters** dialog box.	{'on'} | 'off'
ScreenColor	Background color of the model window. Set by the Screen color option under the **Format** menu.	'black' | {'white'} | 'red' | 'green' | 'blue' | 'cyan' | 'magenta' | 'yellow' | 'gray' | 'lightBlue' | 'orange' | 'darkGreen' | [r,g,b,a] where r, g, b, and a are the red, green, blue, and alpha values of the color normalized to the range 0.0 to 1.0. The alpha value is ignored.
ScrollbarOffset	For internal use.	
SFcnCompatibilityMsg	See SfunCompatibilityCheckMsg parameter for more information.	

Model Parameters (Continued)

Parameter	Description	Values
SfunCompatibility CheckMsg	Specifies diagnostic action to take when S-function upgrades are needed. Set by the **S-function upgrades needed** option on the **Compatibility Diagnostics** pane of the **Configuration Parameters** dialog box.	{'none'} | 'warning' | 'error'
ShowGrid	Show the Model Editor grid.	'on' | {'off'}
ShowLinearization Annotations	Toggles linearization icons in the model.	{'on'} | 'off'
ShowLineDimensions	Show signal dimensions on this model's block diagram. Set by the **Signal Dimensions** command on the **Format->Port/Signal Displays** menu.	'on' | {'off'}
ShowLineDimensions OnError	For internal use.	
ShowLineWidths	Deprecated. Use ShowLineDimensions instead.	
ShowLoopsOnError	Highlight invalid loops graphically.	{'on'} | 'off'
ShowModelReference BlockIO	Toggles display of I/O mismatch on block. Set by the **Model Block I/O Mismatch** item on the **Format->Block Displays** menu.	'on' | {'off'}
ShowModelReference BlockVersion	Toggles display of version on block. Set by the **Model Block Version** item on the **Format->Block Displays** menu.	'on' | {'off'}
Shown	For internal use.	

Model Parameters (Continued)

Parameter	Description	Values
ShowPageBoundaries	Toggles display of page boundaries on the Model Editor's canvas. Set by the **Show Page Boundaries** command on the Model Editor's **View** menu.	'on' | {'off'}
ShowPortDataTypes	Show data types of ports on this model's block diagram. Set by the **Port Data Types** command on the **Format->Port/Signal Displays** menu.	'on' | {'off'}
ShowPortDataTypesOn Error	For internal use.	
ShowStorageClass	Show storage classes of signals on this model's block diagram. Set by the **Storage Class** command on the **Format->Port/Signal Displays** menu.	'on' | {'off'}
ShowTestPointIcons	Show test point icons on this model's block diagram. Set by the **Testpoint Indicators** command on the **Format->Port/Signal Displays** menu.	'on' | {'off'}
ShowViewerIcons	Show viewer icons on this model's block diagram. Set by the **Viewer Indicators** command on the **Format->Port/Signal Displays** menu.	'on' | {'off'}
SignalInfNanChecking	Specifies diagnostic action to take when the value of a block output is Inf or NaN at the current time step. Set by the **Inf or NaN block output** option on the **Diagnostics Data Validity** pane of the **Configuration Parameters** dialog box.	{'none'} | 'warning' | 'error'

Model Parameters (Continued)

Parameter	Description	Values
SignalLabelMismatch Msg	Specifies diagnostic action to take when there is a signal label mismatch. Set by the **Signal label mismatch** option on the **Connectivity Diagnostics** pane of the **Configuration Parameters** dialog box.	{'none'} | 'warning' | 'error'
SignalLogging	Globally enable signal logging for this model. Set by the **Signal logging** check box on the **Data Import/Export** pane of the **Configuration Parameters** dialog box.	{'on'} | 'off'
SignalLoggingName	Name for saving signal logging data to the MATLAB workspace. Set by the **Signal logging** field on the **Data Import/Export** pane of the **Configuration Parameters** dialog box.	string {'logsOut'}
SignalResolution Control	Control which named states and signals get resolved to Simulink signal objects. Set by the **Signal resolution** drop-down list on the **Diagnostics Data Validity** pane of the **Configuration Parameters** dialog box.	'UseLocalSettings' | 'TryResolveAll' | {'TryResolveAll-WithWarning'}

Model Parameters (Continued)

Parameter	Description	Values
SigSpecEnsureSample TimeMsg	Specifies diagnostic action to take when the sample time of the source port of a signal specified by a Signal Specification block differs from the signal's destination port. Set by the **Enforce sample times specified by Signal Specification blocks** control on the **Sample Time Diagnostics** pane of the **Configuration Parameters** dialog box.	'none' | {'warning'} | 'error'
SimulationCommand	Executes a simulation command.	'start' | 'stop' | 'pause' | 'continue' | 'step' | 'update' | 'SimParamDialog' | 'connect' | 'disconnect' | 'WriteExtModeParamVect' | 'AccelBuild'
SimulationMode	Indicates whether Simulink should run in normal, accelerated, or external mode.	{'normal'} | 'accelerator' | 'external'
SimulationStatus	Indicates simulation status.	{'stopped'} | 'updating' | 'initializing' | 'running' | 'paused' | 'terminating' | 'external' |
SimulationTime	Current time value for the simulation.	double {0}

Model Parameters (Continued)

Parameter	Description	Values
`SingleTaskRate TransMsg`	Specifies diagnostic action to take when a rate transition takes place between two blocks operating in single-tasking mode. Set by the **Single task rate transition** control on the **Sample Time Diagnostics** pane of the **Configuration Parameters** dialog box.	`{'none'}` | `'warning'` | `'error'`
`Solver`	Solver used for the simulation. Set by the **Solver** drop-down list on the **Solver** pane of the **Configuration Parameters** dialog box.	`'VariableStepDiscrete'` | `{'ode45'}` | `'ode23'` | `'ode113'` | `'ode15s'` | `'ode23s'` | `'ode23t'` | `'ode23tb'` | `'FixedStepDiscrete'` | `'ode5'` | `'ode4'` | `'ode3'` | `'ode2'` | `'ode1'` | `'ode14x'`
`SolverMode`	Solver mode for this model. Set by the **Tasking mode for periodic sample times** option on the **Solver** pane of the **Configuration Parameters** dialog box. This option is displayed when the solver option type is `Fixed-step`.	`{'Auto'}` | `'SingleTasking'` | `'MultiTasking'`
`SolverName`	Solver used for the simulation. See `Solver` parameter for more information.	

Model Parameters (Continued)

Parameter	Description	Values
SolverPrmCheckMsg	Enables diagnostics to control when Simulink automatically selects solver parameters. Set by the **Automatic solver parameter selection** option on the **Diagnostics** pane of the **Configuration Parameters** dialog box. This option notifies you if • Simulink changes a user-modified parameter to make it consistent with other model settings • Simulink automatically selects solver parameters for the model, such as **FixedStepSize**	'none' | {'warning'} | 'error'
SolverResetMethod	Set by the **Solver reset method** option on the **Solver** pane of the **Configuration Parameters** dialog box. This option is displayed when the solver option type is Variable-step and the solver is either ode15s (Stiff/NDF), ode23t (Mod. Stiff/Trapezoidal), or ode23tb (Stiff/TR-BDF2).	{'Fast'} | 'Robust'
SolverType	Solver type used for the simulation. Set by the **Type** drop-down list on the **Solver** pane of the **Configuration Parameters** dialog box.	{'Variable-step'} | 'Fixed-step'
SortedOrder	Show the sorted order of this model's blocks on the block diagram. Set by the **Sorted Order** command on the model editor's **Format->Block Displays** menu.	'on' | {'off'}

Model Parameters (Continued)

Parameter	Description	Values
StartFcn	Start simulation callback. Created on the **Callbacks** pane of the Model Properties dialog box. See "Creating Model Callback Functions" in the Using Simulink documentation for further information.	command or variable `{''}`
StartTime	Simulation start time. Set by the **Start time** field on the **Solver** pane of the **Configuration Parameters** dialog box.	string `{'0.0'}`
StateSaveName	State output name to be saved to workspace. Set by the **States** field on the **Data Import/Export** pane of the **Configuration Parameters** dialog box.	variable `{'xout'}`
StatusBar	Show/hide the status bar on the model editor window. Set by the **Status Bar** command on the model editor's **View** menu.	`{'on'}` | `'off'`
StopFcn	Stop simulation callback. Created on the **Callbacks** pane of the Model Properties dialog box. See "Creating Model Callback Functions" in the Using Simulink documentation for further information.	command or variable `{''}`
StopTime	Simulation stop time. Set by the **Stop time** field on the **Solver** pane of the **Configuration Parameters** dialog box.	string `{'10.0'}`

Model Parameters (Continued)

Parameter	Description	Values
StrictBusMsg	Specifies diagnostic action to take when Simulink detects buses created by Mux blocks. Set by the **Mux blocks used to create bus signals** control on the **Connectivity Diagnostics** pane of the **Configuration Parameters** dialog box.	{'None'} | 'Warning' | 'ErrorLevel1'
Tag	User-specified text that is assigned to the model's Tag parameter and saved with the model.	string {''}
TargetBitPerChar	Specifies the length in bits of the C char data type supported by the emulation hardware device type targeted by this model. Set by the **char** control in the **Emulation Hardware** panel of the **Hardware Implementation** pane of the **Configuration Parameters** dialog box.	integer {8}
TargetBitPerInt	Specifies the length in bits of the C int data type supported by the emulation hardware device type targeted by this model. Set by the **int** control in the **Emulation Hardware** panel of the **Hardware Implementation** pane of the **Configuration Parameters** dialog box.	integer {32}
TargetBitPerLong	Specifies the length in bits of the C long data type supported by the emulation hardware device type targeted by this model. Set by the **long** control in the **Emulation Hardware** panel of the **Hardware Implementation** pane of the **Configuration Parameters** dialog box.	integer {32}

Model Parameters (Continued)

Parameter	Description	Values
TargetBitPerShort	Specifies the length in bits of the C short data type supported by the emulation hardware device type targeted by this model. Set by the **short** control in the **Emulation Hardware** panel of the **Hardware Implementation** pane of the **Configuration Parameters** dialog box.	integer {16}
TargetEndianess	Specifies the significance of the first byte of a data word of the target hardware. Set by the **Byte ordering** control in the **Emulation Hardware** panel of the **Hardware Implementation** pane of the **Configuration Parameters** dialog box.	{'Unspecified'} | 'LittleEndian' | 'BigEndian'
TargetFcnLib	For internal use.	
TargetHWDeviceType	Specifies the characteristics of hardware used to emulate the production hardware. Set by the **Device type** control in the **Emulation Hardware** panel of the **Hardware Implementation** pane of the **Configuration Parameters** dialog box.	string {'32-bit Generic'}

Model Parameters (Continued)

Parameter	Description	Values
TargetIntDivRoundTo	Specifies how an ANSI C conforming compiler used to compile code for the emulation hardware targeted by this model rounds the result of dividing one signed integer by another to produce a signed integer quotient. Set by the **Signed integer division rounds to** control in the **Emulation Hardware** panel of the **Hardware Implementation** pane of the **Configuration Parameters** dialog box.	'Floor' | 'Zero' | {'Undefined'}
TargetShiftRight IntArith	Specifies whether the C compiler implements a signed integer right shift as an arithmetic right shift. Set by the **Shift right on a signed integer as arithmetic shift** control in the **Emulation Hardware** panel of the **Hardware Implementation** pane of the **Configuration Parameters** dialog box.	{'on'} | 'off'
TargetTypeEmulation WarnSuppressLevel	Specifies whether Real-Time Workshop displays or suppresses warning messages when emulating integer sizes in rapid prototyping environments.	integer {0}
TargetWordSize	Specifies the word length in bits of the emulation hardware device type targeted by this model. Set by the **native word size** control in the **Emulation Hardware** panel of the **Hardware Implementation** pane of the **Configuration Parameters** dialog box.	integer {32}

Model Parameters (Continued)

Parameter	Description	Values
TasksWithSame PriorityMsg	Specifies diagnostic action to take when tasks have equal priority. Set by the **Tasks with equal priority** control on the **Sample Time Diagnostics** pane of the **Configuration Parameters** dialog box.	`'none' | {'warning'} | 'error'`
TiledPageScale	Scales the size of the tiled page relative to the model.	string `{'1'}`
TiledPaperMargins	Controls the size of the margins associated with each tiled page. Each element in the vector represents a margin at the particular edge.	`[left, top, right, bottom]`
TimeSaveName	Simulation time name. Set by the **Time** field on the **Data Import/Export** pane of the **Configuration Parameters** dialog box.	variable `{'tout'}`
TLC...	Parameters whose names begin with TLC are used for code generation. See the Real-Time Workshop documentation for more information.	
Toolbar	Show/hide the toolbar on the Model Editor window. Set by the **Toolbar** command on the model editor's **View** menu.	`{'on'} | 'off'`
TryForcingSFcnDF	This flag is used for backward compatibility with user S-functions that were written prior to R12.	`'on' | {'off'}`
TunableVars	List of global (tunable) parameters. Set in the **Model Parameter Configuration** dialog box.	string `{''}`

Model Parameters (Continued)

Parameter	Description	Values
TunableVarsStorage Class	List of storage classes for their respective tunable parameters. Set in the **Model Parameter Configuration** dialog box.	string {''}
TunableVarsType Qualifier	List of storage type qualifiers for their respective tunable parameters. Set in the **Model Parameter Configuration** dialog box.	string {''}
Type	Simulink object type (read only).	'block_diagram'
UnconnectedInputMsg	Unconnected input ports diagnostic. Set by the **Unconnected block input ports** option on the **Connectivity Diagnostics** pane of the **Configuration Parameters** dialog box.	'none' | {'warning'} | 'error'
UnconnectedLineMsg	Unconnected lines diagnostic. Set by the **Unconnected line** option on the **Connectivity Diagnostics** pane of the **Configuration Parameters** dialog box.	'none' | {'warning'} | 'error'
UnconnectedOutputMsg	Unconnected block output ports diagnostic. Set by the **Unconnected block output ports** option on the **Connectivity Diagnostics** pane of the **Configuration Parameters** dialog box.	'none' | {'warning'} | 'error'
UnderSpecifiedData TypeMsg	Detect usage of heuristics to assign signal data types. Set by the **Underspecified data types** option on the **Diagnostics Data Validity** pane of the **Configuration Parameters** dialog box.	{'none'} | 'warning' | 'error'

Model Parameters (Continued)

Parameter	Description	Values
UniqueDataStoreMsg	Specifies diagnostic action to take when the model contains multiple Data Store Memory blocks that specify the same data store name. Set by the **Duplicate data store names** control on the **Diagnostics Data Validity** pane of the **Configuration Parameters** dialog box.	{'none'} | 'warning' | 'error'
UnknownTsInhSupMsg	Detect blocks that have not set whether they allow the model containing them to inherit a sample time. Set by the **Unspecified inheritability of sample time** option on the **Diagnostics** pane of the **Configuration Parameters** dialog box.	'none' | {'warning'} | 'error'
UnnecessaryDatatype ConvMsg	Detect unnecessary data type conversion blocks. Set by the **Unnecessary type conversions** option on the **Type Conversion Diagnostics** pane of the **Configuration Parameters** dialog box.	{'none'} | 'warning'

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Model Parameters (Continued)

Parameter	Description	Values
UpdateHistory	Specifies when to prompt the user about updating the model history. This is set by the **Prompt to update model history** parameter on the History pane of theModel Properties dialog box. See "Model History Panel" in the Using Simulink documentation for further information. This is also set by the **Prompt to update model history** option on lower right of the **History** pane of the **Model Explorer** dialog box.	{'UpdateHistoryNever'} | 'UpdateHistoryWhenSave'
UpdateModelReference Targets	Rebuilding options. Set on the **Model Referencing** pane of the **Configuration Parameters** dialog box.	'IfOutOfDate' | 'Force' | 'AssumeUpToDate' | {'IfOutOfDateOr Structural Change'}
UseAnalysisPorts	For internal use.	
VectorMatrix ConversionMsg	Detect vector-to-matrix or matrix-to-vector conversions. Set by the **Vector/matrix block input conversion** option on the **Type Conversion Diagnostics** pane of the **Configuration Parameters** dialog box.	{'none'} | 'warning' | 'error'
Version	Simulink version used to modify the model (read only).	release version number
WideLines	Draws lines that carry vector or matrix signals wider than lines that carry scalar signals. Set by the **Wide Nonscalar Lines** command on the model editor's **Format->Port/Signal Displays** menu.	'on' | {'off'}

Model Parameters (Continued)

Parameter	Description	Values
WideVectorLines	Deprecated. Use WideLines instead.	
WriteAfterReadMsg	Specifies diagnostic action to take when the model attempts to store data in a data store after previously reading data from it in the current time step. Set by the **Detect write after read** control on the **Diagnostics Data Validity** pane of the **Configuration Parameters** dialog box.	{'UseLocalSettings'} | 'DisableAll' | 'EnableAllAsWarning' | 'EnableAllAsError'
WriteAfterWriteMsg	Specifies diagnostic action to take when the model attempts to store data in a data store twice in succession in the current time step. Set by the **Detect write after write** control on the **Diagnostics Data Validity** pane of the **Configuration Parameters** dialog box.	{'UseLocalSettings'} | 'DisableAll' | 'EnableAllAsWarning' | 'EnableAllAsError'
ZeroCross	For internal use.	
ZeroCrossControl	Enable zero-crossing detection. Set by the **Zero crossing control** control on the **Solver** pane of the **Configuration Parameters** dialog box.	{'UseLocalSettings'} | 'EnableAll' | 'DisableAll'
ZoomFactor	Zoom factor of the model editor window expressed as a percentage of normal (100%) or by the keywords FitSystem or FitSelection. Set by the zoom commands on the model editor's **View** menu.	string {'100'} | 'FitSystem' | 'FitSelection'

Examples of Setting Model Parameters

These examples show how to set model parameters for the mymodel system.

This command sets the simulation start and stop times.

```
set_param('mymodel','StartTime','5','StopTime','100')
```

This command sets the solver to ode15s and changes the maximum order.

```
set_param('mymodel','Solver','ode15s','MaxOrder','3')
```

This command associates a SaveFcn callback.

```
set_param('mymodel','SaveFcn','my_save_cb')
```

Common Block Parameters

This table lists the parameters common to all Simulink blocks, including block callback parameters (see "Using Callback Functions"). Examples of commands that change these parameters follow this table (see "Examples of Setting Block Parameters" on page 10-65).

Common Block Parameters

Parameter	Description	Values
AncestorBlock	Name of the library block that the block is linked to (for blocks with a disabled link).	string
AttributesFormatString	String format specified for block annotations in the **Block Parameters** dialog box.	string
BackgroundColor	Block background color.	RGB value array string | [r,g,b,a] where r, g, b, and a are the red, green, blue, and alpha values of the color normalized to the range 0.0 to 1.0. The alpha value is ignored.
BlockDescription	Block description shown in the **Block Properties** dialog box.	string
BlockType	Block type (read only).	string
ClipboardFcn	Function called when block is copied to the clipboard (**Ctrl+C**)	string

Common Block Parameters (Continued)

Parameter	Description	Values
CloseFcn	Function called when close_system is run on block.	string
CompiledPort ComplexSignals	Complexity of port signals after updating diagram.	
CompiledPortData Types	Data types of port signals after updating diagram.	
CompiledPort Dimensions	Dimensions of port signals after updating diagram.	
CompiledPortFrame Data	Frame mode of port signals after updating diagram.	
CompiledPortWidths	Structure of port widths after updating diagram.	
CompiledSampleTime	Block sample time after updating diagram.	
CopyFcn	Function called when block is copied.	string
DataTypeOverride_ Compiled	For internal use.	
DeleteFcn	Function called when block is deleted.	MATLAB expression
DestroyFcn	Function called when block is destroyed.	MATLAB expression
Description	Description of block. Set by the **Description** field in the **General** pane of the **Block Properties** dialog box.	text and tokens
Diagnostics		text and tokens

Common Block Parameters (Continued)

Parameter	Description	Values
`DialogParameters`	Names/attributes of parameters in block's parameter dialog box.	structure
`DropShadow`	Display drop shadow.	`{'off'}` | `'on'`
`ExtModeUpload Option`		`{'none'}` | `'log'` | `'monitor'`
`ExtModeLogging Supported`		`{'off'}` | `'on'`
`ExtModeLogging Trig`		`{'off'}` | `'on'`
`FontAngle`	Font angle.	`'normal'` | `'italic'` | `'oblique'` | `{'auto'}`
`FontName`	Font.	string
`FontSize`	Font size. A value of -1 specifies that this block inherits the font size specified by the `DefaultBlockFontSize` model parameter.	real `{'-1'}`
`FontWeight`	Font weight.	`'light'` | `'normal'` | `'demi'` | `'bold'` | `{'auto'}`
`ForegroundColor`	Foreground color of block's icon.	string `{'black'}` | `[r,g,b,a]` where `r`, `g`, `b`, and `a` are the red, green, blue, and alpha values of the color normalized to the range 0.0 to 1.0. The alpha value is ignored.
`Handle`	Block handle.	real

Common Block Parameters (Continued)

Parameter	Description	Values
HiliteAncestors		{'none'} | 'error' | 'redWhite' | 'blueWhite' | 'greenWhite' | 'orangeWhite' | 'blackWhite' | 'find' | 'debug' | 'unique' | 'different' | 'lineTrace' | 'fade' | 'default' | 'user1' | 'user2' | 'user3' | 'user4' | 'user5'
InitFcn	Initialization function for a masked block. Created on the **Callbacks** pane of the Model Properties dialog box. See "Creating Model Callback Functions" in the Using Simulink documentation for further information.	MATLAB expression
InputSignalNames	Names of input signals.	cell array
IOSignalStrings		list
IOType		{'none'} | 'viewer' | 'siggen'
LineHandles	Handles of lines connected to block.	struct
LinkStatus	Link status of block.	{'none'} | 'resolved' | 'unresolved' | 'implicit' | 'inactive' | 'restore' | 'propagate'
LoadFcn	Function called when block is loaded.	MATLAB expression

Common Block Parameters (Continued)

Parameter	Description	Values
MinMaxOverflow Logging_Compiled	For internal use.	
ModelCloseFcn	Function called when model is closed.	MATLAB expression
ModelParamTable Info	For internal use.	
MoveFcn	Function called when block is moved.	MATLAB expression
Name	Block name.	string
NameChangeFcn	Function called when block name is changed.	MATLAB expression
NamePlacement	Position of block name.	{'normal'} | 'alternate'
ObjectParameters	Names/attributes of block's parameters.	structure
OpenFcn	Function called when this block's **Block Parameters** dialog box is opened.	MATLAB expression
Orientation	Where block faces.	{'right'} | 'left' | 'up' | 'down'
OutputSignalNames	Names of output signals.	cell array
Parent	Name of the system that owns the block.	string {'untitled'}
ParentCloseFcn	Function called when parent subsystem is closed.	MATLAB expression

Common Block Parameters (Continued)

Parameter	Description	Values

PortConnectivity	The value of this parameter is an array of structures, each of which describes one of the block's input or output ports. Each port structure has the following fields:
	
	• Type
	
	  Specifies the port's type and/or number. The value of this field can be:
	
	  ▪ *n*, where *n* is the number of the port for data ports
	
	  ▪ 'enable' if the port is an enable port
	
	  ▪ 'trigger' if the port is a trigger port
	
	  ▪ 'state' for state ports
	
	  ▪ 'ifaction' for action ports
	
	  ▪ 'LConn#' for a left connection port where # is the port's number
	
	  ▪ 'RConn#' for a right connection port where # is the port's number
	
	• Position
	
	  The value of this field is a two-element vector, [*x y*], that specifies the port's position.
		structure array

Common Block Parameters (Continued)

Parameter	Description	Values
	• `SrcBlock` Handle of the block connected to this port. This field is null for output ports. • `SrcPort` Number of the port connected to this port. This field is null for output ports. • `DstBlock` Handle of the block to which this port is connected. This field is null for input ports. • `DstPort` Number of the port to which this port is connected. This field is null for input ports.	

Common Block Parameters (Continued)

Parameter	Description	Values

PortHandles	The value of this parameter is a structure that specifies the handles of the block's ports. The structure has the following fields:
	
	• Inport
	
	  Handles of the block's input ports.
	
	• Outport
	
	  Handles of the block's output ports.
	
	• Enable
	
	  Handle of the block's enable port.
	
	• Trigger
	
	  Handle of the block's trigger port.
	
	• State
	
	  Handle of the block's state port.
	
	• LConn
	
	  Handles of the block's left connection ports.
	
	• RConn
	
	  Handles of the block's right connection ports.
	
	• Ifaction
	
	  Handle of the block's action port.
		structure array

Common Block Parameters (Continued)

Parameter	Description	Values
Ports	The value of this parameter is a vector that specifies the numbers of each kind of port. The order of the vector's elements corresponds to the following port types: • Inport • Outport • Enable • Trigger • State • LConn • RConn • Ifaction	vector
Position	Position of block in model window.	vector [left top right bottom] not enclosed in quotation marks. The maximum value for a coordinate is 32767.
PostSaveFcn	Function called after the block is saved. Created on the **Callbacks** pane of the Model Properties dialog box. See "Creating Model Callback Functions" in the Using Simulink documentation for further information.	MATLAB expression
PreSaveFcn	Function called before the block is saved.	MATLAB expression

Common Block Parameters (Continued)

Parameter	Description	Values
Priority	Specifies the block's order of execution relative to other blocks in the same model. Set by the **Priority** field on the **General** pane of the **Block Properties** dialog box.	string {''}
ReferenceBlock	Name of the library block that this block is linked to.	string {''}
RequirementInfo	For internal use.	
RTWData	User specified data, used by Real-Time Workshop.	
SampleTime	Value of the sample time parameter.	
Selected	Status of whether or not block is selected.	{'on'} | 'off'
ShowName	Display block name.	{'on'} | 'off'
StartFcn	Function called at the start of a simulation.	MATLAB expression
StatePerturbation ForJacobian	See the "Block Perturbation" in the Simulink Control Design documentation for details.	
StopFcn	Function called at the termination of a simulation.	MATLAB expression
Tag	Text that appears in the block label that Simulink generates. Set by the **Tag** field on the **General** pane of the **Block Properties** dialog box.	string {''}

Common Block Parameters (Continued)

Parameter	Description	Values
Type	Simulink object type (read only).	`'block'`
UndoDeleteFcn	Function called when block deletion is undone.	MATLAB expression
UserData	User-specified data that can have any MATLAB data type.	`{'[]'}`
UserDataPersistent	Status of whether or not UserData will be saved in the model file.	`'on'` | `{'off'}`

Examples of Setting Block Parameters

These examples illustrate how to change common block parameters.

This command changes the orientation of the Gain block in the `mymodel` system so it faces the opposite direction (right to left).

```
set_param('mymodel/Gain','Orientation','left')
```

This command associates an `OpenFcn` callback with the Gain block in the `mymodel` system.

```
set_param('mymodel/Gain','OpenFcn','my_open_cb')
```

This command sets the `Position` parameter of the Gain block in the `mymodel` system. The block is 75 pixels wide by 25 pixels high. The position vector is *not* enclosed in quotation marks.

```
set_param('mymodel/Gain','Position',[50 250 125 275])
```

Block-Specific Parameters

These tables list block-specific parameters for all Simulink blocks. The type of the block appears in parentheses after the block name. Some Simulink blocks are implemented as masked subsystems. The tables indicate masked blocks by adding the designation "masked" after the block type.

Note The type listed for nonmasked blocks is the value of the block's BlockType parameter; the type listed for masked blocks is the value of the block's MaskType parameter. For more information, see "Mask Parameters" on page 10-164.

The **Dialog Box Prompt** column indicates the text of the prompt for the parameter on the block's dialog box. The **Values** column shows the type of value required (scalar, vector, variable), the possible values (separated with a vertical line), and the default value (enclosed in braces).

Continuous Library Block Parameters

Block (Type)/Parameter	Dialog Box Prompt	Values
Derivative (Derivative)		
LinearizePole	Linearization Time Constant s/(Ns+1)	string {'inf'}
Integrator (Integrator)		
ExternalReset	External reset	{'none'} | 'rising' | 'falling' | 'either' | 'level'
InitialConditionSource	Initial condition source	{'internal'} | 'external'
InitialCondition	Initial condition	scalar or vector {'0'}
LimitOutput	Limit output	{'off'} | 'on'
UpperSaturationLimit	Upper saturation limit	scalar or vector {'inf'}
LowerSaturationLimit	Lower saturation limit	scalar or vector {'-inf'}

Continuous Library Block Parameters (Continued)

Block (Type)/Parameter	Dialog Box Prompt	Values
ShowSaturationPort	Show saturation port	{'off'} | 'on'
ShowStatePort	Show state port	{'off'} | 'on'
AbsoluteTolerance	Absolute tolerance	string {'auto'}
ZeroCross	Enable zero–crossing detection	'off' | {'on'}
State-Space (StateSpace)		
A	A	matrix {'1'}
B	B	matrix {'1'}
C	C	matrix {'1'}
D	D	matrix {'1'}
X0	Initial conditions	vector {'0'}
AbsoluteTolerance	Absolute tolerance	string {'auto'}
Transfer Fcn (TransferFcn)		
Numerator	Numerator	vector or matrix {'[1]'}
Denominator	Denominator	vector {'[1 1]'}
AbsoluteTolerance	Absolute tolerance	string {'auto'}
Transport Delay (TransportDelay)		
DelayTime	Time delay	scalar or vector {'1'}
InitialOutput	Initial output	scalar or vector {'0'}
BufferSize	Initial buffer size	scalar {'1024'}
FixedBuffer	Use fixed buffer size	{'off'} | 'on'
PadeOrder	Pade order (for linearization)	string {'0'}
TransDelayFeedthrough	Direct feedthrough of input during linearization	{'off'} | 'on'
Variable Time Delay (VariableTimeDelay)		

Continuous Library Block Parameters (Continued)

Block (Type)/Parameter	Dialog Box Prompt	Values
VariableDelayType	Select delay type	'Variable transport delay' | {'Variable time delay'}
MaximumDelay	Maximum delay	scalar or vector {'10'}
InitialOutput	Initial output	scalar or vector {'0'}
MaximumPoints	Initial buffer size	scalar {'1024'}
FixedBuffer	Use fixed buffer size	{'off'} | 'on'
ZeroDelay	Handle zero delay	{'off'} | 'on'
TransDelayFeedthrough	Direct feedthrough of input during linearization	{'off'} | 'on'
PadeOrder	Pade order (for linearization)	string {'0'}
Variable Transport Delay (VariableTransportDelay)		
VariableDelayType	Select delay type	{'Variable transport delay'} | 'Variable time delay'
MaximumDelay	Maximum delay	scalar or vector {'10'}
InitialOutput	Initial output	scalar or vector {'0'}
MaximumPoints	Initial buffer size	scalar {'1024'}
FixedBuffer	Use fixed buffer size	{'off'} | 'on'
PadeOrder	Pade order (for linearization)	string {'0'}
TransDelayFeedthrough	Direct feedthrough of input during linearization	{'off'} | 'on'
AbsoluteTolerance	Absolute tolerance	scalar {'auto'}
Zero-Pole (ZeroPole)		
Zeros	Zeros	vector {'[1]'}
Poles	Poles	vector {'[0 -1]'}

Continuous Library Block Parameters (Continued)

Block (Type)/Parameter	Dialog Box Prompt	Values
`Gain`	Gain	vector {`'[1]'`}
`AbsoluteTolerance`	Absolute tolerance	string {`'auto'`}

Discontinuities Library Block Parameters

Block (Type)/Parameter	Dialog Box Prompt	Values
Backlash (`Backlash`)		
`BacklashWidth`	Deadband width	scalar or vector {1}
`InitialOutput`	Initial output	scalar or vector {0}
`ZeroCross`	Enable zero crossing detection	`'off'` | {`'on'`}
`SampleTime`	Sample time (-1 for inherited)	string {`'-1'`}
Coulomb & Viscous Friction (`Coulombic and Viscous Friction`) (masked subsystem)		
`offset`	Coulomb friction value (Offset)	string {`'[1 3 2 0]'`}
`gain`	Coefficient of viscous friction (Gain)	string {`'1'`}
Dead Zone (`DeadZone`)		
`LowerValue`	Start of dead zone	scalar or vector {`-0.5`}
`UpperValue`	End of dead zone	scalar or vector {`0.5`}
`SaturateOnInteger Overflow`	Saturate on integer overflow	`'off'` | {`'on'`}
`LinearizeAsGain`	Treat as gain when linearizing	`'off'` | {`'on'`}
`ZeroCross`	Enable zero crossing detection	`'off'` | {`'on'`}
`SampleTime`	Sample time (-1 for inherited)	string {`'-1'`}
Dead Zone Dynamic (`Dead Zone Dynamic`) (masked subsystem)		
Hit Crossing (`HitCross`)		
`HitCrossingOffset`	Hit crossing offset	scalar or vector {`'0'`}

Discontinuities Library Block Parameters (Continued)

Block (Type)/Parameter	Dialog Box Prompt	Values
HitCrossingDirection	Hit crossing direction	`'rising' | 'falling' | {'either'}`
ShowOutputPort	Show output port	`{'on'} | 'off'`
ZeroCross	Enable zero crossing detection	`'off' | {'on'}`
SampleTime	Sample time (-1 for inherited)	`string {'-1'}`
Quantizer (Quantizer)		
QuantizationInterval	Quantization interval	`scalar or vector {'0.5'}`
LinearizeAsGain	Treat as gain when linearizing	`'off' | {'on'}`
SampleTime	Sample time (-1 for inherited)	`string {'-1'}`
Rate Limiter (RateLimiter)		
RisingSlewLimit	Rising slew rate	`string {'1'}`
FallingSlewLimit	Falling slew rate	`string {'-1'}`
SampleTimeMode	Sample time mode	`'continuous' | {'inherited'}`
InitialCondition	Initial condition	string {'0'}
LinearizeAsGain	Treat as gain when linearizing	`'off' | {'on'}`
Rate Limiter Dynamic (Rate Limiter Dynamic) (masked subsystem)		
Relay (Relay)		
OnSwitchValue	Switch on point	`string {'eps'}`
OffSwitchValue	Switch off point	`string {'eps'}`
OnOutputValue	Output when on	`string {'1'}`
OffOutputValue	Output when off	`string {'0'}`
OutputDataTypeScaling Mode	Output data type mode	`'Specify via dialog' | 'Inherit via back propagation' | {'All ports same datatype'}`

Discontinuities Library Block Parameters (Continued)

Block (Type)/Parameter	Dialog Box Prompt	Values
OutDataType	Output data type (e.g., sfix(16), uint(8), float('single'))	string {'sfix(16)'}
OutScaling	Output scaling value (Slope, e.g., 2^-9 or [Slope Bias], e.g., [1.25 3])	string {'2^0'}
ConRadixGroup	Parameter scaling mode	{'Use specified scaling'} | 'Best Precision: Vector-wise'
ZeroCross	Enable zero crossing detection	'off' | {'on'}
SampleTime	Sample time (-1 for inherited)	string {'-1'}
Saturation (Saturate)		
UpperLimit	Upper limit	scalar or vector {'0.5'}
LowerLimit	Lower limit	scalar or vector {'-0.5'}
LinearizeAsGain	Treat as gain when linearizing	'off' | {'on'}
ZeroCross	Enable zero crossing detection	'off' | {'on'}
SampleTime	Sample time (-1 for inherited)	string {'-1'}
Saturation Dynamic (Saturation Dynamic) (masked subsystem)		
Wrap To Zero (Wrap To Zero) (masked subsystem)		
Threshold	Threshold	string {'255'}

Discrete Library Block Parameters

Block (Type)/Parameter	Dialog Box Prompt	Values
Difference (Difference) (masked subsystem)		
ICPrevInput	Initial condition for previous input	string {'0.0'}

Discrete Library Block Parameters (Continued)

Block (Type)/Parameter	Dialog Box Prompt	Values
OutputDataTypeScaling Mode	Output data type and scaling	'Specify via dialog' | {'Inherit via internal rule'} | 'Inherit via back propagation'
OutDataType	Output data type: ex. sfix(16), uint(8), float('single')	string {'sfix(16)'}
OutScaling	Output scaling: Slope or [Slope Bias] ex. 2^-9	string {'2^-10'}
LockScale	Lock output scaling so autoscaling tool can't change it	{'off'} | 'on'
RndMeth	Round toward	'Zero' | 'Nearest' | 'Ceiling' | {'Floor'}
DoSatur	Saturate to max or min when overflows occur	{'off'} | 'on'
Discrete Derivative (Discrete Derivative) (masked subsystem)		
gainval	Gain value	string {'1.0'}
ICPrevScaledInput	Initial condition for previous weighted input K*u/Ts	string {'0.0'}
OutputDataTypeScaling Mode	Output data type and scaling	'Specify via dialog' | {'Inherit via internal rule'} | 'Inherit via back propagation'
OutDataType	Output data type: ex. sfix(16), uint(8), float('single')	string {'sfix(16)'}
OutScaling	Output scaling: Slope or [Slope Bias] ex. 2^-9	string {'2^-10'}
LockScale	Lock output scaling so autoscaling tool can't change it	{'off'} | 'on'
RndMeth	Round toward	'Zero' | 'Nearest' | 'Ceiling' | {'Floor'}

Discrete Library Block Parameters (Continued)

Block (Type)/Parameter	Dialog Box Prompt	Values
DoSatur	Saturate to max or min when overflows occur	{'off'} | 'on'
Discrete Filter (DiscreteFilter)		
Numerator	Numerator	vector {'[1]'}
Denominator	Denominator	vector {'[1 0.5]'}
SampleTime	Sample time (-1 for inherited)	string {'1'}
StateIdentifier	State name	string {}
StateMustResolveTo SignalObject	State name must resolve to Simulink signal object	{'off'} | 'on'
RTWStateStorageClass	RTW storage class	{'Auto'} | 'ExportedGlobal' | 'ImportedExtern' | 'ImportedExternPointer'
RTWStateStorageType Qualifier	RTW storage type qualifier	string {}
Discrete State-Space (DiscreteStateSpace)		
A	A	string {'1'}
B	B	string {'1'}
C	C	string {'1'}
D	D	string {'1'}
X0	Initial conditions	string {'0'}
SampleTime	Sample time	string {'1'}
StateIdentifier	State name	string {}
StateMustResolveTo SignalObject	State name must resolve to Simulink signal object	{'off'} | 'on'

Discrete Library Block Parameters (Continued)

Block (Type)/Parameter	Dialog Box Prompt	Values
RTWStateStorageClass	RTW storage class	{'Auto'} | 'ExportedGlobal' | 'ImportedExtern' | 'ImportedExternPointer'
RTWStateStorageType Qualifier	RTW storage type qualifier	string {}
Discrete Transfer Fcn (DiscreteTransferFcn)		
Numerator	Numerator	vector {'[1]'}
Denominator	Denominator	vector {'[1 0.5]'}
SampleTime	Sample time (-1 for inherited)	string {'1'}
StateIdentifier	State name	string {}
StateMustResolveTo SignalObject	State name must resolve to Simulink signal object	{'off'} | 'on'
RTWStateStorageClass	RTW storage class	{'Auto'} | 'ExportedGlobal' | 'ImportedExtern' | 'ImportedExternPointer'
RTWStateStorageType Qualifier	RTW storage type qualifier	string {}
Discrete Zero-Pole (DiscreteZeroPole)		
Zeros	Zeros	vector {'[1]'}
Poles	Poles	vector {'[0 0.5]'}
Gain	Gain	string {'1'}
SampleTime	Sample time (-1 for inherited)	string {'1'}
StateIdentifier	State name	string {}
StateMustResolveTo SignalObject	State name must resolve to Simulink signal object	{'off'} | 'on'

Discrete Library Block Parameters (Continued)

Block (Type)/Parameter	Dialog Box Prompt	Values
`RTWStateStorageClass`	RTW storage class	`{'Auto'} | 'ExportedGlobal' | 'ImportedExtern' | 'ImportedExternPointer'`
`RTWStateStorageType Qualifier`	RTW storage type qualifier	`string {}`
Discrete-Time Integrator (`DiscreteIntegrator`)		
`IntegratorMethod`	Integrator method	`{'Integration:  Forward Euler'} | 'Integration: Backward Euler' | 'Integration: Trapezoidal' | 'Accumulation:  Forward Euler' | 'Accumulation: Backward Euler' | 'Accumulation: Trapezoidal'`
`gainval`	Gain value	`string {'1.0'}`
`ExternalReset`	External reset	`{'none'} | 'rising' | 'falling' | 'either' | 'level'`
`InitialConditionSource`	Initial condition source	`{'internal'} | 'external'`
`InitialCondition`	Initial condition	`scalar or vector {'0'}`
`InitialConditionMode`	Use initial condition as initial and reset value for	`'State only (most efficient)' | {'State and output'}`
`SampleTime`	Sample time (-1 for inherited)	`string {'1'}`

Discrete Library Block Parameters (Continued)

Block (Type)/Parameter	Dialog Box Prompt	Values
OutDataTypeMode	Output data type mode	'double' | 'single' | 'int8' | 'uint8' | 'int16' | 'uint16' | 'int32' | 'uint32' | 'Specify via dialog' | {'Inherit via internal rule'} | 'Inherit via back propagation'
OutDataType	Output data type (e.g., sfix(16), uint(8), float('single'))	string {'sfix(16)'}
OutScaling	Output scaling value (Slope, e.g., 2^-9 or [Slope Bias], e.g., [1.25 3])	string {'2^0'}
LockScale	Lock output scaling against changes by the autoscaling tool	{'off'} | 'on'
RndMeth	Round integer calculations toward	'Zero' | 'Nearest' | 'Ceiling' | {'Floor'}
SaturateOnInteger Overflow	Saturate on integer overflow	{'off'} | 'on'
LimitOutput	Limit output	{'off'} | 'on'
UpperSaturationLimit	Upper saturation limit	scalar or vector {inf}
LowerSaturationLimit	Lower saturation limit	scalar or vector {-inf}
ShowSaturationPort	Show saturation port	{'off'} | 'on'
ShowStatePort	Show state port	{'off'} | 'on'
StateIdentifier	State name	string {}
StateMustResolveTo SignalObject	State name must resolve to Simulink signal object	{'off'} | 'on'

Discrete Library Block Parameters (Continued)

Block (Type)/Parameter	Dialog Box Prompt	Values
RTWStateStorageClass	RTW storage class	{'Auto'} | 'ExportedGlobal' | 'ImportedExtern' | 'ImportedExternPointer'
RTWStateStorageType Qualifier	RTW storage type qualifier	string {}
First-Order Hold (First-Order Hold) (masked subsystem)		
Ts	Sample time	string {'1'}
Integer Delay (S-Function) (Integer Delay) (masked subsystem)		
vinit	Initial condition	string {'0.0'}
samptime	Sample time	string {'-1'}
NumDelays	Number of delays	string {'4'}
Memory (Memory)		
X0	Initial condition	scalar or vector {'0'}
InheritSampleTime	Inherit sample time	{'off'} | 'on'
LinearizeMemory	Direct feedthrough of input during linearization	{'off'} | 'on'
StateIdentifier	State name	string {}
StateMustResolveTo SignalObject	State name must resolve to Simulink signal object	{'off'} | 'on'
RTWStateStorageClass	RTW storage class	{'Auto'} | 'ExportedGlobal' | 'ImportedExtern' | 'ImportedExternPointer'
RTWStateStorageType Qualifier	RTW storage type qualifier	string {}
Tapped Delay (S-Function) (Tapped Delay Line) (masked subsystem)		
vinit	Initial condition	string {'0.0'}

Discrete Library Block Parameters (Continued)

Block (Type)/Parameter	Dialog Box Prompt	Values
samptime	Sample time	string {'-1'}
NumDelays	Number of delays	string {'4'}
DelayOrder	Order output vector starting with	{'Oldest'} | 'Newest'
includeCurrent	Include current input in output vector	{'off'} | 'on'
Transfer Fcn (First Order Transfer Fcn) (masked subsystem)		
PoleZ	Pole (in Z plane)	string {'0.95'}
ICPrevOutput	Initial condition for previous output	string {'0.0'}
RndMeth	Round toward	'Zero' | 'Nearest' | 'Ceiling' | {'Floor'}
DoSatur	Saturate to max or min when overflows occur	{'off'} | 'on'
Transfer Fcn Lead or Lag (Lead or Lag Compensator) (masked subsystem)		
PoleZ	Pole of compensator (in Z plane)	string {'0.95'}
ZeroZ	Zero of compensator (in Z plane)	string {'0.75'}
ICPrevOutput	Initial condition for previous output	string {'0.0'}
ICPrevInput	Initial condition for previous input	string {'0.0'}
RndMeth	Round toward	'Zero' | 'Nearest' | 'Ceiling' | {'Floor'}
DoSatur	Saturate to max or min when overflows occur	{'off'} | 'on'
Transfer Fcn Real Zero (Transfer Fcn Real Zero) (masked subsystem)		

Discrete Library Block Parameters (Continued)

Block (Type)/Parameter	Dialog Box Prompt	Values
ZeroZ	Zero (in Z plane)	string {'0.75'}
ICPrevInput	Initial condition for previous input	string {'0.0'}
RndMeth	Round toward	'Zero' | 'Nearest' | 'Ceiling' | {'Floor'}
DoSatur	Saturate to max or min when overflows occur	{'off'} | 'on'
Unit Delay (UnitDelay)		
X0	Initial condition	scalar or vector {'0'}
SampleTime	Sample time (-1 for inherited)	string {'1'}
StateIdentifier	State name	string {}
StateMustResolveTo SignalObject	State name must resolve to Simulink signal object	{'off'} | 'on'
RTWStateStorageClass	RTW storage class	{'Auto'} | 'ExportedGlobal' | 'ImportedExtern' | 'ImportedExternPointer'
RTWStateStorageType Qualifier	RTW storage type qualifier	string {}
Weighted Moving Average (S-Function) (Weighted Moving Average) (masked subsystem)		
mgainval	Weights	string {'[0.1:0.1:1 0.9:-0.1:0.1]'}
vinit	Initial condition	string {'0.0'}
samptime	Sample time	string {'-1'}
GainDataTypeScalingMode	Gain data type and scaling	'Specify via dialog' | {'Inherit via internal rule'}
GainDataType	Parameter data type: ex. sfix(16), uint(8), float('single')	string {'sfix(16)'}

Discrete Library Block Parameters (Continued)

Block (Type)/Parameter	Dialog Box Prompt	Values
MatRadixGroup	Parameter scaling mode	'Use Specified Scaling' | 'Best Precision: Element-wise' | 'Best Precision: Row-wise' | 'Best Precision: Column-wise' | {'Best Precision: Matrix-wise'}
GainScaling	Parameter scaling: Slope ex. 2^-9	string {'2^-10'}
OutputDataTypeScaling Mode	Output data type and scaling	'Specify via dialog' | {'Inherit via internal rule'} | 'Inherit via back propagation'
OutDataType	Output data type: ex. sfix(16), uint(8), float ('single')	string {'sfix(16)'}
OutScaling	Output scaling: Slope or [Slope Bias] ex. 2^-9	string {'2^-10'}
LockScale	Lock output scaling so autoscaling tool can't change it	{'off'} | 'on'
RndMeth	Round toward	'Zero' | 'Nearest' | 'Ceiling' | {'Floor'}
DoSatur	Saturate to max or min when overflows occur	{'off'} | 'on'

Discrete Library Block Parameters (Continued)

Block (Type)/Parameter	Dialog Box Prompt	Values
Zero-Order Hold (`ZeroOrderHold`)		
SampleTime	Sample time (-1 for inherited)	string {'1'}

Logic and Bit Operations Library Block Parameters

Block (Type)/Parameter	Dialog Box Prompt	Values
Bit Clear (`Bit Clear`) (masked subsystem)		
iBit	Index of bit (0 is least significant)	string {'0'}
Bit Set (`Bit Set`) (masked subsystem)		
iBit	Index of bit (0 is least significant)	string {'0'}
Bitwise Operator (S-Function) (`Bitwise Operator`) (masked subsystem)		
logicop	Operator	{'AND'} | 'OR' | 'NAND' | 'NOR' | 'XOR' | 'NOT'
UseBitMask	Use bit mask ...	'off' | {'on'}
NumInputPorts	Number of input ports	string {'1'}
BitMask	Bit mask	string {'bin2dec('11011001')'}
BitMaskRealWorld	Treat mask as	'Real World Value' | {'Stored Integer'}
Combinatorial Logic (`CombinatorialLogic`)		
TruthTable	Truth table	string {'[0 0;0 1;0 1;1 0;0 1;1 0;1 0;1 1]'}
SampleTime	Sample time (-1 for inherited	string {'-1'}
Compare To Constant (`Compare To Constant`) (masked subsystem)		
relop	Operator	'==' | '~=' | '<' | {'<='} | '>=' | '>'

Logic and Bit Operations Library Block Parameters (Continued)

Block (Type)/Parameter	Dialog Box Prompt	Values
const	Constant value	string {'3.0'}
LogicOutDataTypeMode	Output data type mode	{'uint8'} | 'boolean'
ZeroCross	Enable zero crossing detection	{'off'} | 'on'
Compare To Zero (Compare To Zero) (masked subsystem)		
relop	Operator	'==' | '~=' | '<' | {'<='} | '>=' | '>'
LogicOutDataTypeMode	Output data type mode	{'uint8'} | 'boolean'
ZeroCross	Enable zero crossing detection	{'off'} | 'on'
Detect Change (Detect Change) (masked subsystem)		
vinit	Initial condition	string {'0'}
Detect Decrease (Detect Decrease) (masked subsystem)		
vinit	Initial condition	string {'0.0'}
Detect Fall Negative (Detect Fall Negative) (masked subsystem)		
vinit	Initial condition	string {'0'}
Detect Fall Nonpositive (Detect Fall Nonpositive) (masked subsystem)		
vinit	Initial condition	string {'0'}
Detect Increase (Detect Increase) (masked subsystem)		
vinit	Initial condition	string {'0.0'}
Detect Rise Nonnegative (Detect Rise Nonnegative) (masked subsystem)		
vinit	Initial condition	string {'0'}
Detect Rise Positive (Detect Rise Positive) (masked subsystem)		
vinit	Initial condition	string {'0'}
Extract Bits (Extract Bits) (masked subsystem)		

Logic and Bit Operations Library Block Parameters (Continued)

Block (Type)/Parameter	Dialog Box Prompt	Values
`bitsToExtract`	Bits to extract	`{'Upper half'}	'Lower half'	'Range starting with most	significant bit'	'Range ending with least significant bit'	'Range of bits'`
`numBits`	Number of bits	`string {'8'}`
`bitIdxRange`	Bit indices ([start end], 0-based relative to LSB)	`string {'[0 7]'}`
`outScalingMode`	Output scaling mode	`{'Preserve fixed-point scaling'}	'Treat bit field as an integer'`
Interval Test (`Interval Test`) (masked subsystem)		
`IntervalClosedRight`	Interval closed on right	`'off'	{'on'}`
`uplimit`	Upper limit	`string {'0.5'}`
`IntervalClosedLeft`	Interval closed on left	`'off'	{'on'}`
`lowlimit`	Lower limit	`string {'-0.5'}`
`LogicOutDataTypeMode`	Output data type mode	`'uint8'	{'boolean'}`
Interval Test Dynamic (`Interval Test Dynamic`) (masked subsystem)		
`IntervalClosedRight`	Interval closed on right	`'off'	{'on'}`
`IntervalClosedLeft`	Interval closed on left	`'off'	{'on'}`
`LogicOutDataTypeMode`	Output data type mode	`'uint8'	{'boolean'}`
Logical Operator (`Logic`)		
`Operator`	Operator	`{'AND'}	'OR'	'NAND'	'NOR'	'XOR'	'NOT'`
`IconShape`	Shape of the block icon	`{'rectangular'}	'distinctive'`
`Inputs`	Number of input ports	`string {'2'}`

Logic and Bit Operations Library Block Parameters (Continued)

Block (Type)/Parameter	Dialog Box Prompt	Values
`AllPortsSameDT`	Require all inputs and output to have same data type	`{'off'}` | `'on'`
`OutDataTypeMode`	Output data type mode	`{'Boolean'}` | `'Logical (see Advanced Sim. Parameters)'` | `'Specify via dialog'`
`LogicDataType`	Output data type (e.g., uint(8), sint(32))	string `{'uint(8)'}`
`SampleTime`	Sample time (-1 for inherited)	string `{'-1'}`
Relational Operator (`RelationalOperator`)		
`Operator`	Relational Operator	'==' | '~=' | '<' | {'<='} | '>=' | '>'
`InputSameDT`	Require all inputs to have same data type	`{'off'}` | `'on'`
`LogicOutDataTypeMode`	Output data type mode	`'uint8'` | `{'boolean'}`
`LogicDataType`	Output data type (e.g., uint(8), sint(32))	string `{'uint(8)'}`
`ZeroCross`	Enable zero crossing detection	`'off'` | `{'on'}`
`SampleTime`	Sample time (-1 for inherited)	string `{'-1'}`
Shift Arithmetic (`Shift Arithmetic`) (masked subsystem)		
`nBitShiftRight`	Number of bits to shift right (use negative value to shift left)	string `{'0'}`
`nBinPtShiftRight`	Number of places by which binary point shifts right (use negative value to shift left)	string `{'0'}`

Lookup Tables Block Parameters

Block (Type)/Parameter	Dialog Box Prompt	Values
Cosine (Cosine) `(masked subsystem)`		
Formula	Output formula	`'sin(2*pi*u)'` | `{'cos(2*pi*u)'}` | `'exp(j*2*pi*u)'` | `'sin(2*pi*u) and cos(2*pi*u)'`
NumDataPoints	Number of data points for lookup table	string `{'(2^5)+1'}`
OutputWordLength	Output word length	string `{'16'}`
Direct Lookup Table (n-D) (S-Function) `(LookupNDDirect)` (masked subsystem)		
maskTabDims	Number of table dimensions	`'1'` | `{'2'}` | `'3'` | `'4'` | `'More...'`
explicitNumDims	Explicit number of table dimensions	string `{'1'}`
outDims	Inputs select this object from table	`{'Element'}` | `'Column'` | `'2-D Matrix'`
tabIsInput	Make table an input	`{'off'}` | `'on'`
mxTable	Table data	string `{'[4 5 6;16 19 20;10 18 23]'}`
clipFlag	Action for out of range input	`'None'` | `{'Warning'}` | `'Error'`
Interpolation (n-D) using PreLookup `(LookupNDInterpIdx)` (masked subsystem)		
numDimsPopupSelect	Number of table dimensions	`'1'` | `{'2'}` | `'3'` | `'4'` | `'More...'`
explicitNumDims	Explicit number of table dimensions	string `{'2'}`
table	Table data	string `{'sqrt([1:10]'*[1:10])'}`
interpMethod	Interpolation method	'None - Flat' | `{'Linear'}`
extrapMethod	Extrapolation method	`'None - Flat'` | `{'Linear'}`

Lookup Tables Block Parameters (Continued)

Block (Type)/Parameter	Dialog Box Prompt	Values
rangeErrorMode	Action for out of range input	{'None'} | 'Warning' | 'Error' | 'Error - No index checking in generated code' | 'Warning - No index checking in generated code' | 'None - No index checking in generated code'
NumSelectionDims	Number of sub-table selection dimensions	string {'0'}
Lookup Table (Lookup)		
InputValues	Vector of input values	vector {'[-5:5]'}
OutputValues	Table data	vector {'tanh([-5:5])'}
LookUpMeth	Look-up method	{'Interpolation-Extrapolation'} | 'Interpolation-Use End Values' | 'Use Input Nearest' | 'Use Input Below' | 'Use Input Above'
OutDataTypeMode	Output data type mode	'double' | 'single' | 'int8' | 'uint8' | 'int16' | 'uint16' | 'int32' | 'uint32' | 'Specify via dialog' | 'Inherit via back propagation' | {'Same as input'}
OutDataType	Output data type (e.g., sfix(16), uint(8), float('single'))	string {'sfix(16)'}
OutScaling	Output scaling value (Slope, e.g., 2^-9 or [Slope Bias], e.g., [1.25 3])	string {'2^0'}

Lookup Tables Block Parameters (Continued)

Block (Type)/Parameter	Dialog Box Prompt	Values
LockScale	Lock output scaling against changes by the autoscaling tool	{'off'} | 'on'
RndMeth	Round integer calculations toward	'Zero' | 'Nearest' | 'Ceiling' | {'Floor'}
SaturateOnInteger Overflow	Saturate on integer overflow	{'off'} | 'on'
SampleTime	Sample time (-1 for inherited)	string {'-1'}
Lookup Table (2-D) (Lookup2D)		
RowIndex	Row index input values	string {'[1:3]'}
ColumnIndex	Column index input values	string {'[1:3]'}
OutputValues	Table data	string {'[4 5 6;16 19 20;10 18 23]'}
LookUpMeth	Look-up method	{'Interpolation-Extrapolation'} | 'Interpolation-Use End Values' | 'Use Input Nearest' | 'Use Input Below' | 'Use Input Above'
InputSameDT	Require all inputs to have same data type	'on' | {'off'}
OutDataTypeMode	Output data type mode	'double' | 'single' | 'int8' | 'uint8' | 'int16' | 'uint16' | 'int32' | 'uint32' | 'Specify via dialog' | 'Inherit via back propagation' | {'Same as first input'}
OutDataType	Output data type (e.g., sfix(16), uint(8), float ('single'))	string {'sfix(16)'}

Lookup Tables Block Parameters (Continued)

Block (Type)/Parameter	Dialog Box Prompt	Values
OutScaling	Output scaling value (Slope, e.g., 2^-9 or [Slope Bias], e.g., [1.25 3])	string {'2^0'}
LockScale	Lock output scaling against changes by the autoscaling tool	'on' | {'off'}
RndMeth	Round integer calculations toward	'Zero' | 'Nearest' | 'Ceiling' | {'Floor'}
SaturateOnInteger Overflow	Saturate on integer overflow	'on' | {'off'}
SampleTime	Sample time (-1 for inherited)	string {'-1'}
Lookup Table (n-D) (LookupNDInterp) (masked subsystem)		
numDimsPopupSelect	Number of table dimensions	' 1 ' | {' 2 '} | ' 3 ' | ' 4 ' | 'More...'
bp1	First input (row) breakpoint set	string {'[10,22,31]'}
bp2	Second (column) input breakpoint set	string {'[10,22,31]'}
bp3	Third input breakpoint set	string {'[1:3]'}
bp4	Fourth input breakpoint set	string {'[1:3]'}
bpcell	Fifth...Nth breakpoint sets (cell array)	string {'{ [1:3], [1:3] }'}
explicitNumDims	Explicit number of dimensions	string {'2'}
searchMode	Index search method	'Evenly Spaced Points' | 'Linear Search' | {'Binary Search'}

Lookup Tables Block Parameters (Continued)

Block (Type)/Parameter	Dialog Box Prompt	Values
`cacheBpFlag`	Begin index searches using previous index results	`'on'` | `{'off'}`
`vectorInputFlag`	Use one (vector) input port instead of N ports	`'on'` | `{'off'}`
`tableData`	Table data	string `{'[4 5 6;16 19 20;10 18 23]'}`
`interpMethod`	Interpolation method	`'None - Flat'` | `{'Linear'}` | `'Cubic Spline'`
`extrapMethod`	Extrapolation method	`'None - Clip'` | `{'Linear'}` | `'Cubic Spline'`
`rangeErrorMode`	Action for out of range input	`{'None'}` | `'Warning'` | `'Error'`
Lookup Table Dynamic (`Lookup Table Dynamic`) (masked subsystem)		
`LookUpMeth`	Look-Up Method	`'Interpolation-Extrapolation'` | `{'Interpolation-Use End Values'}` | `'Use Input Nearest'` | `'Use Input Below'` | `'Use Input Above'`
`OutputDataTypeScaling Mode`	Output data type and scaling	`{'Specify via dialog'}` | `'Inherit via back propagation'`
`OutDataType`	Output data type: ex. sfix(16), uint(8), float (`'single'`)	string `{'float('double')'}`
`OutScaling`	Output scaling: Slope or [Slope Bias] ex. 2^-9	string `{'2^-10'}`
`LockScale`	Lock output scaling so autoscaling tool can't change it	`'on'` | `{'off'}`
`RndMeth`	Round toward	`'Zero'` | `'Nearest'` | `'Ceiling'` | `{'Floor'}`

Lookup Tables Block Parameters (Continued)

Block (Type)/Parameter	Dialog Box Prompt	Values
DoSatur	Saturate to max or min when overflows occur	`'on'` | `{'off'}`
PreLookup Index Search (`LookupIdxSearch`) (masked subsystem)		
bpData	Breakpoint data	string `{'[10:10:100]'}`
searchMode	Index search method	`'Evenly Spaced Points'` | `'Linear Search'` | `{'Binary Search'}`
cacheBpFlag	Begin index search using previous index result	`'on'` | `{'off'}`
outputFlag	Output only the index	`'on'` | `{'off'}`
IndexDataType	Index data type	`{'uint32'}` | `'int32'`
extrapMode	Process out of range input	`'Clip to Range'` | `{'Linear Extrapolation'}`
rangeErrorMode	Action for out of range input	`{'None'}` | `'Warning'` | `'Error'`
Sine (`Sine`) (masked subsystem)		
Formula	Output formula	`{'sin(2*pi*u)'}` | `'cos(2*pi*u)'` | `'exp(j*2*pi*u)'` | `'sin(2*pi*u) and cos(2*pi*u)'`
NumDataPoints	Number of data points for lookup table	string `{'(2^5)+1'}`
OutputWordLength	Output word length	string `{'16'}`

Math Operations Library Block Parameters

Block (Type)/Parameter	Dialog Box Prompt	Values
Abs (`Abs`)		

Math Operations Library Block Parameters (Continued)

Block (Type)/Parameter	Dialog Box Prompt	Values
SaturateOnInteger Overflow	Saturate on integer overflow	`'on' | {'off'}`
ZeroCross	Enable zero crossing detection	`{'on'} | 'off'`
SampleTime	Sample time (-1 for inherited)	`string {'-1'}`
Add (Sum)		
IconShape	Icon shape	`{'rectangular'} | 'round'`
Inputs	List of signs	`string {'++'}`
InputSameDT	Require all inputs to have same data type	`'on' | {'off'}`
OutDataTypeMode	Output data type mode	`'double' | 'single' | 'int8' | 'uint8' | 'int16' | 'uint16' | 'int32' | 'uint32' | 'Specify via dialog' | {'Inherit via internal rule'} | 'Inherit via back propagation' | 'Same as first input'`
OutDataType	Output data type (e.g., sfix(16), uint(8), float ('single'))	`string {'sfix(16)'}`
OutScaling	Output scaling value (Slope, e.g., 2^-9 or [Slope Bias], e.g., [1.25 3])	`string {'2^-10'}`
LockScale	Lock output scaling against changes by the autoscaling tool	`'on' | {'off'}`
RndMeth	Round integer calculations toward	`'Zero' | 'Nearest' | 'Ceiling' | {'Floor'}`
SaturateOnInteger Overflow	Saturate on integer overflow	`'on' | {'off'}`

Math Operations Library Block Parameters (Continued)

Block (Type)/Parameter	Dialog Box Prompt	Values
SampleTime	Sample time (-1 for inherited)	string {'-1'}
Algebraic Constraint (Algebraic Constraint) (masked subsystem)		
z0	Initial guess	string {'0'}
Assignment (Assignment)		
InputType	Input type	{'Vector'} | 'Matrix'
IndexMode	Index mode	'Zero-based' | {'One-based'}
IndexIsStartValue	Use index as starting value	'on' | {'off'}
ElementSrc	Source of element indices (E)	{'Internal'} | 'External'
Elements	Elements (-1 for all elements)	string {'1'}
RowSrc	Source of row indices (R)	{'Internal'} | 'External'
Rows	Rows (-1 for all rows)	string {'1'}
ColumnSrc	Source of column indices (C)	{'Internal'} | 'External'
Columns	Columns (-1 for all columns)	string {'1'}
OutputInitialize	Output (Y)	'Initialize using input (U1)' | 'Specify required dimensions'
OutputDimensions	Output dimensions	string {'[1 1]'}
DiagnosticForDimensions	Diagnostic if not all required dimensions are populated	{'Error'} | 'Warning' | 'None'
SampleTime	Sample time (-1 for inherited)	string {'-1'}
Bias (Bias)		
Bias	Bias	string {'0.0'}
SaturateOnInteger Overflow	Saturate on integer overflow	'on' | {'off'}
Complex to Magnitude-Angle (ComplexToMagnitudeAngle)		

Math Operations Library Block Parameters (Continued)

Block (Type)/Parameter	Dialog Box Prompt	Values
Output	Output	`'Magnitude' | 'Angle' | {'Magnitude and angle'}`
SampleTime	Sample time (-1 for inherited)	string `{'-1'}`
Complex to Real-Imag (`ComplexToRealImag`)		
Output	Output	`'Real' | 'Imag' | {'Real and imag'}`
SampleTime	Sample time (-1 for inherited)	string `{'-1'}`
Divide (`Product`)		
Inputs	Number of inputs	string `{'*/'}`
Multiplication	Multiplication	`{'Element-wise(.*)'} | 'Matrix(*)'`
InputSameDT	Require all inputs to have same data type	`'on' | {'off'}`
OutDataTypeMode	Output data type mode	`'double' | 'single' | 'int8' | 'uint8' | 'int16' | 'uint16' | 'int32' | 'uint32' | 'Specify via dialog' | {'Inherit via internal rule'} | 'Inherit via back propagation' | 'Same as first input'`
OutDataType	Output data type (e.g., sfix(16), uint(8), float('single'))	string `{'sfix(16)'}`
OutScaling	Output scaling value (Slope, e.g., 2^-9 or [Slope Bias], e.g., [1.25 3])	string `{'2^-10'}`
LockScale	Lock output scaling against changes by the autoscaling tool	`'on' | {'off'}`

Math Operations Library Block Parameters (Continued)

Block (Type)/Parameter	Dialog Box Prompt	Values
RndMeth	Round integer calculations toward	`'Zero'` | `'Nearest'` | `'Ceiling'` | `{'Floor'}`
SaturateOnInteger Overflow	Saturate on integer overflow	`'on'` | `{'off'}`
SampleTime	Sample time (-1 for inherited)	string `{'-1'}`
Dot Product (`Dot Product`) (masked subsystem)		
InputSameDT	Require all inputs to have same data type	`'on'` | `{'off'}`
OutputDataTypeScaling Mode	Output data type mode	`'Specify via dialog'` | `{'Inherit via internal rule'}` | `'Inherit via back propagation'` | `'Same as first input'`
OutDataType	Output data type (e.g., sfix(16), uint(8), float(`'single'`))	string `{'sfix(16)'}`
OutScaling	Output scaling (Slope, e.g., 2^-9 or [Slope Bias], e.g., [1.25 3])	string `{'2^-10'}`
LockScale	Lock output scaling against changes by the autoscaling tool	`'on'` | `{'off'}`
RndMeth	Round integer calculation toward	`'Zero'` | `'Nearest'` | `'Ceiling'` | `{'Floor'}`
DoSatur	Saturate on integer overflow	`'on'` | `{'off'}`
Gain (`Gain`)		
Gain	Gain	string `{'1'}`
Multiplication	Multiplication	`{'Element-wise(K.*u)'}` | `'Matrix(K*u)'` | `'Matrix(u*K)'` | `'Matrix(K*u) (u vector)'`

Math Operations Library Block Parameters (Continued)

Block (Type)/Parameter	Dialog Box Prompt	Values
ParameterDataTypeMode	Parameter data type mode	`'Specify via dialog'` | `{'Inherit via internal rule'}` | `'Same as input'`
ParameterDataType	Parameter data type (e.g., sfix(16), uint(8), float (`'single'`))	string `{'sfix(16)'}`
ParameterScalingMode	Parameter scaling mode	`'Use specified scaling'` | `'Best Precision: Element-wise'` | `'Best Precision:  Row-wise'` | `'Best Precision: Column-wise'` | `{'Best Precision:  Matrix-wise'}`
ParameterScaling	Parameter scaling (Slope or [Slope Bias], e.g., 2^-9)	string `{'2^0'}`
OutDataTypeMode	Output data type mode	`'Specify via dialog'` | `{'Inherit via internal rule'}` | `'Inherit via back propagation'` | `'Same as input'`
OutDataType	Output data type (e.g., sfix(16), uint(8), float (`'single'`))	string `{'sfix(16)'}`
OutScaling	Output scaling value (Slope, e.g., 2^-9 or [Slope Bias], e.g., [1.25 3])	string `{'2^0'}`
LockScale	Lock output scaling against changes by the autoscaling tool	`'on'` | `{'off'}`
RndMeth	Round integer calculations toward	`'Zero'` | `'Nearest'` | `'Ceiling'` | `{'Floor'}`
SaturateOnInteger Overflow	Saturate on integer overflow	`'on'` | `{'off'}`

Math Operations Library Block Parameters (Continued)

Block (Type)/Parameter	Dialog Box Prompt	Values
SampleTime	Sample time (-1 for inherited)	string {'-1'}
Magnitude-Angle to Complex (MagnitudeAngleToComplex)		
Input	Input	'Magnitude' | 'Angle' | {'Magnitude and angle'}
ConstantPart		string {'0'}
SampleTime	Sample time (-1 for inherited)	string {'-1'}
Math Function (Math)		
Operator	Function	{'exp'} | 'log' | '10^u' | 'log10' | 'magnitude^2' | 'square' | 'sqrt' | 'pow' | 'conj' | 'reciprocal' | 'hypot' | 'rem' | 'mod' | 'transpose' | 'hermitian'
OutputSignalType	Output signal type	{'auto'} | 'real' | 'complex'
SampleTime	Sample time (-1 for inherited)	string {'-1'}
OutDataTypeMode	Output data type mode	'double' | 'single' | 'int8' | 'uint8' | 'int16' | 'uint16' | 'int32' | 'uint32' | 'Specify via dialog' | 'Inherit via internal rule' | 'Inherit via back propagation' | {'Same as first input'}
OutDataType	Output data type (e.g., sfix(16), uint(8), float ('single'))	string {'sfix(16)'}
OutScaling	Output scaling value (Slope, e.g., 2^-9 or [Slope Bias], e.g., [1.25 3])	string {'2^0'}

Math Operations Library Block Parameters (Continued)

Block (Type)/Parameter	Dialog Box Prompt	Values
LockScale	Lock output scaling against changes by the autoscaling tool	`'on'` | `{'off'}`
RndMeth	Round integer calculations toward	`'Zero'` | `'Nearest'` | `'Ceiling'` | `{'Floor'}`
SaturateOnInteger Overflow	Saturate on integer overflow	`{'on'}` | `'off'`
Matrix Concatenate (`Concatenate`)		
NumInputs	Number of inputs	string `{'2'}`
Mode	Mode	`'Vector concatenation'` | `{'Horizontal matrix concatenation'}` | `'Vertical matrix concatenation'`
MinMax (`MinMax`)		
Function	Function	`{'min'}` | `'max'`
Inputs	Number of input ports	string `{'1'}`
InputSameDT	Require all inputs to have same data type	`'on'` | `{'off'}`
OutDataTypeMode	Output data type mode	`'double'` | `'single'` | `'int8'` | `'uint8'` | `'int16'` | `'uint16'` | `'int32'` | `'uint32'` | `'Specify via dialog'` | `{'Inherit via internal rule'}` | `'Inherit via back propagation'`
OutDataType	Output data type (e.g., sfix(16), uint(8), float('single'))	string `{'sfix(16)'}`

Math Operations Library Block Parameters (Continued)

Block (Type)/Parameter	Dialog Box Prompt	Values
OutScaling	Output scaling value (Slope, e.g., 2^-9 or [Slope Bias], e.g., [1.25 3])	string {'2^0'}
LockScale	Lock output scaling against changes by the autoscaling tool	'on' | {'off'}
RndMeth	Round integer calculations toward	'Zero' | 'Nearest' | 'Ceiling' | {'Floor'}
SaturateOnInteger Overflow	Saturate on integer overflow	'on' | {'off'}
ZeroCross	Enable zero crossing detection	{'on'} | 'off'
SampleTime	Sample time (-1 for inherited)	string {'-1'}
MinMax Running Resettable (MinMax Running Resettable) (masked subsystem)		
Function	Function	{'min'} | 'max'
vinit	Initial condition	string {'0.0'}
Polynomial (Polyval) (masked subsystem)		
coefs	Polynomial coefficients	string {'[+2.081618890e-019, -1.441693666e-014, +4.719686976e-010, -8.536869453e-006, +1.621573104e-001, -8.087801117e+001]'}
Product (Product)		
Inputs	Number of inputs	string {'2'}
Multiplication	Multiplication	{'Element-wise(.*)'} | 'Matrix(*)'
InputSameDT	Require all inputs to have same data type	'on' | {'off'}

Math Operations Library Block Parameters (Continued)

Block (Type)/Parameter	Dialog Box Prompt	Values
OutDataTypeMode	Output data type mode	'double' | 'single' | 'int8' | 'uint8' | 'int16' | 'uint16' | 'int32' | 'uint32' | 'Specify via dialog' | {'Inherit via internal rule'} | 'Inherit via back propagation' | 'Same as first input'
OutDataType	Output data type (e.g., sfix(16), uint(8), float('single'))	string {'sfix(16)'}
OutScaling	Output scaling value (Slope, e.g., 2^-9 or [Slope Bias], e.g., [1.25 3])	string {'2^0'}
LockScale	Lock output scaling against changes by the autoscaling tool	'on' | {'off'}
RndMeth	Round integer calculations toward	{'Zero'} | 'Nearest' | 'Ceiling' | 'Floor'
SaturateOnInteger Overflow	Saturate on integer overflow	'on' | {'off'}
SampleTime	Sample time (-1 for inherited)	string {'-1'}
Product of Elements (Product)		
Inputs	Number of inputs	string {'*'}
Multiplication	Multiplication	{'Element-wise(.*)'} | 'Matrix(*)'
InputSameDT	Require all inputs to have same data type	'on' | {'off'}

Math Operations Library Block Parameters (Continued)

Block (Type)/Parameter	Dialog Box Prompt	Values
OutDataTypeMode	Output data type mode	`'double'` | `'single'` | `'int8'` | `'uint8'` | `'int16'` | `'uint16'` | `'int32'` | `'uint32'` | `'Specify via dialog'` | `{'Inherit via internal rule'}` | `'Inherit via back propagation'` | `'Same as first input'`
OutDataType	Output data type (e.g., sfix(16), uint(8), float('single'))	string `{'sfix(16)'}`
OutScaling	Output scaling value (Slope, e.g., 2^-9 or [Slope Bias], e.g., [1.25 3])	string `{'2^-10'}`
LockScale	Lock output scaling against changes by the autoscaling tool	`'on'` | `{'off'}`
RndMeth	Round integer calculations toward	`'Zero'` | `'Nearest'` | `'Ceiling'` | `{'Floor'}`
SaturateOnInteger Overflow	Saturate on integer overflow	`'on'` | `{'off'}`
SampleTime	Sample time (-1 for inherited)	string `{'-1'}`
Real-Imag to Complex (`RealImagToComplex`)		
Input	Input	`'Real'` | `'Imag'` | `{'Real and imag'}`
ConstantPart		string `{'0'}`
SampleTime	Sample time (-1 for inherited)	string `{'-1'}`
Reshape (`Reshape`) (masked subsystem)		
OutputDimensionality	Output dimensionality	`{'1-D array'}` | `'Column vector'` | `'Row vector'` | `'Customize'`

Math Operations Library Block Parameters (Continued)

Block (Type)/Parameter	Dialog Box Prompt	Values
OutputDimensions	Output dimensions	string {'[1,1]'}
Rounding Function (Rounding)		
Operator	Function	{'floor'} | 'ceil' | 'round' | 'fix'
SampleTime	Sample time (-1 for inherited)	string {'-1'}
Sign (Signum)		
ZeroCross	Enable zero crossing detection	{'on'} | 'off'
SampleTime	Sample time (-1 for inherited)	string {'-1'}
Sine Wave Function (Sin)		
SineType	Sine type	{'Time based'} | 'Sample based'
TimeSource	Time (t)	'Use simulation time' | {'Use external signal'}
Amplitude	Amplitude	string {'1'}
Bias	Bias	string {'0'}
Frequency	Frequency (rad/sec)	string {'1'}
Phase	Phase (rad)	string {'0'}
Samples	Samples per period	string {'10'}
Offset	Number of offset samples	string {'0'}
SampleTime	Sample time	string {'0'}
VectorParams1D	Interpret vector parameters as 1-D	{'on'} | 'off'
Slider Gain (Slider Gain) (masked subsystem)		
low	Low	string {'0'}
gain	Gain	string {'1'}
high	High	string {'2'}

Math Operations Library Block Parameters (Continued)

Block (Type)/Parameter	Dialog Box Prompt	Values
Subtract (Sum)		
IconShape	Icon shape	{'rectangular'} | 'round'
Inputs	List of signs	string {'+-'}
InputSameDT	Require all inputs to have same data type	'on' | {'off'}
OutDataTypeMode	Output data type mode	'double' | 'single' | 'int8' | 'uint8' | 'int16' | 'uint16' | 'int32' | 'uint32' | 'Specify via dialog' | {'Inherit via internal rule'} | 'Inherit via back propagation' | 'Same as first input'
OutDataType	Output data type (e.g., sfix(16), uint(8), float('single'))	string {'sfix(16)'}
OutScaling	Output scaling value (Slope, e.g., 2^-9 or [Slope Bias], e.g., [1.25 3])	string {'2^-10'}
LockScale	Lock output scaling against changes by the autoscaling tool	'on' | {'off'}
RndMeth	Round integer calculations toward	'Zero' | 'Nearest' | 'Ceiling' | {'Floor'}
SaturateOnInteger Overflow	Saturate on integer overflow	'on' | {'off'}
SampleTime	Sample time (-1 for inherited)	string {'-1'}
Sum (Sum)		
IconShape	Icon shape	'rectangular' | {'round'}
Inputs	List of signs	string {'|++'}

Math Operations Library Block Parameters (Continued)

Block (Type)/Parameter	Dialog Box Prompt	Values
InputSameDT	Require all inputs to have same data type	`'on'` | `{'off'}`
OutDataTypeMode	Output data type mode	`'double'` | `'single'` | `'int8'` | `'uint8'` | `'int16'` | `'uint16'` | `'int32'` | `'uint32'` | `'Specify via dialog'` | `{'Inherit via internal rule'}` | `'Inherit via back propagation'` | `'Same as first input'`
OutDataType	Output data type (e.g., sfix(16), uint(8), float('single'))	string `{'sfix(16)'}`
OutScaling	Output scaling value (Slope, e.g., 2^-9 or [Slope Bias], e.g., [1.25 3])	string `{'2^0'}`
LockScale	Lock output scaling against changes by the autoscaling tool	`'on'` | `{'off'}`
RndMeth	Round integer calculations toward	`'Zero'` | `'Nearest'` | `'Ceiling'` | `{'Floor'}`
SaturateOnInteger Overflow	Saturate on integer overflow	`'on'` | `{'off'}`
SampleTime	Sample time (-1 for inherited)	string `{'-1'}`
Sum of Elements (Sum)		
IconShape	Icon shape	`{'rectangular'}` | `'round'`
Inputs	List of signs	string `{'+'}`
InputSameDT	Require all inputs to have same data type	`'on'` | `{'off'}`

Math Operations Library Block Parameters (Continued)

Block (Type)/Parameter	Dialog Box Prompt	Values
OutDataTypeMode	Output data type mode	'double' | 'single' | 'int8' | 'uint8' | 'int16' | 'uint16' | 'int32' | 'uint32' | 'Specify via dialog' | {'Inherit via internal rule'} | 'Inherit via back propagation' | 'Same as first input'
OutDataType	Output data type (e.g., sfix(16), uint(8), float('single'))	string {'sfix(16)'}
OutScaling	Output scaling value (Slope, e.g., 2^-9 or [Slope Bias], e.g., [1.25 3])	string {'2^-10'}
LockScale	Lock output scaling against changes by the autoscaling tool	'on' | {'off'}
RndMeth	Round integer calculations toward	'Zero' | 'Nearest' | 'Ceiling' | {'Floor'}
SaturateOnInteger Overflow	Saturate on integer overflow	'on' | {'off'}
SampleTime	Sample time (-1 for inherited)	string {'-1'}
Trigonometric Function (Trigonometry)		
Operator	Function	{'sin'} | 'cos' | 'tan' | 'asin' | 'acos' | 'atan' | 'atan2' | 'sinh' | 'cosh' | 'tanh' | 'asinh' | 'acosh' | 'atanh'
OutputSignalType	Output signal type	{'auto'} | 'real' | 'complex'
SampleTime	Sample time (-1 for inherited)	string {'-1'}

Math Operations Library Block Parameters (Continued)

Block (Type)/Parameter	Dialog Box Prompt	Values
Unary Minus (Unary Minus) `(masked subsystem)`		
`DoSatur`	Saturate to max or min when overflows occur	`'on'	{'off'}`
Vector Concatenate (`Concatenate`)		
`NumInputs`	Number of inputs	`string {'2'}`
`Mode`	Mode	`{'Vector concatenation'}	'Horizontal matrix concatenation'	'Vertical matrix concatenation'`
Weighted Sample Time Math (`Sample Time Math`) `(masked subsystem)`		
`TsampMathOp`	Operation	`{'+'}	'-'	'*'	'/'	'Ts Only'	'1/Ts Only'`
`weightValue`	Weight value	`string {'1.0'}`
`TsampMathImp`	Implement using	`{'Online Calculations'}	'Offline Scaling Adjustment'`
`OutputDataTypeScaling Mode`	Output data type and scaling	`{'Inherit via internal rule'}	'Inherit via back propagation'`
`RndMeth`	Round toward	`'Zero'	'Nearest'	'Ceiling'	{'Floor'}`
`DoSatur`	Saturate to max or min when overflows occur	`'on'	{'off'}`

Model Verification Library Block Parameters

Block (Type)/Parameter	Dialog Box Prompt	Values
Assertion (`Assertion`)		
`Enabled`	Enable assertion	`{'on'}	'off'`

Model Verification Library Block Parameters (Continued)

Block (Type)/Parameter	Dialog Box Prompt	Values
AssertionFailFcn	Simulation callback when assertion fails	string {''}
StopWhenAssertionFail	Stop simulation when assertion fails	{'on'} | 'off'
SampleTime	Sample time (-1 for inherited)	string {'-1'}
Check Discrete Gradient (Checks_Gradient) (masked subsystem)		
gradient	Maximum gradient	string {'1'}
enabled	Enable assertion	{'on'} | 'off'
callback	Simulation callback when assertion fails (optional)	string {''}
stopWhenAssertionFail	Stop simulation when assertion fails	{'on'} | 'off'
export	Output assertion signal	'on' | {'off'}
icon	Select icon type	{'graphic'} | 'text'
Check Dynamic Gap (Checks_DGap) (masked subsystem)		
enabled	Enable assertion	{'on'} | 'off'
callback	Simulation callback when assertion fails (optional)	string {''}
stopWhenAssertionFail	Stop simulation when assertion fails	{'on'} | 'off'
export	Output assertion signal	'on' | {'off'}
icon	Select icon type	{'graphic'} | 'text'
Check Dynamic Lower Bound (Checks_DMin) (masked subsystem)		
Enabled	Enable assertion	{'on'} | 'off'
callback	Simulation callback when assertion fails (optional)	string {''}

Model Verification Library Block Parameters (Continued)

Block (Type)/Parameter	Dialog Box Prompt	Values
stopWhenAssertionFail	Stop simulation when assertion fails	{'on'} | 'off'
export	Output assertion signal	'on' | {'off'}
icon	Select icon type	{'graphic'} | 'text'
Check Dynamic Range (Checks_DRange) (masked subsystem)		
enabled	Enable assertion	{'on'} | 'off'
callback	Simulation callback when assertion fails (optional)	string {''}
stopWhenAssertionFail	Stop simulation when assertion fails	{'on'} | 'off'
export	Output assertion signal	'on' | {'off'}
icon	Select icon type	{'graphic'} | 'text'
Check Dynamic Upper Bound (Checks_DMax) (masked subsystem)		
enabled	Enable assertion	{'on'} | 'off'
callback	Simulation callback when assertion fails (optional)	string {''}
stopWhenAssertionFail	Stop simulation when assertion fails	{'on'} | 'off'
export	Output assertion signal	'on' | {'off'}
icon	Select icon type	{'graphic'} | 'text'
Check Input Resolution (Checks_Resolution) (masked subsystem)		
resolution	Resolution	string {'1'}
enabled	Enable assertion	{'on'} | 'off'
callback	Simulation callback when assertion fails (optional)	string {''}
stopWhenAssertionFail	Stop simulation when assertion fails	{'on'} | 'off'

Model Verification Library Block Parameters (Continued)

Block (Type)/Parameter	Dialog Box Prompt	Values
export	Output assertion signal	`'on'	{'off'}`
Check Static Gap (`Checks_SGap`) (masked subsystem)		
max	Upper bound	string `{'100'}`
max_included	Inclusive upper bound	`{'on'}	'off'`
min	Lower bound	string `{'0'}`
min_included	Inclusive lower bound	`{'on'}	'off'`
enabled	Enable assertion	`{'on'}	'off'`
callback	Simulation callback when assertion fails (optional)	string `{''}`
stopWhenAssertionFail	Stop simulation when assertion fails	`{'on'}	'off'`
export	Output assertion signal	`'on'	{'off'}`
icon	Select icon type	`{'graphic'}	'text'`
Check Static Lower Bound (`Checks_SMin`) (masked subsystem)		
min	Lower bound	string `{'0'}`
min_included	Inclusive boundary	`{'on'}	'off'`
enabled	Enable assertion	`{'on'}	'off'`
callback	Simulation callback when assertion fails (optional)	string `{''}`
stopWhenAssertionFail	Stop simulation when assertion fails	`{'on'}	'off'`
export	Output assertion signal	`'on'	{'off'}`
icon	Select icon type	`{'graphic'}	'text'`
Check Static Range (`Checks_SRange`) (masked subsystem)		
max	Upper bound	string `{'100'}`
max_included	Inclusive upper bound	`{'on'}	'off'`

Model Verification Library Block Parameters (Continued)

Block (Type)/Parameter	Dialog Box Prompt	Values
min	Lower bound	string {'0'}
min_included	Inclusive lower bound	{'on'} | 'off'
enabled	Enable assertion	{'on'} | 'off'
callback	Simulation callback when assertion fails (optional)	string {''}
stopWhenAssertionFail	Stop simulation when assertion fails	{'on'} | 'off'
export	Output assertion signal	'on' | {'off'}
icon	Select icon type	{'graphic'} | 'text'
Check Static Upper Bound (Checks_SMax) (masked subsystem)		
max	Upper bound	string {'0'}
max_included	Inclusive boundary	{'on'} | 'off'
enabled	Enable assertion	{'on'} | 'off'
callback	Simulation callback when assertion fails (optional)	string {''}
stopWhenAssertionFail	Stop simulation when assertion fails	{'on'} | 'off'
export	Output assertion signal	'on' | {'off'}
icon	Select icon type	{'graphic'} | 'text'

Model-Wide Utilities Library Block Parameters

Block (Type)/Parameter	Dialog Box Prompt	Values
Block Support Table (Block Support Table) (masked subsystem)		
DocBlock (DocBlock) (masked subsystem)		
ECoderFlag	RTW Embedded Coder Flag	string {''}
DocumentType	Document Type	{'Text'} | 'RTF' | 'HTML'

Model-Wide Utilities Library Block Parameters (Continued)

Block (Type)/Parameter	Dialog Box Prompt	Values
Model Info (CMBlock) (masked subsystem)		
InitialSaveTempField	InitialSaveTempField	string {''}
InitialBlockCM	InitialBlockCM	string {'None'}
BlockCM	BlockCM	string {'None'}
Frame	Show block frame	string {'on'}
SaveTempField	SaveTempField	string {''}
DisplayStringWithTags	DisplayStringWithTags	string {'Model Info'}
MaskDisplayString	MaskDisplayString	string {'Model Info'}
HorizontalTextAlignment	Horizontal text alignment	string {'Center'}
LeftAlignmentValue	LeftAlignmentValue	string {'0.5'}
SourceBlockDiagram	SourceBlockDiagram	string {'untitled'}
TagMaxNumber	TagMaxNumber	string {'20'}
CMTag1	CMTag1	string {''}
CMTag2	CMTag2	string {''}
CMTag3	CMTag3	string {''}
CMTag4	CMTag4	string {''}
CMTag5	CMTag5	string {''}
CMTag6	CMTag6	string {''}
CMTag7	CMTag7	string {''}
CMTag8	CMTag8	string {''}
CMTag9	CMTag9	string {''}
CMTag10	CMTag10	string {''}
CMTag11	CMTag11	string {''}
CMTag12	CMTag12	string {''}
CMTag13	CMTag13	string {''}

Model-Wide Utilities Library Block Parameters (Continued)

Block (Type)/Parameter	Dialog Box Prompt	Values
CMTag14	CMTag14	string {''}
CMTag15	CMTag15	string {''}
CMTag16	CMTag16	string {''}
CMTag17	CMTag17	string {''}
CMTag18	CMTag18	string {''}
CMTag19	CMTag19	string {''}
CMTag20	CMTag20	string {''}
Timed-Based Linearization (`Timed Linearization`) (masked subsystem)		
LinearizationTime	Linearization time	string {'1'}
SampleTime	Sample time (of linearized model)	string {'0'}
Trigger-Based Linearization (`Triggered Linearization`) (masked subsystem)		
TriggerType	Trigger type	{'rising'} | 'falling' | 'either' | 'function-call'
SampleTime	Sample time (of linearized model)	string {'0'}

Ports & Subsystems Library Block Parameters

Block (Type)/Parameter	Dialog Box Prompt	Values
Configurable Subsystem (`SubSystem`)		
ShowPortLabels	Show port labels	{'on'} | 'off'
BlockChoice	Block choice	{''}
TemplateBlock	Template block	string {'self'}
MemberBlocks	Member blocks	string {''}

Ports & Subsystems Library Block Parameters (Continued)

Block (Type)/Parameter	Dialog Box Prompt	Values

`Permissions`	Read/Write permissions	`{'ReadWrite'}`
		`| 'ReadOnly' |`
		`'NoReadOrWrite'`

`ErrorFcn`	Name of error callback function	`string {''}`

`PermitHierarchical`
`Resolution`
	Permit hierarchical resolution	`{'All'} |`
		`'ParametersOnly' |`
		`'None'`

`TreatAsAtomicUnit`	Treat as atomic unit	`'on' | {'off'}`
`MinAlgLoopOccurrences`	Minimize algebraic loop occurrences	`'on' | {'off'}`
`PropExecContext` `OutsideSubsystem`	Propagate execution context across subsystem boundary	`{'on'} | 'off'`
`CheckFcnCallInp` `InsideContextMsg`	Warn if function-call inputs are context-specific	`'on' | {'off'}`
`SystemSampleTime`	Sample time (-1 for inherited)	`string {'-1'}`

`RTWSystemCode`	Real-Time Workshop system code	`{'Auto'} | 'Inline' |`
		`'Function' | 'Reusable`
		`function'`

`RTWFcnNameOpts`	Real-Time Workshop function name options	`{'Auto'} | 'Use subsystem` `name' | 'User specified'`
`RTWFcnName`	Real-Time Workshop function name	`string {''}`

`RTWFileNameOpts`	Real-Time Workshop filename options	`{'Auto'} | 'Use subsystem`
		`name' | 'Use function`
		`name' | 'User specified'`

`RTWFileName`	Real-Time Workshop filename (no extension)	`string {''}`

Ports & Subsystems Library Block Parameters (Continued)

Block (Type)/Parameter	Dialog Box Prompt	Values
`DataTypeOverride`		`{'UseLocalSettings'}` `| 'ScaledDoubles'` `| 'TrueDoubles' |` `'TrueSingles' |` `'ForceOff'`
`MinMaxOverflowLogging`		`{'UseLocalSettings'}` `| 'MinMaxAndOverflow'` `| 'OverflowOnly' |` `'ForceOff'`
Atomic Subsystem (`SubSystem`)		
`ShowPortLabels`	Show port labels	`{'on'} | 'off'`
`BlockChoice`	Block choice	`{''}`
`TemplateBlock`	Template block	string `{''}`
`MemberBlocks`	Member blocks	string `{''}`
`Permissions`	Read/Write permissions	`{'ReadWrite'}` `| 'ReadOnly' |` `'NoReadOrWrite'`
`ErrorFcn`	Name of error callback function	string `{''}`
`PermitHierarchical Resolution`	Permit hierarchical resolution	`{'All'} |` `'ParametersOnly' |` `'None'`
`TreatAsAtomicUnit`	Treat as atomic unit	`{'on'} | 'off'`
`MinAlgLoopOccurrences`	Minimize algebraic loop occurrences	`'on' | {'off'}`
`PropExecContext OutsideSubsystem`	Propagate execution context across subsystem boundary	`{'on'} | 'off'`
`CheckFcnCallInp InsideContextMsg`	Warn if function-call inputs are context-specific	`'on' | {'off'}`
`SystemSampleTime`	Sample time (-1 for inherited)	string `{'-1'}`

Ports & Subsystems Library Block Parameters (Continued)

Block (Type)/Parameter	Dialog Box Prompt	Values
RTWSystemCode	Real-Time Workshop system code	{'Auto'} | 'Inline' | 'Function' | 'Reusable function'
RTWFcnNameOpts	Real-Time Workshop function name options	{'Auto'} | 'Use subsystem name' | 'User specified'
RTWFcnName	Real-Time Workshop function name	string {''}
RTWFileNameOpts	Real-Time Workshop filename options	{'Auto'} | 'Use subsystem name' | 'Use function name' | 'User specified'
RTWFileName	Real-Time Workshop filename (no extension)	string {''}
DataTypeOverride		{'UseLocalSettings'} | 'ScaledDoubles' | 'TrueDoubles' | 'TrueSingles' | 'ForceOff'
MinMaxOverflowLogging		{'UseLocalSettings'} | 'MinMaxAndOverflow' | 'OverflowOnly' | 'ForceOff'
Code Reuse Subsystem (SubSystem)		
ShowPortLabels	Show port labels	{'on'} | 'off'
BlockChoice	Block choice	{''}
TemplateBlock	Template block	string {''}
MemberBlocks	Member blocks	string {''}
Permissions	Read/Write permissions	{'ReadWrite'} | 'ReadOnly' | 'NoReadOrWrite'

Ports & Subsystems Library Block Parameters (Continued)

Block (Type)/Parameter	Dialog Box Prompt	Values
ErrorFcn	Name of error callback function	string {''}
PermitHierarchical Resolution	Permit hierarchical resolution	{'All'} | 'ParametersOnly' | 'None'
TreatAsAtomicUnit	Treat as atomic unit	{'on'} | 'off'
MinAlgLoopOccurrences	Minimize algebraic loop occurrences	'on' | {'off'}
PropExecContext OutsideSubsystem	Propagate execution context across subsystem boundary	{'on'} | 'off'
CheckFcnCallInp InsideContextMsg	Warn if function-call inputs are context-specific	'on' | {'off'}
SystemSampleTime	Sample time (-1 for inherited)	string {'-1'}
RTWSystemCode	Real-Time Workshop system code	'Auto' | 'Inline' | 'Function' | {'Reusable function'}
RTWFcnNameOpts	Real-Time Workshop function name options	'Auto' | {'Use subsystem name'} | 'User specified'
RTWFcnName	Real-Time Workshop function name	string {''}
RTWFileNameOpts	Real-Time Workshop filename options	'Auto' | 'Use subsystem name' | {'Use function name'} | 'User specified'
RTWFileName	Real-Time Workshop filename (no extension)	string {''}
DataTypeOverride		{'UseLocalSettings'} | 'ScaledDoubles' | 'TrueDoubles' | 'TrueSingles' | 'ForceOff'

Ports & Subsystems Library Block Parameters (Continued)

Block (Type)/Parameter	Dialog Box Prompt	Values
`MinMaxOverflowLogging`		`{'UseLocalSettings'}` `| 'MinMaxAndOverflow'` `| 'OverflowOnly' |` `'ForceOff'`
Enable (`EnablePort`)		
`StatesWhenEnabling`	States when enabling	`{'held'}	'reset'`
`ShowOutputPort`	Show output port	`'on'	{'off'}`
`ZeroCross`	Enable zero crossing detection	`{'on'}	'off'`
Enabled and Triggered Subsystem (`SubSystem`)		
`ShowPortLabels`	Show port labels	`{'on'}	'off'`
`BlockChoice`	Block choice	`{''}`
`TemplateBlock`	Template block	`string {''}`
`MemberBlocks`	Member blocks	`string {''}`
`Permissions`	Read/Write permissions	`{'ReadWrite'}` `| 'ReadOnly' |` `'NoReadOrWrite'`
`ErrorFcn`	Name of error callback function	`string {''}`
`PermitHierarchical Resolution`	Permit hierarchical resolution	`{'All'} |` `'ParametersOnly' |` `'None'`
`TreatAsAtomicUnit`	Treat as atomic unit	`{'on'}	'off'`
`MinAlgLoopOccurrences`	Minimize algebraic loop occurrences	`'on'	{'off'}`
`PropExecContext OutsideSubsystem`	Propagate execution context across subsystem boundary	`{'on'}	'off'`
`CheckFcnCallInp InsideContextMsg`	Warn if function-call inputs are context-specific	`'on'	{'off'}`

Ports & Subsystems Library Block Parameters (Continued)

Block (Type)/Parameter	Dialog Box Prompt	Values
SystemSampleTime	Sample time (-1 for inherited)	string {'-1'}
RTWSystemCode	Real-Time Workshop system code	{'Auto'} | 'Inline' | 'Function' | 'Reusable function'
RTWFcnNameOpts	Real-Time Workshop function name options	{'Auto'} | 'Use subsystem name' | 'User specified'
RTWFcnName	Real-Time Workshop function name	string {''}
RTWFileNameOpts	Real-Time Workshop filename options	{'Auto'} | 'Use subsystem name' | 'Use function name' | 'User specified'
RTWFileName	Real-Time Workshop filename (no extension)	string {''}
DataTypeOverride		{'UseLocalSettings'} | 'ScaledDoubles' | 'TrueDoubles' | 'TrueSingles' | 'ForceOff'
MinMaxOverflowLogging		{'UseLocalSettings'} | 'MinMaxAndOverflow' | 'OverflowOnly' | 'ForceOff'
EnabledSubsystem (SubSystem)		
ShowPortLabels	Show port labels	{'on'} | 'off'
BlockChoice	Block choice	{''}
TemplateBlock	Template block	string {''}
MemberBlocks	Member blocks	string {''}
Permissions	Read/Write permissions	{'ReadWrite'} | 'ReadOnly' | 'NoReadOrWrite'

Ports & Subsystems Library Block Parameters (Continued)

Block (Type)/Parameter	Dialog Box Prompt	Values
ErrorFcn	Name of error callback function	string {''}
PermitHierarchical Resolution	Permit hierarchical resolution	{'All'} | 'ParametersOnly' | 'None'
TreatAsAtomicUnit	Treat as atomic unit	{'on'} | 'off'
MinAlgLoopOccurrences	Minimize algebraic loop occurrences	'on' | {'off'}
PropExecContext OutsideSubsystem	Propagate execution context across subsystem boundary	{'on'} | 'off'
CheckFcnCallInp InsideContextMsg	Warn if function-call inputs are context-specific	'on' | {'off'}
SystemSampleTime	Sample time (-1 for inherited)	string {'-1'}
RTWSystemCode	Real-Time Workshop system code	{'Auto'} | 'Inline' | 'Function' | 'Reusable function'
RTWFcnNameOpts	Real-Time Workshop function name options	{'Auto'} | 'Use subsystem name' | 'User specified'
RTWFcnName	Real-Time Workshop function name	string {''}
RTWFileNameOpts	Real-Time Workshop filename options	{'Auto'} | 'Use subsystem name' | 'Use function name' | 'User specified'
RTWFileName	Real-Time Workshop filename (no extension)	string {''}
DataTypeOverride		{'UseLocalSettings'} | 'ScaledDoubles' | 'TrueDoubles' | 'TrueSingles' | 'ForceOff'

Ports & Subsystems Library Block Parameters (Continued)

Block (Type)/Parameter	Dialog Box Prompt	Values
MinMaxOverflowLogging		{'UseLocalSettings'} | 'MinMaxAndOverflow' | 'OverflowOnly' | 'ForceOff'
For Iterator (ForIterator)		
ResetStates	States when starting	{'held'} | 'reset'
IterationSource	Iteration limit source	{'internal'} | 'external'
IterationLimit	Iteration limit	string {'5'}
ExternalIncrement	Set next i (iteration variable) externally	'on' | {'off'}
ShowIterationPort	Show iteration variable	{'on'} | 'off'
IndexMode	Index mode	'Zero-based' | {'One-based'}
IterationVariable DataType	Iteration variable data type	{'int32'} | 'int16' | 'int8' | 'double'
For Iterator Subsystem (SubSystem)		
ShowPortLabels	Show port labels	{'on'} | 'off'
BlockChoice	Block choice	{''}
TemplateBlock	Template block	string {''}
MemberBlocks	Member blocks	string {''}
Permissions	Read/Write permissions	{'ReadWrite'} | 'ReadOnly' | 'NoReadOrWrite'
ErrorFcn	Name of error callback function	string {''}
PermitHierarchical Resolution	Permit hierarchical resolution	{'All'} | 'ParametersOnly' | 'None'

Ports & Subsystems Library Block Parameters (Continued)

Block (Type)/Parameter	Dialog Box Prompt	Values
`TreatAsAtomicUnit`	Treat as atomic unit	`{'on'}	'off'`
`MinAlgLoopOccurrences`	Minimize algebraic loop occurrences	`'on'	{'off'}`
`PropExecContext OutsideSubsystem`	Propagate execution context across subsystem boundary	`{'on'}	'off'`
`CheckFcnCallInp InsideContextMsg`	Warn if function-call inputs are context-specific	`'on'	{'off'}`
`SystemSampleTime`	Sample time (-1 for inherited)	`string{'-1'}`
`RTWSystemCode`	Real-Time Workshop system code	`{'Auto'}	'Inline'	'Function'	'Reusable function'`
`RTWFcnNameOpts`	Real-Time Workshop function name options	`{'Auto'}	'Use subsystem name'	'User specified'`
`RTWFcnName`	Real-Time Workshop function name	`string {''}`
`RTWFileNameOpts`	Real-Time Workshop filename options	`{'Auto'}	'Use subsystem name'	'Use function name'	'User specified'`
`RTWFileName`	Real-Time Workshop filename (no extension)	`string {''}`
`DataTypeOverride`		`{'UseLocalSettings'}	'ScaledDoubles'	'TrueDoubles'	'TrueSingles'	'ForceOff'`
`MinMaxOverflowLogging`		`{'UseLocalSettings'}	'MinMaxAndOverflow'	'OverflowOnly'	'ForceOff'`
Function-Call Generator (`Function-Call Generator`) (masked subsystem)		

Ports & Subsystems Library Block Parameters (Continued)

Block (Type)/Parameter	Dialog Box Prompt	Values
sample_time	Sample time	string {'1'}
numberOfIterations	Number of iterations	string {'1'}
Function-Call Subsystem (SubSystem)		
ShowPortLabels	Show port labels	{'on'} | 'off'
BlockChoice	Block choice	{''}
TemplateBlock	Template block	string {''}
MemberBlocks	Member blocks	string {''}
Permissions	Read/Write permissions	{'ReadWrite'} | 'ReadOnly' | 'NoReadOrWrite'
ErrorFcn	Name of error callback function	string {''}
PermitHierarchical Resolution	Permit hierarchical resolution	{'All'} | 'ParametersOnly' | 'None'
TreatAsAtomicUnit	Treat as atomic unit	{'on'} | 'off'
MinAlgLoopOccurrences	Minimize algebraic loop occurrences	'on' | {'off'}
PropExecContext OutsideSubsystem	Propagate execution context across subsystem boundary	{'on'} | 'off'
CheckFcnCallInp InsideContextMsg	Warn if function-call inputs are context-specific	'on' | {'off'}
SystemSampleTime	Sample time (-1 for inherited)	string {'-1'}
RTWSystemCode	Real-Time Workshop system code	{'Auto'} | 'Inline' | 'Function' | 'Reusable function'
RTWFcnNameOpts	Real-Time Workshop function name options	{'Auto'} | 'Use subsystem name' | 'User specified'

Ports & Subsystems Library Block Parameters (Continued)

Block (Type)/Parameter	Dialog Box Prompt	Values
RTWFcnName	Real-Time Workshop function name	string {''}
RTWFileNameOpts	Real-Time Workshop filename options	{'Auto'} | 'Use subsystem name' | 'Use function name' | 'User specified'
RTWFileName	Real-Time Workshop filename (no extension)	string {''}
DataTypeOverride		{'UseLocalSettings'} | 'ScaledDoubles' | 'TrueDoubles' | 'TrueSingles' | 'ForceOff'
MinMaxOverflowLogging		{'UseLocalSettings'} | 'MinMaxAndOverflow' | 'OverflowOnly' | 'ForceOff'
If (If)		
NumInputs	Number of inputs	string {'1'}
IfExpression	If expression (e.g., u1 ~= 0)	string {'u1 > 0'}
ElseIfExpressions	Elseif expressions (comma-separated list, e.g., u2 ~= 0, u3(2) < u2)	string {''}
ShowElse	Show else condition	{'on'} | 'off'
ZeroCross	Enable zero crossing detection	{'on'} | 'off'
SampleTime	Sample time (-1 for inherited)	string {'-1'}
If Action Subsystem (SubSystem)		
ShowPortLabels	Show port labels	{'on'} | 'off'
BlockChoice	Block choice	{''}
TemplateBlock	Template block	string {''}

Ports & Subsystems Library Block Parameters (Continued)

Block (Type)/Parameter	Dialog Box Prompt	Values
MemberBlocks	Member blocks	string {''}
Permissions	Read/Write permissions	{'ReadWrite'} | 'ReadOnly' | 'NoReadOrWrite'
ErrorFcn	Name of error callback function	string {''}
PermitHierarchical Resolution	Permit hierarchical resolution	{'All'} | 'ParametersOnly' | 'None'
TreatAsAtomicUnit	Treat as atomic unit	{'on'} | 'off'
MinAlgLoopOccurrences	Minimize algebraic loop occurrences	'on' | {'off'}
PropExecContext OutsideSubsystem	Propagate execution context across subsystem boundary	{'on'} | 'off'
CheckFcnCallInp InsideContextMsg	Warn if function-call inputs are context-specific	'on' | {'off'}
SystemSampleTime	Sample time (-1 for inherited)	string {'-1'}
RTWSystemCode	Real-Time Workshop system code	{'Auto'} | 'Inline' | 'Function' | 'Reusable function'
RTWFcnNameOpts	Real-Time Workshop function name options	{'Auto'} | 'Use subsystem name' | 'User specified'
RTWFcnName	Real-Time Workshop function name	string {''}
RTWFileNameOpts	Real-Time Workshop filename options	{'Auto'} | 'Use subsystem name' | 'Use function name' | 'User specified'
RTWFileName	Real-Time Workshop filename (no extension)	string {''}

Ports & Subsystems Library Block Parameters (Continued)

Block (Type)/Parameter	Dialog Box Prompt	Values
DataTypeOverride		{'UseLocalSettings'} | 'ScaledDoubles' | 'TrueDoubles' | 'TrueSingles' | 'ForceOff'
MinMaxOverflowLogging		{'UseLocalSettings'} | 'MinMaxAndOverflow' | 'OverflowOnly' | 'ForceOff'
In1 (Inport)		
Port	Port number	string {'1'}
IconDisplay	Icon display	'Signal name' | {'Port number'} | 'Port number and signal name'
UseBusObject	Specify properties via bus object	'on' | {'off'}
BusObject	Bus object for validating input bus	string {'BusObject'}
BusOutputAsStruct	Output as nonvirtual bus	'on' | {'off'}
PortDimensions	Port dimensions (-1 for inherited)	string {'-1'}
SampleTime	Sample time (-1 for inherited)	string {'-1'}
DataType	Data type	{'auto'} | 'double' | 'single' | 'int8' | 'uint8' | 'int16' | 'uint16' | 'int32' | 'uint32' | 'boolean' | 'Specify via dialog'
OutDataType	Output data type (e.g., sfix(16), uint(8), float('single'))	string {'sfix(16)'}

Ports & Subsystems Library Block Parameters (Continued)

Block (Type)/Parameter	Dialog Box Prompt	Values
OutScaling	Output scaling value (Slope, e.g., 2^-9 or [Slope Bias], e.g., [1.25 3])	string {'2^0'}
SignalType	Signal type	{'auto'} | 'real' | 'complex'
SamplingMode	Sampling mode	{'auto'} | 'Sample based' | 'Frame based'
LatchByDelaying OutsideSignal	Latch input by delaying outside signal	'on' | {'off'}
LatchByCopying InsideSignal	Latch input by copying inside signal	'on' | {'off'}
Interpolate	Interpolate data	{'on'} | 'off'
Model (ModelReference)		
ModelName	Model name (without the .mdl extension)	string {'<Enter Model Name>'}
ParameterArgumentNames	Model arguments	string {''}
ParameterArgumentValues	Model argument values (for this instance)	string {''}
AvailSigsInstanceProps		handle vector {''}
AvailSigsDefaultProps		handle vector {''}
UpdateSigLoggingInfo	For internal use	
DefaultDataLogging		'on' | {'off'}
Out1 (Outport)		
Port	Port number	string {'1'}
IconDisplay	Icon display	'Signal name' | {'Port number'} | 'Port number and signal name'

Ports & Subsystems Library Block Parameters (Continued)

Block (Type)/Parameter	Dialog Box Prompt	Values
UseBusObject	Specify properties via bus object	`'on'	{'off'}`
BusObject	Bus object for validating input bus	
BusOutputAsStruct	Output as nonvirtual bus in parent model	`'on'	{'off'}`
PortDimensions	Port dimensions (-1 for inherited)	`string {'-1'}`
SampleTime	Sample time (-1 for inherited)	`string {'-1'}`
DataType	Data type	`{'auto'}	'double'	'single'	'int8'	'uint8'	'int16'	'uint16'	'int32'	'uint32'	'boolean'	'Specify via dialog'`
OutDataType	Output data type (e.g., sfix(16), uint(8), float('single'))	`string {'sfix(16)'}`
OutScaling	Output scaling value (Slope, e.g., 2^-9 or [Slope Bias], e.g., [1.25 3])	`string {'2^0'}`
SignalType	Signal type	`{'auto'}	'real'	'complex'`
SamplingMode	Sampling mode	`{'auto'}	'Sample based'	'Frame based'`
OutputWhenDisabled	Output when disabled	`{'held'}	'reset'`
InitialOutput	Initial output	`string {'[]'}`
Subsystem (SubSystem)		
ShowPortLabels	Show port labels	`{'on'}	'off'`
BlockChoice	Block choice	`{''}`

Ports & Subsystems Library Block Parameters (Continued)

Block (Type)/Parameter	Dialog Box Prompt	Values
TemplateBlock	Template block	string {''}
MemberBlocks	Member blocks	string {''}
Permissions	Read/Write permissions	{'ReadWrite'} | 'ReadOnly' | 'NoReadOrWrite'
ErrorFcn	Name of error callback function	string {''}
PermitHierarchical Resolution	Permit hierarchical resolution	{'All'} | 'ParametersOnly' | 'None'
TreatAsAtomicUnit	Treat as atomic unit	'on' | {'off'}
MinAlgLoopOccurrences	Minimize algebraic loop occurrences	'on' | {'off'}
PropExecContext OutsideSubsystem	Propagate execution context across subsystem boundary	{'on'} | 'off'
CheckFcnCallInp InsideContextMsg	Warn if function-call inputs are context-specific	'on' | {'off'}
SystemSampleTime	Sample time (-1 for inherited)	string {'-1'}
RTWSystemCode	Real-Time Workshop system code	{'Auto'} | 'Inline' | 'Function' | 'Reusable function'
RTWFcnNameOpts	Real-Time Workshop function name options	{'Auto'} | 'Use subsystem name' | 'User specified'
RTWFcnName	Real-Time Workshop function name	string {''}
RTWFileNameOpts	Real-Time Workshop filename options	{'Auto'} | 'Use subsystem name' | 'Use function name' | 'User specified'
RTWFileName	Real-Time Workshop filename (no extension)	string {''}

Ports & Subsystems Library Block Parameters (Continued)

Block (Type)/Parameter	Dialog Box Prompt	Values
DataTypeOverride		{'UseLocalSettings'} | 'ScaledDoubles' | 'TrueDoubles' | 'TrueSingles' | 'ForceOff'
MinMaxOverflowLogging		{'UseLocalSettings'} | 'MinMaxAndOverflow' | 'OverflowOnly' | 'ForceOff'
Virtual	For internal use	
Switch Case (SwitchCase)		
CaseConditions	Case conditions (e.g., {1,[2,3]})	string {'{1}'}
CaseShowDefault	Show default case	{'on'} | 'off'
ZeroCross	Enable zero-crossing detection	{'on'} | 'off'
SampleTime	Sample time (-1 for inherited)	string {'-1'}
Switch Case Action Subsystem (SubSystem)		
ShowPortLabels	Show port labels	{'on'} | 'off'
BlockChoice	Block choice	{''}
TemplateBlock	Template block	string {''}
MemberBlocks	Member blocks	string {''}
Permissions	Read/Write permissions	{'ReadWrite'} | 'ReadOnly' | 'NoReadOrWrite'
ErrorFcn	Name of error callback function	string {''}
PermitHierarchical Resolution	Permit hierarchical resolution	{'All'} | 'ParametersOnly' | 'None'
TreatAsAtomicUnit	Treat as atomic unit	{'on'} | 'off'

Ports & Subsystems Library Block Parameters (Continued)

Block (Type)/Parameter	Dialog Box Prompt	Values
MinAlgLoopOccurrences	Minimize algebraic loop occurrences	`'on'` | `{'off'}`
PropExecContext OutsideSubsystem	Propagate execution context across subsystem boundary	`{'on'}` | `'off'`
CheckFcnCallInp InsideContextMsg	Warn if function-call inputs are context-specific	`'on'` | `{'off'}`
SystemSampleTime	Sample time (-1 for inherited)	string `{'-1'}`
RTWSystemCode	Real-Time Workshop system code	`{'Auto'}` | `'Inline'` | `'Function'` | `'Reusable function'`
RTWFcnNameOpts	Real-Time Workshop function name options	`{'Auto'}` | `'Use subsystem name'` | `'User specified'`
RTWFcnName	Real-Time Workshop function name	string `{''}`
RTWFileNameOpts	Real-Time Workshop filename options	`{'Auto'}` | `'Use subsystem name'` | `'Use function name'` | `'User specified'`
RTWFileName	Real-Time Workshop filename (no extension)	string `{''}`
DataTypeOverride		`{'UseLocalSettings'}` | `'ScaledDoubles'` | `'TrueDoubles'` | `'TrueSingles'` | `'ForceOff'`
MinMaxOverflowLogging		`{'UseLocalSettings'}` | `'MinMaxAndOverflow'` | `'OverflowOnly'` | `'ForceOff'`
Trigger (TriggerPort)		

Ports & Subsystems Library Block Parameters (Continued)

Block (Type)/Parameter	Dialog Box Prompt	Values
`TriggerType`	Trigger type	`{'rising'} | 'falling' | 'either' | 'function-call'`
`StatesWhenEnabling`	States when enabling	`{'held'} | 'reset' | 'inherit'`
`ShowOutputPort`	Show output port	`'on' | {'off'}`
`OutputDataType`	Output data type	`{'auto'} | 'double' | 'int8'`
`SampleTimeType`	Sample time type	`{'triggered'} | 'periodic'`
`SampleTime`	Sample time	`string {'1'}`
`ZeroCross`	Enable zero crossing detection	`{'on'} | 'off'`
Triggered Subsystem (`SubSystem`)		
`ShowPortLabels`	Show port labels	`{'on'} | 'off'`
`BlockChoice`	Block choice	`{''}`
`TemplateBlock`	Template block	`string {''}`
`MemberBlocks`	Member blocks	`string {''}`
`Permissions`	Read/Write permissions	`{'ReadWrite'} | 'ReadOnly' | 'NoReadOrWrite'`
`ErrorFcn`	Name of error callback function	`string {''}`
`PermitHierarchical Resolution`	Permit hierarchical resolution	`{'All'} | 'ParametersOnly' | 'None'`
`TreatAsAtomicUnit`	Treat as atomic unit	`{'on'} | 'off'`
`MinAlgLoopOccurrences`	Minimize algebraic loop occurrences	`'on' | {'off'}`

Ports & Subsystems Library Block Parameters (Continued)

Block (Type)/Parameter	Dialog Box Prompt	Values
PropExecContext OutsideSubsystem	Propagate execution context across subsystem boundary	{'on'} | 'off'
CheckFcnCallInp InsideContextMsg	Warn if function-call inputs are context-specific	'on' | {'off'}
SystemSampleTime	Sample time (-1 for inherited)	string {'-1'}
RTWSystemCode	Real-Time Workshop system code	{'Auto'} | 'Inline' | 'Function' | 'Reusable function'
RTWFcnNameOpts	Real-Time Workshop function name options	{'Auto'} | 'Use subsystem name' | 'User specified'
RTWFcnName	Real-Time Workshop function name	string {''}
RTWFileNameOpts	Real-Time Workshop filename options	{'Auto'} | 'Use subsystem name' | 'Use function name' | 'User specified'
RTWFileName	Real-Time Workshop filename (no extension)	string {''}
DataTypeOverride		{'UseLocalSettings'} | 'ScaledDoubles' | 'TrueDoubles' | 'TrueSingles' | 'ForceOff'
MinMaxOverflowLogging		{'UseLocalSettings'} | 'MinMaxAndOverflow' | 'OverflowOnly' | 'ForceOff'
While Iterator (WhileIterator)		
MaxIters	Maximum number of iterations (-1 for unlimited)	string {'5'}
WhileBlockType	While loop type	{'while'} | 'do-while'

Ports & Subsystems Library Block Parameters (Continued)

Block (Type)/Parameter	Dialog Box Prompt	Values
ResetStates	States when starting	{'held'} | 'reset'
ShowIterationPort	Show iteration number port	'on' | {'off'}
OutputDataType	Output data type	{'int32'} | 'int16' | 'int8' | 'double'
While Iterator Subsystem (SubSystem)		
ShowPortLabels	Show port labels	{'on'} | 'off'
BlockChoice	Block choice	{''}
TemplateBlock	Template block	string {''}
MemberBlocks	Member blocks	string {''}
Permissions	Read/Write permissions	{'ReadWrite'} | 'ReadOnly' | 'NoReadOrWrite'
ErrorFcn	Name of error callback function	string {''}
PermitHierarchical Resolution	Permit hierarchical resolution	{'All'} | 'ParametersOnly' | 'None'
TreatAsAtomicUnit	Treat as atomic unit	{'on'} | 'off'
MinAlgLoopOccurrences	Minimize algebraic loop occurrences	'on' | {'off'}
PropExecContext OutsideSubsystem	Propagate execution context across subsystem boundary	{'on'} | 'off'
CheckFcnCallInp InsideContextMsg	Warn if function-call inputs are context-specific	'on' | {'off'}
SystemSampleTime	Sample time (-1 for inherited)	string {'-1'}
RTWSystemCode	Real-Time Workshop system code	{'Auto'} | 'Inline' | 'Function' | 'Reusable function'

Ports & Subsystems Library Block Parameters (Continued)

Block (Type)/Parameter	Dialog Box Prompt	Values
RTWFcnNameOpts	Real-Time Workshop function name options	{'Auto'} | 'Use subsystem name' | 'User specified'
RTWFcnName	Real-Time Workshop function name	string {''}
RTWFileNameOpts	Real-Time Workshop filename options	{'Auto'} | 'Use subsystem name' | 'Use function name' | 'User specified'
RTWFileName	Real-Time Workshop filename (no extension)	string {''}
DataTypeOverride		{'UseLocalSettings'} | 'ScaledDoubles' | 'TrueDoubles' | 'TrueSingles' | 'ForceOff'
MinMaxOverflowLogging		{'UseLocalSettings'} | 'MinMaxAndOverflow' | 'OverflowOnly' | 'ForceOff'

Signal Attributes Library Block Parameters

Block (Type)/Parameter	Dialog Box Prompt	Values
Data Type Conversion (DataTypeConversion)		
OutDataTypeMode	Output data type mode	'double' | 'single' | 'int8' | 'uint8' | 'int16' | 'uint16' | 'int32' | 'uint32' | 'boolean' | 'Specify via dialog' | {'Inherit via back propagation'}
OutDataType	Output data type (e.g., sfix(16), uint(8), float('single'))	string {'sfix(16)'}

Signal Attributes Library Block Parameters (Continued)

Block (Type)/Parameter	Dialog Box Prompt	Values
OutScaling	Output scaling value (Slope, e.g., 2^-9 or [Slope Bias], e.g., [1.25 3])	string {'2^0'}
LockScale	Lock output scaling against changes by the autoscaling tool	'on' | {'off'}
ConvertRealWorld	Input and output to have equal	{'Real World Value (RWV)'} | 'Stored Integer (SI)'
RndMeth	Round integer calculations toward	'Zero' | 'Nearest' | 'Ceiling' | {'Floor'}
SaturateOnInteger Overflow	Saturate on integer overflow	'on' | {'off'}
SampleTime	Sample time (-1 for inherited)	string {'-1'}
Data Type Conversion Inherited (Conversion Inherited) (masked subsystem)		
ConvertRealWorld	Input and Output to have equal	{'Real World Value'} | 'Stored Integer'
RndMeth	Round toward	'Zero' | 'Nearest' | 'Ceiling' | {'Floor'}
DoSatur	Saturate to max or min when overflows occur	'on' | {'off'}
Data Type Duplicate (Data Type Duplicate) (masked subsystem)		
NumInputPorts	Number of input ports	string {'2'}
Data Type Propagation (Data Type Propagation) (masked subsystem)		
PropDataTypeMode	1. Propagated data type	'Specify via dialog' | {'Inherit via propagation rule'}
PropDataType	1.1. Propagated data type: ex. sfix(16), uint(8), float('single')	string {'sfix(16)'}

Signal Attributes Library Block Parameters (Continued)

Block (Type)/Parameter	Dialog Box Prompt	Values
IfRefDouble	1.1. If any reference input is double, output is	{'double'} | 'single'
IfRefSingle	1.2. If any reference input is single, output is	'double' | {'single'}
IsSigned	1.3. Is-Signed	'IsSigned1' | 'IsSigned2' | {'IsSigned1 or IsSigned2'} | 'TRUE' | 'FALSE'
NumBitsBase	1.4.1. Number-of-Bits: Base	'NumBits1' | 'NumBits2' | {'max([NumBits1 NumBits2])'} | 'min([NumBits1 NumBits2])' | 'NumBits1+NumBits2'
NumBitsMult	1.4.2. Number-of-Bits: Multiplicative adjustment	string {'1'}
NumBitsAdd	1.4.3. Number-of-Bits: Additive adjustment	string {'0'}
NumBitsAllowFinal	1.4.4. Number-of-Bits: Allowable final values	string {'1:128'}
PropScalingMode	2. Propagated scaling	'Specify via dialog' | {'Inherit via propagation rule'} | 'Obtain via best precision'
PropScaling	2.1. Propagated scaling: Slope or [Slope Bias] ex. 2^-9	string {'2^-10'}
ValuesUsedBestPrec	2.1. Values used to determine best precision scaling	string {'[5 -7]'}

Signal Attributes Library Block Parameters (Continued)

Block (Type)/Parameter	Dialog Box Prompt	Values
`SlopeBase`	2.1.1. Slope: Base	`'Slope1'` | `'Slope2'` | `'max([Slope1 Slope2])'` | `{'min([Slope1 Slope2])'}` | `'Slope1*Slope2'` | `'Slope1/Slope2'` | `'PosRange1'` | `'PosRange2'` | `'max([PosRange1 PosRange2])'` | `'min([PosRange1 PosRange2])'` | `'PosRange1*PosRange2'` | `'PosRange1/PosRange2'`
`SlopeMult`	2.1.2. Slope: Multiplicative adjustment	string `{'1'}`
`SlopeAdd`	2.1.3. Slope: Additive adjustment	string `{'0'}`
`BiasBase`	2.2.1. Bias: Base	`{'Bias1'}` | `'Bias2'` | `'max([Bias1 Bias2])'` | `'min([Bias1 Bias2])'` | `'Bias1*Bias2'` | `'Bias1/Bias2'` | `'Bias1+Bias2'` | `'Bias1-Bias2'`
`BiasMult`	2.2.2. Bias: Multiplicative adjustment	string `{'1'}`
`BiasAdd`	2.2.3. Bias: Additive adjustment	string `{'0'}`
Data Type Scaling Strip (`Scaling Strip`) (masked subsystem)		
IC (`InitialCondition`)		
Value	Initial value	string `{'1'}`
SampleTime	Sample time (-1 for inherited)	string `{'-1'}`

Signal Attributes Library Block Parameters (Continued)

Block (Type)/Parameter	Dialog Box Prompt	Values
Probe (Probe)		
ProbeWidth	Probe width	{'on'} | 'off'
ProbeSampleTime	Probe sample time	{'on'} | 'off'
ProbeComplexSignal	Detect complex signal	{'on'} | 'off'
ProbeSignalDimensions	Probe signal dimensions	{'on'} | 'off'
ProbeFramedSignal	Detect framed signal	{'on'} | 'off'
ProbeWidthDataType	Data type for width	{'double'} | 'single' | 'int8' | 'uint8' | 'int16' | 'uint16' | 'int32' | 'uint32' | 'boolean' | 'Same as input'
ProbeSampleTimeDataType	Data type for sample time	{'double'} | 'single' | 'int8' | 'uint8' | 'int16' | 'uint16' | 'int32' | 'uint32' | 'boolean' | 'Same as input'
ProbeComplexityDataType	Data type for signal complexity	{'double'} | 'single' | 'int8' | 'uint8' | 'int16' | 'uint16' | 'int32' | 'uint32' | 'boolean' | 'Same as input'
ProbeDimensionsDataType	Data type for signal dimensions	{'double'} | 'single' | 'int8' | 'uint8' | 'int16' | 'uint16' | 'int32' | 'uint32' | 'boolean' | 'Same as input'

Signal Attributes Library Block Parameters (Continued)

Block (Type)/Parameter	Dialog Box Prompt	Values
ProbeFrameDataType	Data type for signal frames	{'double'} | 'single' | 'int8' | 'uint8' | 'int16' | 'uint16' | 'int32' | 'uint32' | 'boolean' | 'Same as input'
Rate Transition (RateTransition)		
Integrity	Ensure data integrity during data transfer	{'on'} | 'off'
Deterministic	Ensure deterministic data transfer (maximum delay)	{'on'} | 'off'
X0	Initial conditions	string {'0'}
OutPortSampleTime	Output port sample time	string {'-1'}
Signal Conversion (SignalConversion)		
ConversionOutput	Output	{'Contiguous copy'} | 'Bus copy' | 'Virtual bus' | 'Nonvirtual bus'
OverrideOpt	Override optimizations and always copy signal	'on' | {'off'}
Signal Specification (SignalSpecification)		
Dimensions	Dimensions (-1 for inherited)	string {'-1'}
SampleTime	Sample time (-1 for inherited)	string {'-1'}
DataType	Data type	{'auto'} | 'double' | 'single' | 'int8' | 'uint8' | 'int16' | 'uint16' | 'int32' | 'uint32' | 'boolean' | 'Specify via dialog'
OutDataType	Output data type (e.g., sfix(16), uint(8), float('single'))	string {'sfix(16)'}

Signal Attributes Library Block Parameters (Continued)

Block (Type)/Parameter	Dialog Box Prompt	Values
OutScaling	Output scaling value (Slope, e.g., 2^-9 or [Slope Bias], e.g., [1.25 3])	string {'2^0'}
SignalType	Signal type	{'auto'} | 'real' | 'complex'
SamplingMode	Sampling mode	{'auto'} | 'Sample based' | 'Frame based'
Weighted Sample Time (Sample Time Math) (masked subsystem)		
TsampMathOp	Operation	'+' | '-' | '*' | '/' | {'Ts Only'} | '1/Ts Only'
weightValue	Weight value	string {'1.0'}
TsampMathImp	Implement using	{'Online Calculations'} | 'Offline Scaling Adjustment'
OutputDataTypeScaling Mode	Output data type and scaling	{'Inherit via internal rule'} | 'Inherit via back propagation'
RndMeth	Round toward	'Zero' | 'Nearest' | 'Ceiling' | {'Floor'}
DoSatur	Saturate to max or min when overflows occur	'on' | {'off'}
Width (Width)		
OutputDataTypeScaling Mode	Output data type mode	{'Choose intrinsic data type'} | 'Inherit via back propagation' | 'All ports same datatype'
DataType	Output data type	{'double'} | 'single' | 'int8' | 'uint8' | 'int16' | 'uint16' | 'int32' | 'uint32'

Signal Routing Library Block Parameters

Block (Type)/Parameter	Dialog Box Prompt	Values
Bus Assignment (`BusAssignment`)		
`AssignedSignals`	Signals that are being assigned	string {''}
`InputSignals`	Signals in the bus	matrix {'{}'}
Bus Creator (`BusCreator`)		
`Inputs`	Number of inputs. Can be an integer or a comma-separated list of signal names. For example, set_param(gcb, '''a'',''b''); sets the currently selected Bus Creator block two have two inputs named a and b.	string {'2'}
`DisplayOption`		'none' | 'signals' | {'bar'}
`UseBusObject`	Specify properties via bus object	'on' | {'off'}
`BusObject`	For internal use	
`NonVirtualBus`	Output as nonvirtual bus	'on' | {'off'}
Bus Selector (`BusSelector`)		
`OutputSignals`	Specifies the names of the input bus signals selected for output. Corresponds to the **Selected signals** list on the block's parameter dialog box.	string {'signal1,signal2'}

Signal Routing Library Block Parameters (Continued)

Block (Type)/Parameter	Dialog Box Prompt	Values
OutputAsBus	Output as bus	`'on'` | `{'off'}`
InputSignals	Specifies the names of the signal elements of the bus connected to the Bus Selector's input port.	`matrix {'{}'}`
Data Store Memory (`DataStoreMemory`)		
DataStoreName	Data store name	`string {'A'}`
ReadBeforeWriteMsg	Detect read before write	`'none'` | `{'warning'}` | `'error'`
WriteAfterWriteMsg	Detect write after write	`'none'` | `{'warning'}` | `'error'`
WriteAfterReadMsg	Detect write after read	`'none'` | `{'warning'}` | `'error'`
InitialValue	Initial value	`string {'0'}`
StateMustResolveTo SignalObject	Data store name must resolve to Simulink signal object	`'on'` | `{'off'}`
RTWStateStorageClass	RTW storage class	`{'Auto'}` | `'ExportedGlobal'` | `'ImportedExtern'` | `'ImportedExternPointer'`
RTWStateStorageType Qualifier	RTW type qualifier	`string {''}`
VectorParams1D	Interpret vector parameters as 1-D	`{'on'}` | `'off'`
ShowAdditionalParam	Show additional parameters	`'on'` | `{'off'}`

Signal Routing Library Block Parameters (Continued)

Block (Type)/Parameter	Dialog Box Prompt	Values
DataType	Data type	{'auto'} | 'double' | 'single' | 'int8' | 'uint8' | 'int16' | 'uint16' | 'int32' | 'uint32' | 'boolean' | 'Specify via dialog'
OutDataType	Output data type (e.g., sfix(16), uint(8), float('single'))	string {'sfix(16)'}
OutScaling	Output scaling value (Slope, e.g., 2^-9 or [Slope Bias], e.g., [1.25 3])	string {'2^0'}
SignalType	Signal type	{'auto'} | 'real' | 'complex'
Data Store Read (DataStoreRead)		
DataStoreName	Data store name	string {'A'}
SampleTime	Sample time	string {'0'}
Data Store Write (DataStoreWrite)		
DataStoreName	Data store name	string {'A'}
SampleTime	Sample time (-1 for inherited)	string {'-1'}
Demux (Demux)		
Outputs	Number of outputs	string {'2'}
DisplayOption	Display option	'none' | {'bar'}
BusSelectionMode	Bus selection mode	'on' | {'off'}
Environment Controller (Environment Controller) (masked subsystem)		
From (From)		

Signal Routing Library Block Parameters (Continued)

Block (Type)/Parameter	Dialog Box Prompt	Values
GotoTag	Goto tag	string {'A'}
IconDisplay	Icon display	'Signal name' | {'Tag'} | 'Tag and signal name'
Goto (Goto)		
GotoTag	Tag	string {'A'}
IconDisplay	Icon display	'Signal name' | {'Tag'} | 'Tag and signal name'
TagVisibility	Tag visibility	{'local'} | 'scoped' | 'global'
Goto Tag Visibility (GotoTagVisibility)		
GotoTag	Goto tag	string {'A'}
Index Vector (MultiPortSwitch)		
Inputs	Number of inputs	string {'1'}
zeroidx	Use zero-based indexing	{'on'} | 'off'
InputSameDT	Require all data port inputs to have same data type	'on' | {'off'}
OutDataTypeMode	Output data type mode	{'Inherit via internal rule'} | 'Inherit via back propagation'
RndMeth	Round integer calculations toward	'Zero' | 'Nearest' | 'Ceiling' | {'Floor'}
SaturateOnInteger Overflow	Saturate on integer overflow	'on' | {'off'}

Signal Routing Library Block Parameters (Continued)

Block (Type)/Parameter	Dialog Box Prompt	Values
SampleTime	Sample time (-1 for inherited)	string {'-1'}
Manual Switch (`Manual Switch`) (masked subsystem)		
sw	Current setting	string {'1'}
action	Action	string {'0'}
Merge (`Merge`)		
Inputs	Number of inputs	string {'2'}
InitialOutput	Initial output	string {'[]'}
AllowUnequalInput PortWidths	Allow unequal port widths	'on' | {'off'}
InputPortOffsets	Input port offsets	string {'[]'}
Multiport Switch (`MultiPortSwitch`)		
Inputs	Number of inputs	string {'3'}
zeroidx	Use zero-based indexing	'on' | {'off'}
InputSameDT	Require all data port inputs to have same data type	'on' | {'off'}
OutDataTypeMode	Output data type mode	{'Inherit via internal rule'} | 'Inherit via back propagation'
RndMeth	Round integer calculations toward	'Zero' | 'Nearest' | 'Ceiling' | {'Floor'}
SaturateOnInteger Overflow	Saturate on integer overflow	'on' | {'off'}
SampleTime	Sample time (-1 for inherited)	string {'-1'}

Signal Routing Library Block Parameters (Continued)

Block (Type)/Parameter	Dialog Box Prompt	Values
Mux (Mux)		
Inputs	Number of inputs	string {'2'}
DisplayOption	Display option	'none' | 'signals' | {'bar'}
UseBusObject	For internal use	
BusObject	For internal use	
NonVirtualBus	For internal use	
Selector (Selector)		
InputType	Input type	{'Vector'} | 'Matrix'
IndexMode	Index mode	'Zero-based' | {'One-based'}
ElementSrc	Source of element indices (E)	{'Internal'} | 'External'
Elements	Elements (-1 for all elements)	string {'[1 3]'}
RowSrc	Source of row indices (R)	{'Internal'} | 'External'
Rows	Rows (-1 for all rows)	string {'1'}
ColumnSrc	Source of column indices (C)	{'Internal'} | 'External'
Columns	Columns (-1 for all columns)	string {'1'}
InputPortWidth	Input port width	string {'3'}
IndexIsStartValue	Use index as starting value	'on' | {'off'}
OutputPortSize	Output port dimensions	string {'1'}

Signal Routing Library Block Parameters (Continued)

Block (Type)/Parameter	Dialog Box Prompt	Values
Switch (Switch)		
Criteria	Criteria for passing first input	{'u2 >= Threshold'} | 'u2 > Threshold' | 'u2 ~= 0'
Threshold	Threshold	string {'0'}
InputSameDT	Require all data port inputs to have same data type	'on' | {'off'}
OutDataTypeMode	Output data type mode	{'Inherit via internal rule'} | 'Inherit via back propagation'
RndMeth	Round integer calculations toward	'Zero' | 'Nearest' | 'Ceiling' | {'Floor'}
SaturateOnInteger Overflow	Saturate on integer overflow	'on' | {'off'}
ZeroCross	Enable zero crossing detection	{'on'} | 'off'
SampleTime	Sample time (-1 for inherited)	string {'-1'}

Sinks Library Block Parameters

Block (Type)/Parameter	Dialog Box Prompt	Values
Display (Display)		

Sinks Library Block Parameters (Continued)

Block (Type)/Parameter	Dialog Box Prompt	Values
Format	Format	{'short'} | 'long' | 'short_e' | 'long_e' | 'bank' | 'hex (Stored Integer)' | 'binary (Stored Integer)' | 'decimal (Stored Integer)' | 'octal (Stored Integer)'
Decimation	Decimation	string {'1'}
Floating	Floating display	'on' | {'off'}
SampleTime	Sample time (-1 for inherited)	string {'-1'}
Floating Scope (Scope)		
Floating		{'on'} | 'off'
Location		rectangle {'[376 294 700 533]'}
Open		'on' | {'off'}
NumInputPorts		string {'1'}
TickLabels		'on' | 'off' | {'OneTimeTick'}
ZoomMode		{'on'} | 'xonly' | 'yonly'
AxesTitles		list
Grid		'off' | {'on'} | 'xonly' | 'yonly'
TimeRange		string {'auto'}
YMin		string {'-5'}
YMax		string {'5'}
SaveToWorkspace		'on' | {'off'}

Sinks Library Block Parameters (Continued)

Block (Type)/Parameter	Dialog Box Prompt	Values
SaveName		string {'ScopeData'}
DataFormat		{'StructureWithTime'} | 'Structure' | 'Array'
LimitDataPoints		{'on'} | 'off'
MaxDataPoints		string {'5000'}
Decimation		string {'1'}
SampleInput		'on' | {'off'}
SampleTime		string {'0'}
Out1 (Outport)		
Port	Port number	string {'1'}
IconDisplay	Icon display	'Signal name' | {'Port number'} | 'Port number and signal name'
UseBusObject	Specify properties via bus object	'on' | {'off'}
BusObject	For internal use	
BusOutputAsStruct	Output as nonvirtual bus in parent model	'on' | {'off'}
PortDimensions	Port dimensions (-1 for inherited)	string {'-1'}
SampleTime	Sample time (-1 for inherited)	string {'-1'}

Sinks Library Block Parameters (Continued)

Block (Type)/Parameter	Dialog Box Prompt	Values
DataType	Data type	{'auto'} | 'double' | 'single' | 'int8' | 'uint8' | 'int16' | 'uint16' | 'int32' | 'uint32' | 'boolean' | 'Specify via dialog'
OutDataType	Output data type (e.g., sfix(16), uint(8), float('single'))	string {'sfix(16)'}
OutScaling	Output scaling value (Slope, e.g., 2^-9 or [Slope Bias], e.g., [1.25 3])	string {'2^0'}
SignalType	Signal type	{'auto'} | 'real' | 'complex'
SamplingMode	Sampling mode	{'auto'} | 'Sample based' | 'Frame based'
OutputWhenDisabled	Output when disabled	{'held'} | 'reset'
InitialOutput	Initial output	string {'[]'}
Scope (Scope)		
Floating		'on' | {'off'}
Location		rectangle {'[188 390 512 629]'}
Open		'on' | {'off'}
NumInputPorts		string {'1'}
TickLabels		'on' | 'off' | {'OneTimeTick'}
ZoomMode		{'on'} | 'xonly' | 'yonly'
AxesTitles		list

Sinks Library Block Parameters (Continued)

Block (Type)/Parameter	Dialog Box Prompt	Values
Grid		`'off'` | `{'on'}` | `'xonly'` | `'yonly'`
TimeRange		string `{'auto'}`
YMin		string `{'-5'}`
YMax		string `{'5'}`
SaveToWorkspace		`'on'` | `{'off'}`
SaveName		string `{'ScopeData1'}`
DataFormat		`{'StructureWithTime'}` | `'Structure'` | `'Array'`
LimitDataPoints		`{'on'}` | `'off'`
MaxDataPoints		string `{'5000'}`
Decimation		string `{'1'}`
SampleInput		`'on'` | `{'off'}`
SampleTime		string `{'0'}`
Stop Simulation		
Terminator		
To File (`ToFile`)		
Filename	Filename	string `{'untitled.mat'}`
MatrixName	Variable name	string `{'ans'}`
Decimation	Decimation	string `{'1'}`
SampleTime	Sample time (-1 for inherited)	string `{'-1'}`
To Workspace (`ToWorkspace`)		
VariableName	Variable name	string `{'simout'}`
MaxDataPoints	Limit data points to last	string `{'inf'}`
Decimation	Decimation	string `{'1'}`
SampleTime	Sample time (-1 for inherited)	string `{'-1'}`

Sinks Library Block Parameters (Continued)

Block (Type)/Parameter	Dialog Box Prompt	Values
SaveFormat	Save format	`'Structure With Time'` | `{'Structure'}` | `'Array'`
FixptAsFi	Log fixed-point data as an fi object	`'on'` | `{'off'}`
XY Graph (XY scope) (masked subsystem)		
xmin	x-min	string `{'-1'}`
xmax	x-max	string `{'1'}`
ymin	y-min	string `{'-1'}`
ymax	y-max	string `{'1'}`
st	Sample time	string `{'-1'}`

Sources Library Block Parameters

Block (Type)/Parameter	Dialog Box Prompt	Values
Band-Limited White Noise (Band-Limited White Noise) (masked subsystem)		
Cov	Noise power	string `{'[0.1]'}`
Ts	Sample time	string `{'0.1'}`
seed	Seed	string `{'[23341]'}`
VectorParams1D	Interpret vector parameters as 1-D	`{'on'}` | `'off'`
Chirp Signal (chirp) (masked subsystem)		
f1	Initial frequency (Hz)	string `{'0.1'}`
T	Target time (secs)	string `{'100'}`
f2	Frequency at target time (Hz)	string `{'1'}`
VectorParams1D	Interpret vectors parameters as 1-D	`{'on'}` | `'off'`
Clock (Clock)		

Sources Library Block Parameters (Continued)

Block (Type)/Parameter	Dialog Box Prompt	Values
DisplayTime	Display time	`'on'` | `{'off'}`
Decimation	Decimation	`string` `{'10'}`
Constant (`Constant`)		
Value	Constant value	`string {'1'}`
VectorParams1D	Interpret vector parameters as 1-D	`{'on'}` | `'off'`
OutDataTypeMode	Output data type mode	`'double'` | `'single'` | `'int8'` | `'uint8'` | `'int16'` | `'uint16'` | `'int32'` | `'uint32'` | `'boolean'` | `'Specify via dialog'` | `{'Inherit from 'Constant value''}` | `'Inherit via back propagation'`
OutDataType	Output data type (e.g., sfix(16), uint(8), float('single'))	`string {'sfix(16)'}`
ConRadixGroup	Output scaling mode	`{'Use specified scaling'}` | `'Best Precision: Vector-wise'`
OutScaling	Output scaling value (Slope, e.g., 2^-9 or [Slope Bias], e.g., [1.25 3])	`string {'2^0'}`
SampleTime	Sample time	`string {'inf'}`
Counter Free-Running (`Counter Free-Running`) (masked subsystem)		
NumBits	Number of Bits	`string {'16'}`
tsamp	Sample time	`string {'-1'}`
Counter Limited (`Counter Limited`) (masked subsystem)		
uplimit	Upper limit	`string {'7'}`

Sources Library Block Parameters (Continued)

Block (Type)/Parameter	Dialog Box Prompt	Values
tsamp	Sample time	string {'-1'}
Digital Clock (DigitalClock)		
SampleTime	Sample time	string {'1'}
From File (FromFile)		
FileName	Filename	string {'untitled.mat'}
SampleTime	Sample time	string {'0'}
From Workspace (FromWorkspace)		
VariableName	Data	string {'simin'}
SampleTime	Sample time	string {'0'}
Interpolate	Interpolate data	{'on'} | 'off'
ZeroCross	Enable zero crossing detection	{'on'} | 'off'
OutputAfterFinalValue	Form output after final data value by	{'Extrapolation'} | 'Setting to zero' | 'Holding final value' | 'Cyclic repetition'
Ground		
In1 (Inport)		
Port	Port number	string {'1'}
IconDisplay	Icon display	'Signal name' | {'Port number'} | 'Port number and signal name'
UseBusObject	Specify properties via bus object	'on' | {'off'}
BusObject	For internal use	
BusOutputAsStruct	Output as nonvirtual bus	'on' | {'off'}
PortDimensions	Port dimensions (-1 for inherited)	string {'-1'}

Sources Library Block Parameters (Continued)

Block (Type)/Parameter	Dialog Box Prompt	Values
SampleTime	Sample time (-1 for inherited)	string {'-1'}
DataType	Data type	{'auto'}	'double'	'single'	'int8'	'uint8'	'int16'	'uint16'	'int32'	'uint32'	'boolean'	'Specify via dialog'
OutDataType	Output data type (e.g., sfix(16), uint(8), float('single'))	string {'sfix(16)'}
OutScaling	Output scaling value (Slope, e.g., 2^-9 or [Slope Bias], e.g., [1.25 3])	string {'2^0'}
SignalType	Signal type	{'auto'}	'real'	'complex'
SamplingMode	Sampling mode	{'auto'}	'Sample based'	'Frame based'
LatchInput	Latch (buffer) input	'on'	{'off'}
Interpolate	Interpolate data	{'on'}	'off'
Pulse Generator (DiscretePulseGenerator)		
PulseType	Pulse type	{'Time based'}	'Sample based'
TimeSource	Time (t)	{'Use simulation time'}	'Use external signal'
Amplitude	Amplitude	string {'1'}
Period	Period	string {'2'}
PulseWidth	Pulse width	string {'50'}
PhaseDelay	Phase delay	string {'0'}
SampleTime	Sample time	string {'1'}

Sources Library Block Parameters (Continued)

Block (Type)/Parameter	Dialog Box Prompt	Values
VectorParams1D	Interpret vector parameters as 1-D	{'on'} | 'off'
Ramp (Ramp) (masked subsystem)		
slope	Slope	string {'1'}
start	Start time	string {'0'}
X0	Initial output	string {'0'}
VectorParams1D	Interpret vector parameters as 1-D	{'on'} | 'off'
Random Number (RandomNumber)		
Mean	Mean	string {'0'}
Variance	Variance	string {'1'}
Seed	Initial seed	string {'0'}
SampleTime	Sample time	string {'0'}
VectorParams1D	Interpret vector parameters as 1-D	{'on'} | 'off'
Repeating Sequence (Repeating table) (masked subsystem)		
rep_seq_t	Time values	string {'[0 2]'}
rep_seq_y	Output values	string {'[0 2]'}
Repeating Sequence Interpolated (Repeating Sequence Interpolated) (masked subsystem)		
OutValues	Vector of output values	string {'[3 1 4 2 1].''}
TimeValues	Vector of time values	string {'[0 0.1 0.5 0.6 1].''}
LookUpMeth	Lookup method	{'Interpolation-Use End Values'} | 'Use Input Nearest' | 'Use Input Below' | 'Use Input Above'

Sources Library Block Parameters (Continued)

Block (Type)/Parameter	Dialog Box Prompt	Values
tsamp	Sample time	string {'0.01'}
OutputDataTypeScaling Mode	Output data type and scaling	{'Specify via dialog'} | 'Inherit via back propagation'
OutDataType	Output data type: ex. sfix(16), uint(8), float('single')	string {'float('double')'}
OutScaling	Output scaling: Slope or [Slope Bias] ex. 2^-9	string {'2^-10'}
LockScale	Lock output scaling so autoscaling tool can't change it	'on' | {'off'}
Repeating Sequence Stair (Repeating Sequence Stair) (masked subsystem)		
OutValues	Vector of output values	string {'[3 1 4 2 1].''}
tsamp	Sample time	string {'-1'}
OutputDataTypeScaling Mode	Output data type and scaling	{'Specify via dialog'} | 'Inherit via back propagation'
OutDataType	Output data type: ex. sfix(16), uint(8), float('single')	string {'float('double')'}
ConRadixGroup	Output scaling mode	'Use Specified Scaling' | {'Best Precision: Vector-wise'}
OutScaling	Output scaling: Slope or [Slope Bias] ex. 2^-9	string {'2^-12'}
LockScale	Lock output scaling so autoscaling tool can't change it	'on' | {'off'}
Signal Builder (Sigbuilder block) (masked subsystem)		
Signal Generator (SignalGenerator)		
WaveForm	Wave form	{'sine'} | 'square' | 'sawtooth' | 'random'

Sources Library Block Parameters (Continued)

Block (Type)/Parameter	Dialog Box Prompt	Values
TimeSource	Time (t)	{'Use simulation time'} | 'Use external signal'
Amplitude	Amplitude	string {'1'}
Frequency	Frequency	string {'1'}
Units	Units	'rad/sec' | {'Hertz'}
VectorParams1D	Interpret vector parameters as 1-D	{'on'} | 'off'
Sine Wave (Sin)		
SineType	Sine type	{'Time based'} | 'Sample based'
TimeSource	Time (t)	{'Use simulation time'} | 'Use external signal'
Amplitude	Amplitude	string {'1'}
Bias	Bias	string {'0'}
Frequency	Frequency (rad/sec)	string {'1'}
Phase	Phase (rad)	string {'0'}
Samples	Samples per period	string {'10'}
Offset	Number of offset samples	string {'0'}
SampleTime	Sample time	string {'0'}
VectorParams1D	Interpret vector parameters as 1-D	{'on'} | 'off'
Step (Step)		
Time	Step time	string {'1'}
Before	Initial value	string {'0'}
After	Final value	string {'1'}
SampleTime	Sample time	string {'0'}

Sources Library Block Parameters (Continued)

Block (Type)/Parameter	Dialog Box Prompt	Values
`VectorParams1D`	Interpret vector parameters as 1-D	`{'on'}	'off'`
`ZeroCross`	Enable zero crossing detection	`{'on'}	'off'`
Uniform Random Number (`UniformRandomNumber`)		
`Minimum`	Minimum	string `{'-1'}`
`Maximum`	Maximum	string `{'1'}`
`Seed`	Initial seed	string `{'0'}`
`SampleTime`	Sample time	string `{'0'}`
`VectorParams1D`	Interpret vector parameters as 1-D	`{'on'}	'off'`

User-Defined Functions Library Block Parameters

Block (Type)/Parameter	Dialog Box Prompt	Values
Embedded MATLAB Fcn (`Stateflow`) (masked subsystem)		
Fcn (`Fcn`)		
`Expr`	Expression	string `{'sin(u(1)*exp(2.3*(-u(2))))'}`
`SampleTime`	Sample time (-1 for inherited)	string `{'-1'}`
Level-2 M-file S-Function (`M-S-Function`)		
`FunctionName`	M-file name	string `{'mlfile'}`
`Parameters`	Parameters	string `{''}`
MATLAB Fcn (`MATLABFcn`)		
`MATLABFcn`	MATLAB function	string `{'sin'}`
`OutputDimensions`	Output dimensions	string `{'-1'}`
`OutputSignalType`	Output signal type	`{'auto'}	'real'	'complex'`

User-Defined Functions Library Block Parameters (Continued)

Block (Type)/Parameter	Dialog Box Prompt	Values
Output1D	Collapse 2-D results to 1-D	{'on'} | 'off'
SampleTime	Sample time (-1 for inherited)	string {'-1'}
S-Function (S-Function)		
FunctionName	S-function name	string {'system'}
Parameters	S-function parameters	string {''}
SFunctionModules	S-function modules	string {''}
S-Function Builder (S-Function Builder) (masked subsystem)		
FunctionName	S-function name	string {'system'}
Parameters	S-function parameters	string {''}
SFunctionModules	S-function modules	string {''}

Additional Discrete Block Library Parameters

Block (Type)/Parameter	Dialog Box Prompt	Values
Fixed-Point State-Space (Fixed-Point State-Space) (masked subsystem)		
A	State Matrix A	string {'[2.6020 -2.2793 0.6708; 1 0 0; 0 1 0]'}
B	Input Matrix B	string {'[1; 0; 0]'}
C	Output Matrix C	string {'[0.0184 0.0024 0.0055]'}
D	Direct Feedthrough Matrix D	string {'[0.0033]'}
X0	Initial condition for state	string {'0.0'}

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Additional Discrete Block Library Parameters (Continued)

Block (Type)/Parameter	Dialog Box Prompt	Values
InternalDataType	Data type for internal calculations: ex. sfix(16), uint(8), float('single')	string {'float('double')'}
StateEqScaling	Scaling for State Equation AX+BU: ex. 2^-9	string {'2^0'}
OutputEqScaling	Scaling for Output Equation CX+DU: ex. 2^-9	string {'2^0'}
LockScale	Lock output scaling so autoscaling tool can't change it	'on' | {'off'}
RndMeth	Round toward	'Zero' | 'Nearest' | 'Ceiling' | {'Floor'}
DoSatur	Saturate to max or min when overflows occur	'on' | {'off'}
Transfer Fcn Direct Form II (Transfer Fcn Direct Form II) (masked subsystem)		
NumCoefVec	Numerator coefficients	string {'[0.2 0.3 0.2]'}
DenCoefVec	Denominator coefficients excluding lead (which must be 1.0)	string {'[-0.9 0.6]'}
vinit	Initial condition	string {'0.0'}
RndMeth	Round toward	'Zero' | 'Nearest' | 'Ceiling' | {'Floor'}
DoSatur	Saturate to max or min when overflows occur	'on' | {'off'}
Transfer Fcn Direct Form II Time Varying (Transfer Fcn Direct Form II Time Varying) (masked subsystem)		
vinit	Initial condition	string {'0.0'}
RndMeth	Round toward	'Zero' | 'Nearest' | 'Ceiling' | {'Floor'}

Additional Discrete Block Library Parameters (Continued)

Block (Type)/Parameter	Dialog Box Prompt	Values
DoSatur	Saturate to max or min when overflows occur	'on' | {'off'}
Unit Delay Enabled (Unit Delay Enabled) (masked subsystem)		
vinit	Initial condition	string {'0.0'}
tsamp	Sample time	string {'-1'}
Unit Delay Enabled External IC (Unit Delay Enabled External Initial Condition) (masked subsystem)		
tsamp	Sample time	string {'-1'}
Unit Delay Enabled Resettable (Unit Delay Enabled Resettable) (masked subsystem)		
vinit	Initial condition	string {'0.0'}
tsamp	Sample time	string {'-1'}
Unit Delay Enabled Resettable External IC (Unit Delay Enabled Resettable External Initial Condition) (masked subsystem)		
tsamp	Sample time	string {'-1'}
Unit Delay External IC (Unit Delay External Initial Condition) (masked subsystem)		
tsamp	Sample time	string {'-1'}
Unit Delay Resettable (Unit Delay Resettable) (masked subsystem)		
vinit	Initial condition	string {'0.0'}
tsamp	Sample time	string {'-1'}
Unit Delay Resettable External IC (Unit Delay Resettable External Initial Condition) (masked subsystem)		
tsamp	Sample time	string {'-1'}
Unit Delay With Preview Enabled (Unit Delay With Preview Enabled) (masked subsystem)		

Additional Discrete Block Library Parameters (Continued)

Block (Type)/Parameter	Dialog Box Prompt	Values
vinit	Initial condition	string {'0.0'}
tsamp	Sample time	string {'-1'}
Unit Delay With Preview Enabled Resettable (Unit Delay With Preview Enabled Resettable) (masked subsystem)		
vinit	Initial condition	string {'0.0'}
tsamp	Sample time	string {'-1'}
Unit Delay With Preview Enabled Resettable External RV (Unit Delay With Preview Enabled Resettable External RV) (masked subsystem)		
vinit	Initial condition	string {'0.0'}
tsamp	Sample time	string {'-1'}
Unit Delay With Preview Resettable (Unit Delay With Preview Resettable) (masked subsystem)		
vinit	Initial condition	string {'0.0'}
tsamp	Sample time	string {'-1'}
Unit Delay With Preview Resettable External RV (Unit Delay With Preview Resettable External RV) (masked subsystem)		
vinit	Initial condition	string {'0.0'}
tsamp	Sample time	string {'-1'}

Additional Math: Increment - Decrement Block Parameters

Block (Type)/Parameter	Dialog Box Prompt	Values
Decrement Real World (Real World Value Decrement) (masked subsystem)		
Decrement Stored Integer (Stored Integer Value Decrement) (masked subsystem)		

Additional Math: Increment - Decrement Block Parameters (Continued)

Block (Type)/Parameter	Dialog Box Prompt	Values
Decrement Time To Zero (`Decrement Time To Zero`) (masked subsystem)		
Decrement To Zero (`Decrement To Zero`) (masked subsystem)		
Increment Real World (`Real World Value Increment`) (masked subsystem)		
Increment Stored Integer (`Stored Integer Value Increment`) (masked subsystem)		

Mask Parameters

This section lists parameters that describe masked blocks. This table lists masking parameters, which correspond to Mask Editor dialog box parameters (see "Setting Mask Parameters" on page 10-168).

Mask Parameters

Parameter	Description/Prompt	Values
Mask	Turns mask on or off.	{'on'} | 'off'
MaskCallbackString	Mask parameter callbacks that are executed when the respective parameter is changed on the dialog. Set by the **Dialog callback** field on the **Parameters** pane of the Mask Editor dialog box.	pipe-delimited string {''}
MaskCallbacks	Cell array version of MaskCallbackString.	cell array {'[]'}
MaskDescription	Block description. Set by the **Mask description** field on the **Documentation** pane of the Mask Editor dialog box.	string {''}
MaskDisplay	Drawing commands for the block icon. Set by the **Drawing commands** field on the **Icon** pane of the Mask Editor dialog box.	string {''}
MaskEditorHandle	For internal use.	
MaskEnableString	Option that determines whether a parameter is greyed out in the dialog. Set by the **Enable parameter** check box on the **Parameters** pane of the Mask Editor dialog box.	pipe-delimited string {''}

Mask Parameters (Continued)

Parameter	Description/Prompt	Values
MaskEnables	Cell array version of MaskEnableString.	cell array of strings, each either 'on' or 'off' {'[]'}
MaskHelp	Block help. Set by the **Mask help** field on the **Documentation** pane of the Mask Editor dialog box.	string {''}
MaskIconFrame	Set the visibility of the icon frame (Visible is on, Invisible is off). Set by the **Frame** option on the **Icon** pane of the Mask Editor dialog box.	{'on'} | 'off'
MaskIconOpaque	Set the transparency of the icon (Opaque is on, Transparent is off). Set by the **Transparency** option on the **Icon** pane of the Mask Editor dialog box.	{'on'} | 'off'
MaskIconRotate	Set the rotation of the icon (Rotates is on, Fixed is off). Set by the **Rotation** option on the **Icon** pane of the Mask Editor dialog box.	'on' | {'off'}
MaskIconUnits	Set the units for the drawing commands. Set by the **Units** option on the **Icon** pane of the Mask Editor dialog box.	'pixel' | {'autoscale'} | 'normalized'
MaskInitialization	Initialization commands. Set by the **Initialization commands** field on the **Initialization** pane of the Mask Editor dialog box.	MATLAB command {''}

Mask Parameters (Continued)

Parameter	Description/Prompt	Values
MaskNames	Cell array of mask dialog parameter names. Set inside the **Variable** column in the **Parameters** pane of the Mask Editor dialog box.	matrix {'[]'}
MaskPrompts	List of dialog parameter prompts (see below). Set inside the **Dialog parameters** area on the **Parameters** pane of the Mask Editor dialog box.	cell array of strings {'[]'}
MaskPromptString	List of dialog parameter prompts (see below). Set inside the **Dialog parameters** area on the **Parameters** pane of the Mask Editor dialog box.	string {''}
MaskPropertyName String	Pipe-delimited version of **MaskNames**.	string {''}
MaskRunInitForIconRedraw	For internal use.	
MaskSelfModifiable	Indicates that the block can modify itself. Set by the **Allow library block to modify its contents** check box on the **Initialization** pane of the Mask Editor dialog box.	'on'	{'off'}
MaskStyles	Determines whether the dialog parameter is a check box, edit field, or pop-up list. Set by the **Type** column in the **Parameters** pane of the Mask Editor dialog box.	cell array {'[]'}
MaskStyleString	Comma-separated version of **MaskStyles**.	string {''}

Mask Parameters (Continued)

Parameter	Description/Prompt	Values
`MaskTabNameString`	For internal use.	
`MaskTabNames`	For internal use.	
`MaskToolTips Display`	Determines which of the mask dialog parameters to display.	cell array of `'on'` and `'off'` {"}
`MaskToolTipString`	Comma-delimited version of `MaskToolTipsDisplay`.	string {`''`}
`MaskTunableValues`	Allows the changing of mask dialog values during simulation. Set by the **Tunable** column in the **Parameters** pane of the Mask Editor dialog box.	cell array of strings {`'[]'`}
`MaskTunableValueString`	Comma-delimited string version of `MaskTunableValues`.	delimited string {`''`}
`MaskType`	Mask type. Set by the **Mask type** field on the **Documentation** pane of the Mask Editor dialog box.	string {`'Stateflow'`}
`MaskValues`	Dialog parameter values.	cell array {`'[]'`}
`MaskValueString`	Delimited string version of `MaskValues`.	delimited string {`''`}
`MaskVarAliases`	Specify aliases for a block's mask parameters. The aliases must appear in the same order as the parameters appear in the block's MaskValues parameter.	cell array {`'[]'`}
`MaskVarAliasString`	For internal use.	

Mask Parameters (Continued)

Parameter	Description/Prompt	Values
MaskVariables	List of the dialog parameters' variables (see below). Set inside the **Dialog parameters** area on the **Parameters** pane of the Mask Editor dialog box.	string {''}
MaskVisibilities	Specifies visibility of parameters. Set with the **Show parameter** check box in the **Options for selected parameter** area on the **Parameters** pane of the Mask Editor dialog box.	matrix {'[]'}
MaskVisibility String	Cell array version of MaskVisibilities.	string {''}
MaskWSVariables	List of the variables defined in the mask workspace (read only).	matrix {'[]'}

Setting Mask Parameters

When you use the Mask Editor to create a dialog box parameter for a masked block, you provide this information:

- The prompt, which you enter in the **Prompt** field

- The variable that holds the parameter value, which you enter in the **Variable** field

- The type of field created, which you specify by selecting a control **Type**

- Whether the value entered in the field is to be evaluated or stored as a literal, which you specify by selecting an **Evaluate** type

How Masked Parameters are Stored

The mask parameters, listed in the preceding table, store the values specified for the dialog box parameters in these ways:

- The **Prompt** field values for all dialog box parameters are stored in the `MaskPromptString` parameter as a string, with individual values separated by a vertical bar (|), as shown in this example:

  ```
  "Slope:|Intercept:"
  ```

- The **Variable** field values for all dialog box parameters are stored in the `MaskVariables` parameter as a string, with individual assignments separated by a semicolon. A sequence number indicates the prompt that is associated with a variable. A special character preceding the sequence number indicates the **Evaluate** type: @ indicates **Evaluate**, & indicates **Literal**.

  For example, "a=@1;b=&2;" indicates that the value entered in the first parameter field is assigned to variable `a` and is evaluated in MATLAB before assignment, and the value entered in the second field is assigned to variable `b` and is stored as a literal, which means that its value is the string entered in the dialog box.

- The control **Type** field values for all dialog box parameters are stored in the `MaskStyleString` parameter as a string, with individual values separated by a comma. The **Popup strings** values appear after the `popup` type, as shown in this example:

  ```
  "edit,checkbox,popup(red|blue|green)"
  ```

- The parameter values are stored in the `MaskValueString` mask parameter as a string, with individual values separated by a vertical bar. The order of the values is the same as the order in which the parameters appear on the dialog box. For example, these statements define values for the parameter field prompts and the values for those parameters:

  ```
  MaskPromptString      "Slope:|Intercept:"
  MaskValueString       "2|5"
  ```

Model File Format

This section describes the format of a Simulink model file.

Model File Contents

A model file is a structured ASCII file that contains keywords and
parameter-value pairs that describe the model. The file describes model
components in hierarchical order.

The structure of the model file is as follows.

```
Model {
  <Model Parameter Name> <Model Parameter Value>
  ...
  BlockDefaults {
    <Block Parameter Name> <Block Parameter Value>
    ...
  }
  AnnotationDefaults {
    <Annotation Parameter Name> <Annotation Parameter Value>
    ...
  }
  System {
    <System Parameter Name> <System Parameter Value>
    ...
    Block {
      <Block Parameter Name> <Block Parameter Value>
      ...
    }
    Line {
      <Line Parameter Name> <Line Parameter Value>
      ...
      Branch {
        <Branch Parameter Name> <Branch Parameter Value>
        ...
      }
    }
    Annotation {
      <Annotation Parameter Name> <Annotation Parameter Value>
      ...
    }
  }
}
```

The model file consists of sections that describe different model components:

- The `Model` section defines model parameters.
- The `BlockDefaults` section contains default settings for blocks in the model.
- The `AnnotationDefaults` section contains default settings for annotations in the model.
- The `System` section contains parameters that describe each system (including the top-level system and each subsystem) in the model. Each `System` section contains block, line, and annotation descriptions.

See Chapter 10, "Model and Block Parameters" for descriptions of model and block parameters.

Model Section

The `Model` section, located at the top of the model file, defines the values for model-level parameters. These parameters include the model name, the version of Simulink last used to modify the model, and simulation parameters.

BlockDefaults Section

The `BlockDefaults` section appears after the simulation parameters and defines the default values for block parameters within this model. These values can be overridden by individual block parameters, defined in the `Block` sections.

AnnotationDefaults Section

The `AnnotationDefaults` section appears after the `BlockDefaults` section. This section defines the default parameters for all annotations in the model. These parameter values cannot be modified using the set_param command.

System Section

The top-level system and each subsystem in the model are described in a separate `System` section. Each `System` section defines system-level parameters

and includes `Block`, `Line`, and `Annotation` sections for each block, line, and
annotation in the system. Each `Line` that contains a branch point includes a
`Branch` section that defines the branch line.

Embedded MATLAB Function Block Reference

An Embedded MATLAB Function block lets you compose a MATLAB language function in a Simulink model that generates embeddable code. In an Embedded MATLAB Function block, you create functions with a rich subset of the MATLAB language. Later, when you simulate the model or generate code for a target environment, a function in an Embedded MATLAB Function block generates efficient C code. This code meets the strict memory and data type requirements of embedded target environments. In this way, Embedded MATLAB Function blocks bring the power of MATLAB for the embedded environment into Simulink.

The following sections describe the supported MATLAB features in Embedded MATLAB functions:

Supported Variable Types in Embedded MATLAB Functions (p. 12-2)	Data types supported by Embedded MATLAB Function blocks.
Operators in Embedded MATLAB Functions (p. 12-4)	Operators supported by Embedded MATLAB Function blocks.
Embedded MATLAB Run-Time Function Library (p. 12-8)	Lists of run-time library functions that you can call in an Embedded MATLAB function.
Unsupported MATLAB Features and Limitations (p. 12-37)	Features not supported by Embedded MATLAB Function blocks.

Supported Variable Types in Embedded MATLAB Functions

Embedded MATLAB functions support a subset of MATLAB data types for input (argument) and output (return) variables, and variables local to the function. This section lists and describes the data types supported in Embedded MATLAB functions, along with any exceptions or deviations from MATLAB behavior.

Embedded MATLAB functions support scalar, vector, and matrix (two-dimensional) variables of the types represented by the following cast functions.

Type/Function	Description
char	Character array (string)
complex	Complex data. Cast function takes real and imaginary components. See "Declaring Local Complex Variables Implicitly" in Using Simulink.
double	Double-precision floating point
int8, int16, int32	Signed integer
logical	Boolean true or false
single	Single-precision floating point
uint8, uint16, uint32	Unsigned integer

Note For more information on fixed-point support in Embedded MATLAB, refer to "Using the Fixed-Point Toolbox with Embedded MATLAB" in the Fixed-Point Toolbox User's Guide documentation.

For further information on Embedded MATLAB, see

- "Using the Embedded MATLAB Function Block" in the Simulink user's documentation

- Embedded MATLAB Function in the Simulink reference documentation

- "Using Embedded MATLAB Functions" in the Stateflow user's documentation

Operators in Embedded MATLAB Functions

Embedded MATLAB functions support a large subset of MATLAB operators for data operands of type `double` and `single`. Allowed MATLAB operators in Embedded MATLAB functions are listed in the following topics:

- "Control Flow Statements in Embedded MATLAB Functions" on page 12-4 – Common programming statements supported in Embedded MATLAB functions

- "Arithmetic Operators in Embedded MATLAB Functions" on page 12-5 – Operators for arithmetic operations supported in Embedded MATLAB functions.

- "Relational Operators in Embedded MATLAB Functions" on page 12-6 – Operators for relational operations supported in Embedded MATLAB functions.

- "Logical Operators in Embedded MATLAB Functions" on page 12-6 – Lists operators for logical operations supported in Embedded MATLAB functions.

Each listing includes a link to the MATLAB Function Reference documentation (help) for the equivalent MATLAB function along with a one-line description and any limitations that apply.

Control Flow Statements in Embedded MATLAB Functions

Embedded MATLAB functions support the following MATLAB program statements:

Statement	Description
break	break statement
continue	continue statement
for	for statement

Statement	Description
if	if statement
	The conditions of an if statement cannot use & and | operators. In their place, use the && and || operators, respectively. To logically collapse vectors into scalars, use the function all.
return	return statement
switch	switch statement
while	while statement
	The conditions of while statements cannot use & and | operators. In their place, use the && and || operators, respectively. To logically collapse vectors into scalars, use the function all.

Arithmetic Operators in Embedded MATLAB Functions

Embedded MATLAB functions support the following MATLAB arithmetic operations for matrix operands (maximum two-dimensional) of type double or single. See "Arithmetic Operators + - * / \ ^ '" in the MATLAB Function Reference documentation for detailed descriptions of each operation and any requirements for the data types of the operands.

Operator	Description
+	Addition
-	Subtraction
*	Multiplication
.*	Elementwise multiplication
/	Slash or matrix right division
./	Elementwise division
\	Backslash or matrix left division
.\	Array left division
^	Matrix power

Operator	Description
.^	Elementwise raising to a scalar power
[ ]	Concatenation of matrices
'	Complex conjugate transpose
.'	Transpose
(r, c)	Matrix indexing, where r and c are vectors of row and column indices, respectively

Relational Operators in Embedded MATLAB Functions

Embedded MATLAB functions support the following elementwise relational operators between matrix operands (maximum two-dimensional) of type double or single of the same size. See "Relational Operators < > <= >= == ~=" in the MATLAB Function Reference documentation for detailed descriptions of each operation and any requirements for the data types of the operands.

Operation	Description
<	Less than
<=	Less than or equal to
>=	Greater than or equal to
>	Greater than
==	Equal
~=	Not equal

Logical Operators in Embedded MATLAB Functions

Embedded MATLAB functions support the following elementwise logical operators between matrix operands (maximum two-dimensional) of type double or single of the same size. See "Logical Operators, Element-wise & | ~" and "Logical Operators, Short-circuit && ||" in the MATLAB Function Reference documenation for detailed descriptions of each operation and any requirements for the data types of the operands.

Operation	Description
&	Logical AND
	This & operator is limited to use outside `if` and `while` statement conditions. In its place, use the && operator. To logically collapse vectors into scalars, use the Embedded MATLAB function `all`.
|	Logical OR
	This | operator is limited to use outside `if` and `while` statements. In its place, use the || operator. To logically collapse vectors into scalars use, the Embedded MATLAB function `all`.
-	Element complement
xor	Logical XOR
&&	Logical AND (short-circuiting)
||	Logical OR (short-circuiting)

Embedded MATLAB Run-Time Function Library

This section lists the callable functions of the Embedded MATLAB run-time function library. Functions in the Embedded MATLAB run-time library have the same name, same arguments (with limitations), and the same functionality (with limitations) as their MATLAB or Fixed-Point Toolbox counterparts, but are written in C to produce efficient embeddable generated code. If you restrict your function calls in Embedded MATLAB functions to these functions, you can use the code generated for an Embedded MATLAB function to build a stand-alone executable target that you can move to different platforms for execution.

For more information on fixed-point support in Embedded MATLAB, refer to "Using the Fixed-Point Toolbox with Embedded MATLAB" in the Fixed-Point Toolbox documentation.

The following topics list and describe the functions supported by the Embedded MATLAB run-time library:

- "Embedded MATLAB Run-Time Function Library – Alphabetical List" on page 12-8

- "Embedded MATLAB Run-Time Library – Categorical List" on page 12-24

Embedded MATLAB Run-Time Function Library – Alphabetical List

This topic lists functions in the Embedded MATLAB run-time library in alphabetical order. Each entry includes a link to the help for the equivalent MATLAB or Fixed-Point Toolbox function along with any limitations that apply to it. See also "Embedded MATLAB Run-Time Library – Categorical List" on page 12-24.

Function	Product	Remarks/Limitations
abs	MATLAB	—
abs	Fixed-Point Toolbox	—

Function	Product	Remarks/Limitations
acos	MATLAB	• Returns NaN when the input value x is real, but the output should be complex. To get the complex result, make the input value complex by passing in complex(x).
acosd	MATLAB	—
acosh	MATLAB	• Returns NaN when the input value x is real, but the output should be complex. To get the complex result, make the input value complex by passing in complex(x).
acot	MATLAB	—
acotd	MATLAB	—
acoth	MATLAB	—
acsc	MATLAB	—
acscd	MATLAB	—
acsch	MATLAB	—
all	MATLAB	—
all	Fixed-Point Toolbox	—
and	MATLAB	—
angle	MATLAB	—
any	MATLAB	—
any	Fixed-Point Toolbox	—
asec	MATLAB	—
asecd	MATLAB	—
asech	MATLAB	—
asin	MATLAB	• Returns NaN when the input value x is real, but the output should be complex. To get the complex result, make the input value complex by passing in complex(x).

Function	Product	Remarks/Limitations
asind	MATLAB	—
asinh	MATLAB	—
atan	MATLAB	—
atan2	MATLAB	—
atand	MATLAB	—
atanh	MATLAB	• Returns NaN when the input value x is real, but the output should be complex. To get the complex result, make the input value complex by passing in complex(x).
bitand	MATLAB	• Does not support floating point inputs. The arguments must belong to an integer class.
bitand	Fixed-Point Toolbox	—
bitcmp	MATLAB	• Does not support floating point input for the first argument. The first argument must belong to an integer class.
bitcmp	Fixed-Point Toolbox	—
bitget	MATLAB	• Does not support floating point input for the first argument. The first argument must belong to an integer class.
bitget	Fixed-Point Toolbox	—
bitor	MATLAB	• Does not support floating point inputs. The arguments must belong to an integer class.
bitor	Fixed-Point Toolbox	—
bitset	MATLAB	• Does not support floating point input for the first argument. The first argument must belong to an integer class.

Function	Product	Remarks/Limitations
`bitset`	Fixed-Point Toolbox	—
`bitshift`	MATLAB	• Does not support floating point input for the first argument. The first argument must belong to an integer class.
`bitshift`	Fixed-Point Toolbox	—
`bitxor`	MATLAB	• Does not support floating point inputs. The arguments must belong to an integer class.
`bitxor`	Fixed-Point Toolbox	—
`cast`	MATLAB	
`ceil`	MATLAB	—
`char`	MATLAB	—
`chol`	MATLAB	• Does not allow two output arguments
`class`	MATLAB	—
`compan`	MATLAB	—
`complex`	MATLAB	—
`complex`	Fixed-Point Toolbox	—
`conj`	MATLAB	—
`conj`	Fixed-Point Toolbox	—
`conv`	MATLAB	—
`cos`	MATLAB	—
`cosd`	MATLAB	—
`cosh`	MATLAB	—
`cot`	MATLAB	—

Function	Product	Remarks/Limitations
cotd	MATLAB	—
coth	MATLAB	—
cross	MATLAB	• If supplied, dim must be a constant
csc	MATLAB	—
cscd	MATLAB	—
csch	MATLAB	—
ctranspose	MATLAB	—
ctranspose	Fixed-Point Toolbox	—
cumprod	MATLAB	—
cumsum	MATLAB	—
diag	MATLAB	• If supplied, k must be a real and scalar integer value
diff	MATLAB	• If applied, n and dim must be constants
disp	Fixed-Point Toolbox	—
divide	Fixed-Point Toolbox	• Any non-fi input must be constant; that is, its value must be known at compile time so that it can be cast to a fi • Complex and imaginary divisors are not supported
dot	MATLAB	—
double	MATLAB	—
double	Fixed-Point Toolbox	—

Function	Product	Remarks/Limitations
eig	MATLAB	• `QZ` algorithm used in all cases. Consequently, for the standard eigenvalue problem (`B` identity), results will be similar to those obtained using the following in MATLAB: `[V,D] = eig(A,eye(size(A)),'qz')` However, `V` may represent a different basis of eigenvectors, and the eigenvalues in `D` may not be in the same order. • Options `'balance'`, `'nobalance'`, and `'chol'` are not yet supported. • Outputs are always of complex type.
end	Fixed-Point Toolbox	—
eps	MATLAB	
eps	Fixed-Point Toolbox	—
eq	MATLAB	—
eq	Fixed-Point Toolbox	• Not supported for fixed-point signals with different biases
exp	MATLAB	—
eye	MATLAB	• Dimensions must be real, non-negative, integer constants
factorial	MATLAB	—
false	MATLAB	Dimensions must be real, non-negative, integer constants
fft	MATLAB	• Length of input vector must be a power of 2
fftshift	MATLAB	—

Function	Product	Remarks/Limitations
fi	Fixed-Point Toolbox	• Use to create a fixed-point constant or variable in Embedded MATLAB • The syntax `fi('PropertyName',PropertyValue...)` is not supported. To use property name/property value pairs, you must first specify the value v of the fi object as in `fi(v,'PropertyName',PropertyValue...)` • Works for constant input values only; that is, the value of the input must be known at compile time • Numerictype information must be available for nonfixed-point Simulink inputs
filter	MATLAB	• Results might differ from MATLAB if the input contains NaNs
fimath	Fixed-Point Toolbox	• Fixed-point signals coming in to an Embedded MATLAB Function block from Simulink are assigned the default fimath object • fimath objects in Embedded MATLAB
fix	MATLAB	—
fliplr	MATLAB	—
flipud	MATLAB	—
floor	MATLAB	—
freqspace	MATLAB	—
ge	MATLAB	—
ge	Fixed-Point Toolbox	• Not supported for fixed-point signals with different biases
gt	MATLAB	—
gt	Fixed-Point Toolbox	• Not supported for fixed-point signals with different biases

Function	Product	Remarks/Limitations
hilb	MATLAB	—
horzcat	Fixed-Point Toolbox	—
idivide	MATLAB	• opt string must be in lower case • For efficient generated code, MATLAB divide-by-zero rules are supported only for the 'round' option
ifft	MATLAB	• Length of input vector must be a power of 2 • Output of ifft block is always complex
imag	MATLAB	—
imag	Fixed-Point Toolbox	—
ind2sub	MATLAB	• No support for N-dimensional matrices. Size vector must have exactly two elements.
inf	MATLAB	• Dimensions must be real, non-negative, integer constants.
int8, int16, int32	MATLAB	—
int8, int16, int32	Fixed-Point Toolbox	—
interp1	MATLAB	• Supports only linear and nearest interpolation methods • Does not handle evenly spaced X indices separately • X must be strictly monotonically increasing or strictly monotonically decreasing; does not reorder indices

Function	Product	Remarks/Limitations
interp1q, see interp1	MATLAB	• X must be strictly monotonically increasing or strictly monotonically decreasing; does not reorder indices
intmax	MATLAB	
intmin	MATLAB	
inv	MATLAB	—
invhilb	MATLAB	—
isa	MATLAB	—
ischar	MATLAB	—
iscolumn	Fixed-Point Toolbox	—
isempty	MATLAB	—
isempty	Fixed-Point Toolbox	—
isequal	MATLAB	• Supports only two arguments.
isfi	Fixed-Point Toolbox	—
isfimath	Fixed-Point Toolbox	—
isfinite	MATLAB	—
isfinite	Fixed-Point Toolbox	—
isfloat	MATLAB	—
isinf	MATLAB	—
isinf	Fixed-Point Toolbox	—
isinteger	MATLAB	—

Function	Product	Remarks/Limitations
islogical	MATLAB	—
isnan	MATLAB	—
isnan	Fixed-Point Toolbox	—
isnumeric	MATLAB	—
isnumeric	Fixed-Point Toolbox	—
isnumerictype	Fixed-Point Toolbox	—
isreal	MATLAB	—
isreal	Fixed-Point Toolbox	—
isrow	Fixed-Point Toolbox	—
isscalar	MATLAB	—
isscalar	Fixed-Point Toolbox	—
issigned	Fixed-Point Toolbox	—
isvector	MATLAB	—
isvector	Fixed-Point Toolbox	—
ldivide	MATLAB	—
le	MATLAB	—
le	Fixed-Point Toolbox	• Not supported for fixed-point signals with different biases
length	MATLAB	—
length	Fixed-Point Toolbox	—

Function	Product	Remarks/Limitations
linspace	MATLAB	• Number of points N must be a constant that is positive, real, and integer valued
log	MATLAB	• Returns NaN when the input value x is real, but the output should be complex. To get the complex result, make the input value complex by passing in complex(x).
logical	MATLAB	—
logical	Fixed-Point Toolbox	—
logspace	MATLAB	—
lowerbound	Fixed-Point Toolbox	—
lsb	Fixed-Point Toolbox	—
lt	MATLAB	—
lt	Fixed-Point Toolbox	• Not supported for fixed-point signals with different biases
lu	MATLAB	—
magic	MATLAB	—
max	MATLAB	—
max	Fixed-Point Toolbox	—
mean	MATLAB	—
median	MATLAB	—
meshgrid	MATLAB	• Does not support character arrays
min	MATLAB	—
min	Fixed-Point Toolbox	—

Function	Product	Remarks/Limitations
minus	MATLAB	—
minus	Fixed-Point Toolbox	• Any non-fi input must be constant; that is, its value must be known at compile time so that it can be cast to a fi
mldivide	MATLAB	—
mod	MATLAB	—
mpower	MATLAB	—
mrdivide	MATLAB	—
mtimes	MATLAB	—
mtimes	Fixed-Point Toolbox	• Any non-fi input must be constant; that is, its value must be known at compile time so that it can be cast to a fi
NaN or nan	MATLAB	• Dimensions must be real, non-negative, integer constants • Supports only one or two dimension arguments
nargin	MATLAB	—
nargout	MATLAB	—
ndims	MATLAB	—
ndims	Fixed-Point Toolbox	—
ne	MATLAB	—
ne	Fixed-Point Toolbox	• Not supported for fixed-point signals with different biases

Function	Product	Remarks/Limitations
norm	MATLAB	—
not	MATLAB	—
numberofelements	Fixed-Point Toolbox	• numberofelements and numel both work the same as MATLAB numel for fi objects in Embedded MATLAB
numerictype	Fixed-Point Toolbox	• Fixed-point signals coming in to an Embedded MATLAB Function block from Simulink are assigned a numerictype object that is populated with the signal's data type and scaling information • Returns the data type when the input is a nonfixed-point signal
ones	MATLAB	Dimensions must be real, non-negative, integer constants
or	MATLAB	—
pascal	MATLAB	—
pi	MATLAB	—
pinv	MATLAB	—
plus	MATLAB	—
plus	Fixed-Point Toolbox	• Any non-fi input must be constant; that is, its value must be known at compile time so that it can be cast to a fi
polyfit	MATLAB	• Supports only one output.
polyval	MATLAB	• Supports only two input arguments and one output argument.
pow2	Fixed-Point Toolbox	—

Function	Product	Remarks/Limitations
power	MATLAB	• Returns NaN when both X and Y are real, but power(X,Y) is complex. To get the complex result, make the input value X complex by passing in complex(X). For example, power(complex(X),Y). • Returns NaN when both X and Y are real, but X .^ Y is complex. To get the complex result, make the input value X complex by using complex(X). For example, complex(X).^Y.
prod	MATLAB	—
qr	MATLAB	—
range	Fixed-Point Toolbox	—
rdivide	MATLAB	—
real	MATLAB	—
real	Fixed-Point Toolbox	—
realmax	MATLAB	—
realmax	Fixed-Point Toolbox	—
realmin	MATLAB	—
realmin	Fixed-Point Toolbox	—
rem	MATLAB	—
repmat	MATLAB	
repmat	Fixed-Point Toolbox	—
rescale	Fixed-Point Toolbox	—
reshape	MATLAB	• Accepts a maximum of three arguments

Function	Product	Remarks/Limitations
reshape	Fixed-Point Toolbox	• Supported for 1-D and 2-D arrays only
rot90	MATLAB	—
round	MATLAB	—
sec	MATLAB	—
secd	MATLAB	—
sech	MATLAB	—
sign	MATLAB	—
sign	Fixed-Point Toolbox	—
sin	MATLAB	—
sind	MATLAB	—
single	MATLAB	—
single	Fixed-Point Toolbox	—
sinh	MATLAB	—
size	MATLAB	—
size	Fixed-Point Toolbox	—
sort	MATLAB	—
sosfilt	Signal Processing Toolbox	—
sqrt	MATLAB	• Returns NaN when the input value x is real, but the output should be complex. To get the complex result, make the input value complex by passing in complex(x).
strcmp	MATLAB	—

Function	Product	Remarks/Limitations
sub2ind	MATLAB	• Does not support N-dimensional matrices. Size vector must have exactly two elements. • Maximum number of input arguments is three.
subsasgn	Fixed-Point Toolbox	—
subsref	Fixed-Point Toolbox	—
sum	MATLAB	—
sum	Fixed-Point Toolbox	—
svd	MATLAB	—
tan	MATLAB	—
tand	MATLAB	—
tanh	MATLAB	—
times	MATLAB	—
times	Fixed-Point Toolbox	• Any non-fi input must be constant; that is, its value must be known at compile time so that it can be cast to a fi
toeplitz	MATLAB	—
tril	MATLAB	—
triu	MATLAB	—
transpose	MATLAB	—
transpose	Fixed-Point Toolbox	—
true	MATLAB	Dimensions must be real, non-negative, integer constants
uint8, uint16, uint32	MATLAB	—

Function	Product	Remarks/Limitations
uint8, uint16, uint32	Fixed-Point Toolbox	—
uminus	MATLAB	—
uminus	Fixed-Point Toolbox	—
uplus	MATLAB	—
uplus	Fixed-Point Toolbox	—
upperbound	Fixed-Point Toolbox	—
vander	MATLAB	—
vertcat	Fixed-Point Toolbox	—
wilkinson	MATLAB	—
xcorr	Signal Processing Toolbox	• Does not support the case where A is a matrix • Does not support partial (abbreviated) strings of biased, unbiased, coeff, or none
zeros	MATLAB	Dimensions must be real, non-negative, integer constants

Embedded MATLAB Run-Time Library – Categorical List

The following topics list functions in the Embedded MATLAB run-time library by different function types. Each entry includes a function name link to online help for the equivalent MATLAB of Fixed-Point Toolbox function along with a one-line description.

- "Arithmetic Operator Functions" on page 12-25
- "Casting Functions" on page 12-26
- "Complex Number Functions" on page 12-26

For an alphabetical list of these functions, and remarks and limitations for them, see "Embedded MATLAB Run-Time Function Library – Alphabetical List" on page 12-8.

Arithmetic Operator Functions

See "Arithmetic Operators + - * / \ ^ '" in the MATLAB Function Reference documentation for detailed descriptions on any of the following operator equivalent functions.

Function	Description
ctranspose	Complex conjugate transpose (')
isa	Determine if input is object of given class
ldivide	Arraywise left division
minus	Minus (-)
mldivide	Left matrix divide (\)
mpower	Equivalent of elementwise power operator (.^)
mrdivide	Matrix right division
mtimes	Matrix multiply (*)

Function	Description
plus	Plus (+)
power	Arraywise power
rdivide	Arraywise right division
times	Arraywise multiplication
transpose	Matrix transpose (')
uminus	Unary minus (-)
uplus	Unary plus (+)

Casting Functions
Embedded MATLAB functions support the following functions for converting one type of data to another:

Data Type	Description
cast	Cast variable to different data type
char	Create character array (string)
class	Query class of object argument
double	Convert to double-precision floating point
int8, int16, int32	Convert to signed integer data type
logical	Convert to Boolean true or false data type
single	Convert to single-precision floating point
uint8, uint16, uint32	Convert to unsigned integer data type

Complex Number Functions
Embedded MATLAB functions support the following functions for complex numbers:

Function	Description
complex	Construct complex data from real and imaginary components; see "Declaring Local Complex Variables Implicitly" in Using Simulink
conj	Return the conjugate of a complex number
imag	Return the imaginary part of a complex number
isnumeric	True for numeric arrays
isreal	Return false (0) for a complex number
isscalar	True if array is a scalar
real	Return the real part of a complex number

Exponential Functions

Embedded MATLAB functions support the following elementary exponential functions:

Function	Description
exp	Exponential
factorial	Factorial function
log	Natural logarithm
sqrt	Square root

Fixed-Point Toolbox Functions

For more information on fixed-point support in Embedded MATLAB, see "Using the Fixed-Point Toolbox with Embedded MATLAB" in the Fixed-Point Toolbox documentation. Embedded MATLAB supports the following functions from the Fixed-Point Toolbox:

Function	Description
abs	Absolute value of fi object
all	Determine whether all array elements are nonzero
any	Determine whether any array elements are nonzero

Function	Description
bitand	Bitwise AND of two fi objects
bitcmp	Bitwise complement of fi object
bitget	Bit at certain position
bitor	Bitwise OR of two fi objects
bitset	Set bit at certain position
bitshift	Shift bits specified number of places
bitxor	Bitwise exclusive OR of two fi objects
complex	Construct complex fi object from real and imaginary parts
conj	Complex conjugate of fi object
ctranspose	Complex conjugate transpose of fi object
disp	Object
divide	Divide two objects
double	Double-precision floating-point real-world value of fi object
end	Last index of array
eps	Quantized relative accuracy for fi or quantizer objects
eq	Determine whether real-world values of two fi objects are equal
fi	Construct fi object
fimath	Construct fimath object
ge	Determine whether real-world value of one fi object is greater than or equal to another
gt	Determine whether real-world value of one fi object is greater than another
horzcat	Horizontally concatenate multiple fi objects
imag	Imaginary part of complex number
int8, int16, or int32	Stored integer value of fi object as built-in int8, int16, or int32
iscolumn	Determine whether fi object is column vector

Function	Description
isempty	Determine whether array is empty
isfi	Determine whether variable is `fi` object
isfimath	Determine whether variable is `fimath` object
isfinite	Determine whether array elements are finite
isinf	Determine whether array elements are infinite
isnan	Determine whether array elements are NaN
isnumeric	Determine whether input is numeric array
isnumerictype	Determine whether variable is `numerictype` object
isreal	Determine whether array elements are real
isrow	Determine whether `fi` object is row vector
isscalar	Determine whether input is scalar
issigned	Determine whether `fi` object is signed
isvector	Determine whether input is vector
le	Determine whether real-world value of `fi` object is less than or equal to another
length	Vector length
logical	Convert numeric values to logical
lowerbound	Lower bound of range of `fi` object
lsb	Scaling of least significant bit of `fi` object
lt	Determine whether real-world value of one `fi` object is less than another
max	Largest element in array of `fi` objects
min	Smallest element in array of `fi` objects
minus	Matrix difference between `fi` objects
mtimes	Matrix product of `fi` objects
ndims	Number of array dimensions
ne	Determine whether real-world values of two `fi` objects are not equal
numberofelements	Number of data elements in `fi` array

Function	Description
numerictype	Construct numerictype object
plus	Matrix sum of fi objects
pow2	Multiply by a power of 2
range	Numerical range of fi or quantizer object
real	Real part of complex number
realmax	Largest positive fixed-point value or quantized number
realmin	Smallest positive normalized fixed-point value or quantized number
repmat	Replicate and tile array
rescale	Change scaling of fi object
reshape	Reshape array
sign	Perform signum function on array
single	Single-precision floating-point real-world value of fi object
size	Return array dimensions
subsasgn	Subscripted assignment
subsref	Subscripted reference
sum	Sum of array elements
times	Element-by-element multiplication of fi objects
transpose	Transpose
uint8, uint16, or uint32	Stored integer value of fi object as built-in uint8, uint16, or uint32
uminus	Negate elements of fi object array
uplus	Unary plus
upperbound	Upper bound of range of fi object
vertcat	Vertically concatenate multiplefi objects

Input and Output Functions

Embedded MATLAB functions support the following functions for accessing argument and return values:

Function	Description
nargin	Return the number of input arguments a user has supplied
nargout	Return the number of output return values a user has requested

Logical Operator Functions

Embedded MATLAB functions support the following functions for performing logical operations:

Function	Description
and	Logical AND (&)
not	Logical NOT (~)
or	Logical OR (|)

Matrix/Array Functions

Embedded MATLAB functions support the following functions:

Function	Description
abs	Return absolute value and complex magnitude of an array
all	Test if all elements are nonzero
angle	Phase angle
any	Test for any nonzero elements
cross	Vector cross product
cumprod	Cumulative product of array elements
cumsum	Cumulative sum of array elements
diag	Return a matrix formed around the specified diagonal vector and the specified diagonal (0, 1, 2,...) it occupies

Function	Description
`diff`	Differences and approximate derivatives
`eye`	Identity matrix
`false`	Return an array of 0's for the specified dimensions
`interp1`	One-dimensional interpolation (table lookup)
`interp1q`, see `interp1`	One-dimensional data interpolation (table lookup)
`inv`	Inverse of a square matrix
`isempty`	Determine whether array is empty
`isfloat`	Determine if input is floating-point array
`isfinite`	Detect finite elements of an array
`isinf`	Detect infinite elements of an array (simulation only)
`isnan`	Detect NaN elements of an array (simulation only)
`length`	Return the length of a matrix
`lu`	Matrix factorization
`max`	Maximum elements of a matrix
`min`	Minimum elements of a matrix
`ndims`	Number of dimensions
`ones`	Create a matrix of all 1s
`pinv`	Pseudoinverse of a matrix
`prod`	Product of array element
`repmat`	Replicate and tile an array
`reshape`	Reshape one array into the dimensions of another
`sign`	Signum function
`size`	Return the size of a matrix
`sort`	Sort elements in ascending or descending order
`sum`	Sum of matrix elements
`tril`	Extract lower triangular part

Function	Description
triu	Extract upper triangular part
true	Return an array of logical (Boolean) 1s for the specified dimensions
zeros	Create a matrix of all zeros

Relational Operator Functions

Embedded MATLAB functions support the following functions for performing relational operations:

Function	Description
eq	Equal (==)
ge	Greater than or equal to (>=)
gt	Greater than (>)
le	Less than or equal to (<=)
lt	Less than (<)
ne	Not equal (~=)

Rounding and Remainder Functions

Embedded MATLAB functions support the following rounding and remainder functions:

Function	Description
ceil	Round toward plus infinity
fix	Round toward zero
floor	Round toward minus infinity
mean	Average or mean value
mod	Modulus (signed remainder after division)
rem	Remainder after division
round	Round toward nearest integer

Signal Processing Functions

Embedded MATLAB supports the following signal processing functions:

Function	Description
chol	Cholesky factorization
conv	Convolution and polynomial multiplication (license required – see the following note)
fft	Discrete Fourier transform (license required – see the following note)
filter	Filter a data sequence using a digital filter that works for both real and complex inputs (license required – see the following note)
ifft	Inverse discrete Fourier transform (license required – see the following note)
sosfilt	Second order (biquadratic) IIR filtering (license required – see the following note)
svd	Singular value decomposition
xcorr	Cross-correlation function estimates (license required – see the following note)

Note Some signal processing functions for the Embedded MATLAB Run-Time Function library require a Signal Processing Blockset license. These functions also have file dependencies on static functions supplied for some of the Signal Processing blocks. For code deployment to another environment, be sure to consult the generated make file for the Real-Time Workshop target you build to identify and locate these file dependencies.

Special Values

Embedded MATLAB functions support the following special data values:

Symbol	Description
eps	Return floating-point relative accuracy
Inf or inf	Return IEEE arithmetic representation for positive infinity (simulation only)

Symbol	Description
intmax	Largest possible value of specified integer type
intmin	Smallest possible value of specified integer type
NaN or nan	Return not a number (simulation only)
pi	Return the ratio of the circumference to the diameter for a circle
realmax	Return the largest positive floating-point number
realmin	Return the smallest positive floating-point number

String Functions

Embedded MATLAB functions support the following functions for handling strings:

Function	Description
char	Create character array (string)
ischar	True for character array (string)
strcmp	Return a logical result for the comparison of two strings; limited to strings known at compile time

Trigonometric Functions

Embedded MATLAB functions support the following elementary trigonometric functions:

Function	Description
acos	Inverse cosine
acosh	Inverse hyperbolic cosine
asin	Inverse sine
asinh	Inverse hyperbolic sine
atan	Inverse tangent
atan2	Four quadrant inverse tangent
atanh	Inverse hyperbolic tangent

Function	Description
cos	Cosine
cosh	Hyperbolic cosine
sin	Sine
sinh	Hyperbolic sine
tan	Tangent
tanh	Hyperbolic tangent

Unsupported MATLAB Features and Limitations

Embedded MATLAB Function blocks provide a subset of the full list of MATLAB features. Unsupported features and features with limitations are described in the following topics:

- "List of Unsupported Features" on page 12-37
- "Limitations on Indexing Operations" on page 12-38
- "Limitations with Complex Numbers" on page 12-39

Note For information about fixed-point support in Embedded MATLAB and its limitations, see "Using the Fixed-Point Toolbox with Embedded MATLAB" in the Fixed-Point Toolbox documentation.

List of Unsupported Features

The following is a list of MATLAB features that are not supported by Embedded MATLAB functions.

Feature Not Supported	Remarks
Cell arrays	Supported data types are listed in "Supported Variable Types in Embedded MATLAB Functions" on page 12-2.
Command-line duality	—
Dynamic variables	You cannot use variables of dynamic size, or variables of different sizes.
Function handles	—
Global	—
Java	—
M-files	User M-files in the MATLAB path are not supported for code generation, but they can be called during simulation.

Feature Not Supported	Remarks
Matrix deletion	
N-dimensional matrices	Supported sizes are scalar and two-dimensional matrices. Vectors are two-dimensional matrices with a row or column dimension of 1.
Nested functions	—
Objects	—
Sparse matrices	—
Structures	—
Try/catch	—

Limitations on Indexing Operations

Matrix indexing operations for a matrix M are supported with limitations for the following types of expressions:

- M(i:j) where i and j change in a loop

  Embedded MATLAB never dynamically allocates memory for the size of the expressions that change as the program executes. The workaround is to use for loops as shown in the following example:

  ```
  for i=1:10
   for j = i:10
    M(i,j) = 2 * M(i,j);
   end
  end
  ```

- M(i:i+k) where i is unknown but k is known

  In this case, since i and therefore i+k are not known, memory cannot be allocated for the numerical result. However, memory can be allocated for the following workaround:

  ```
  M(i + (0:k))
  ```

In this case, an unkown scalar value `i` is added to each element of the known index vector `0...k`. This means that memory for `k+1` elements of `M` is allocated.

- Initialization of the following style:

```
for i = 1:10
 M(i) = 5;
end
```

In this case, the size of `M` changes as the loop is executed.

Limitations with Complex Numbers

Complex numbers and operations are supported in Embedded MATLAB Function blocks with the following exceptions:

- The first use of a variable that is later assigned a complex result must also be complex. For example,

```
X = 3;
 .
 .
 .
X = 4 + 5i;
```

fails because `X` is not defined as a complex variable by its first assignment. However,

```
X = 3 + 0i;
 .
 .
 .
X = 4 + 5i;
```

succeeds because `X` is defined as a complex variable in its first assignment.

- Even if the imaginary part is zero, if the result might be complex, Embedded MATLAB will treat it as complex. For example, although

```
X = ifft(fft(Y));
```

yields a real answer, Embedded MATLAB assumes that the function `ifft` might return a complex result. The workaround is to use the `real` function:

```
X = real(ifft(fft(Y)));
```

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