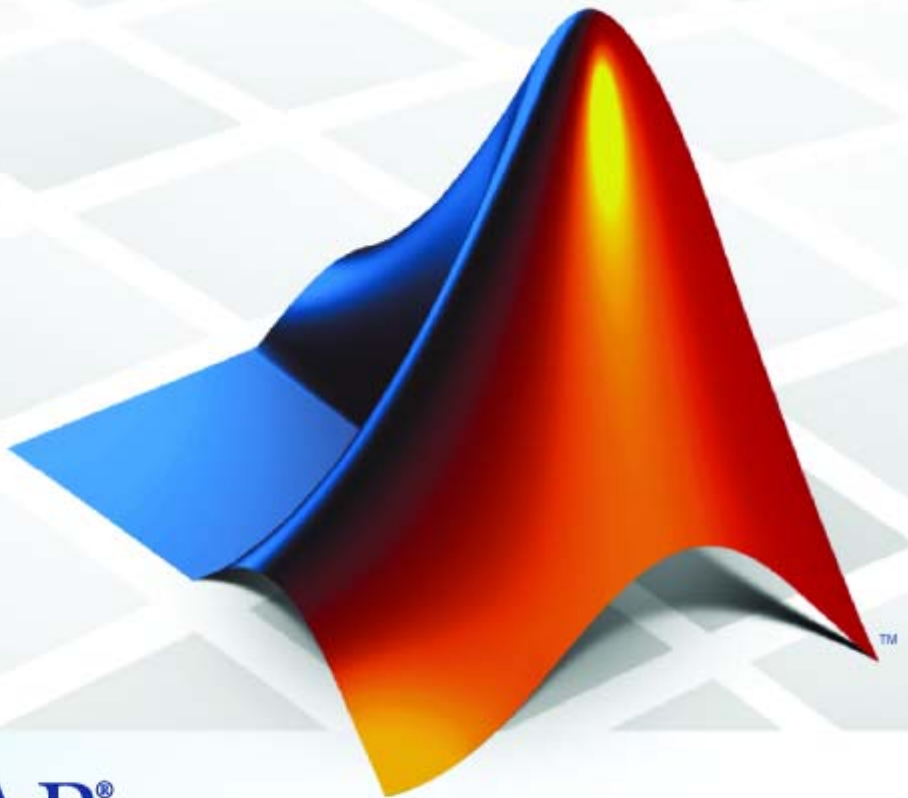


# Simulink® 7 Reference



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508-647-7000 (Phone)



508-647-7001 (Fax)



The MathWorks, Inc.  
3 Apple Hill Drive  
Natick, MA 01760-2098

For contact information about worldwide offices, see the MathWorks Web site.

*Simulink*<sup>®</sup> Reference

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## Revision History

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March 2009	Online only	Revised for Simulink 7.3 (Release 2009a)



## Block Reference

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# Block Reference

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Discontinuities (p. 1-3)	Define discontinuous states
Discrete (p. 1-4)	Define discrete states
Logic and Bit Operations (p. 1-5)	Perform logic and bit operations
Lookup Tables (p. 1-7)	Support lookup tables
Math Operations (p. 1-7)	Perform math operations
Model Verification (p. 1-9)	Perform model verification
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Signal Attributes (p. 1-12)	Support signal attributes
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Sources (p. 1-15)	Input to other blocks
User-Defined Functions (p. 1-16)	Support custom functions
Additional Math & Discrete (p. 1-17)	Provide additional math and discrete support

## Commonly Used

Bus Creator	Create signal bus
Bus Selector	Select signals from incoming bus
Constant	Generate constant value
Data Type Conversion	Convert input signal to specified data type
Demux	Extract and output elements of vector signal
Discrete-Time Integrator	Perform discrete-time integration or accumulation of signal
Gain	Multiply input by constant
Ground	Ground unconnected input port
Inport	Create input port for subsystem or external input
Integrator	Integrate signal
Logical Operator	Perform specified logical operation on input
Mux	Combine several input signals into vector
Outport	Create output port for subsystem or external output
Product	Multiply and divide scalars and nonscalars or multiply and invert matrices
Relational Operator	Perform specified relational operation on inputs
Saturation	Limit range of signal
Scope and Floating Scope	Display signals generated during simulation

Subsystem, Atomic Subsystem, Nonvirtual Subsystem, CodeReuse Subsystem	Represent system within another system
Sum, Add, Subtract, Sum of Elements	Add or subtract inputs
Switch	Switch output between first input and third input based on value of second input
Terminator	Terminate unconnected output port
Unit Delay	Delay signal one sample period

## Continuous

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

## Discontinuities

Backlash	Model behavior of system with play
Coulomb and Viscous Friction	Model discontinuity at zero, with linear gain elsewhere

Dead Zone	Provide region of zero output
Dead Zone Dynamic	Set inputs within bounds to zero
Hit Crossing	Detect crossing point
Quantizer	Discretize input at specified interval
Rate Limiter	Limit rate of change of signal
Rate Limiter Dynamic	Limit rising and falling rates of signal
Relay	Switch output between two constants
Saturation	Limit range of signal
Saturation Dynamic	Bound range of input
Wrap To Zero	Set output to zero if input is above threshold

## **Discrete**

Difference	Calculate change in signal over one time step
Discrete Derivative	Compute discrete time derivative
Discrete Filter	Model IIR direct form II filters
Discrete FIR Filter	Model FIR filters
Discrete State-Space	Implement discrete state-space system
Discrete Transfer Fcn	Implement discrete transfer function
Discrete Zero-Pole	Model system defined by zeros and poles of discrete transfer function
Discrete-Time Integrator	Perform discrete-time integration or accumulation of signal
First-Order Hold	Implement first-order sample-and-hold

Integer Delay	Delay signal N sample periods
Memory	Output input from previous time step
Tapped Delay	Delay scalar signal multiple sample periods and output all delayed versions
Transfer Fcn First Order	Implement discrete-time first order transfer function
Transfer Fcn Lead or Lag	Implement discrete-time lead or lag compensator
Transfer Fcn Real Zero	Implement discrete-time transfer function that has real zero and no pole
Unit Delay	Delay signal one sample period
Weighted Moving Average (Obsolete)	Implement weighted moving average (obsolete)
Zero-Order Hold	Implement zero-order hold of one sample period

## Logic and Bit Operations

Bit Clear	Set specified bit of stored integer to zero
Bit Set	Set specified bit of stored integer to one
Bitwise Operator	Perform specified bitwise operation on inputs
Combinatorial Logic	Implement truth table
Compare To Constant	Determine how signal compares to specified constant

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



## Lookup Tables

Direct Lookup Table (n-D)	Index into N-dimensional table to retrieve element, column, or 2-D matrix
Interpolation Using Prelookup	Use output of Prelookup block to accelerate approximation of N-dimensional function
Lookup Table	Approximate one-dimensional function
Lookup Table (2-D)	Approximate two-dimensional function
Lookup Table (n-D)	Approximate N-dimensional function
Lookup Table Dynamic	Approximate one-dimensional function using dynamically specified table
Prelookup	Compute index and fraction for Interpolation Using Prelookup block
Sine, Cosine	Implement sine and/or cosine wave in fixed point using lookup table approach that exploits quarter wave symmetry

## Math Operations

Abs	Output absolute value of input
Algebraic Constraint	Constrain input signal to zero
Assignment	Assign values to specified elements of signal
Bias	Add bias to input

Complex to Magnitude-Angle	Compute magnitude and/or phase angle of complex signal
Complex to Real-Imag	Output real and imaginary parts of complex input signal
Divide	Divide one input by another
Dot Product	Generate dot product of two vectors
Gain	Multiply input by constant
Magnitude-Angle to Complex	Convert magnitude and/or a phase angle signal to complex signal
Math Function	Perform mathematical function
Matrix Concatenate, Vector Concatenate	Concatenate input signals of same data type to create contiguous output signal
MinMax	Output minimum or maximum input value
MinMax Running Resettable	Determine minimum or maximum of signal over time
Permute Dimensions	Rearrange dimensions of multidimensional array dimensions
Polynomial	Perform evaluation of polynomial coefficients on input values
Product	Multiply and divide scalars and nonscalars or multiply and invert matrices
Product of Elements	Copy or invert one scalar input, or collapse one nonscalar input
Real-Imag to Complex	Convert real and/or imaginary inputs to complex signal
Reshape	Change dimensionality of signal
Rounding Function	Apply rounding function to signal
Sign	Indicate sign of input

Sine Wave Function	Generate sine wave, using external signal as time source
Slider Gain	Vary scalar gain using slider
Squeeze	Remove singleton dimensions from multidimensional signal
Sum, Add, Subtract, Sum of Elements	Add or subtract inputs
Trigonometric Function	Perform trigonometric function
Unary Minus	Negate input
Weighted Sample Time Math	Support calculations involving sample time

## Model Verification

Assertion	Check whether signal is nonzero
Check Discrete Gradient	Check that absolute value of difference between successive samples of discrete signal is less than upper bound
Check Dynamic Gap	Check that gap of possibly varying width occurs in range of signal's amplitudes
Check Dynamic Lower Bound	Check that one signal is always less than another signal
Check Dynamic Range	Check that signal falls inside 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 input signal has specified resolution

Check Static Gap	Check that gap exists in signal's range of amplitudes
Check Static Lower Bound	Check that signal is greater than (or optionally equal to) static lower bound
Check Static Range	Check that signal falls inside fixed range of amplitudes
Check Static Upper Bound	Check that signal is less than (or optionally equal to) static upper bound

## **Model-Wide Utilities**

Block Support Table	View data type support for Simulink® blocks
DocBlock	Create text that documents model and save text with model
Model Info	Display revision control information in model
Time-Based Linearization	Generate linear models in base workspace at specific times
Trigger-Based Linearization	Generate linear models in base workspace when triggered

## Ports & Subsystems

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

Subsystem, Atomic Subsystem, Nonvirtual Subsystem, CodeReuse Subsystem	Represent system within another system
Switch Case	Implement C-like switch control flow statement
Switch Case Action Subsystem	Represent subsystem whose execution is triggered by Switch Case block
Trigger	Add trigger port to subsystem or function-call model
Triggered Subsystem	Represent subsystem whose execution is triggered by external input
While Iterator Subsystem	Represent subsystem that executes repeatedly while condition is satisfied during simulation time step

## Signal Attributes

Bus to Vector	Convert virtual bus to vector
Data Type Conversion	Convert input signal to 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 same data type
Data Type Propagation	Set data type and scaling of propagated signal based on information from reference signals
Data Type Scaling Strip	Remove scaling and map to built in integer

IC	Set initial value of signal
Probe	Output 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 signal to new type without altering signal values
Signal Specification	Specify desired dimensions, sample time, data type, numeric type, and other attributes of signal
Weighted Sample Time	Support calculations involving sample time
Width	Output width of input vector

## Signal Routing

Bus Assignment	Replace specified bus elements
Bus Creator	Create signal bus
Bus Selector	Select signals from incoming bus
Data Store Memory	Define data store
Data Store Read	Read data from data store
Data Store Write	Write data to data store
Demux	Extract and output elements of vector signal
Environment Controller	Create branches of block diagram that apply only to simulation or only to code generation
From	Accept input from 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 value of first input
Manual Switch	Switch between two inputs
Merge	Combine multiple signals into single signal
Multiport Switch	Choose between multiple block inputs
Mux	Combine several input signals into vector
Selector	Select input elements from vector, matrix, or multidimensional signal
Switch	Switch output between first input and third input based on value of second input

## Sinks

Display	Show value of input
Outport	Create output port for subsystem or external output
Scope and Floating Scope	Display signals generated during simulation
Stop Simulation	Stop simulation when input is nonzero
Terminator	Terminate unconnected output port
To File	Write data to file
To Workspace	Write data to MATLAB® workspace
XY Graph	Display X-Y plot of signals using MATLAB figure window



## Sources

Band-Limited White Noise	Introduce white noise into continuous system
Chirp Signal	Generate sine wave with increasing frequency
Clock	Display and provide simulation time
Constant	Generate constant value
Counter Free-Running	Count up and overflow back to zero after maximum value possible is reached for specified number of bits
Counter Limited	Count up and wrap back to zero after outputting specified upper limit
Digital Clock	Output simulation time at specified sampling interval
From File	Read data from MAT-file
From Workspace	Read data from workspace
Ground	Ground unconnected input port
Inport	Create input port for subsystem or 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 arbitrarily shaped periodic signal
Repeating Sequence Interpolated	Output discrete-time sequence and repeat, interpolating between data points

Repeating Sequence Stair	Output and repeat 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 sine wave
Step	Generate 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 specified expression to input
Level-2 M-File S-Function	Use Level-2 M-file S-function in model
MATLAB Fcn	Apply MATLAB function or expression to input
S-Function	Include S-function in model
S-Function Builder	Create S-function from C code that you provide

## Additional Math & Discrete

Additional Discrete (p. 1-17)	Provide additional discrete math support
Additional Math: Increment — Decrement (p. 1-18)	Increment or decrement value of signal by one

### Additional Discrete

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

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

## **Additional Math: Increment – Decrement**

# Blocks — Alphabetical List

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# Abs

---

**Purpose** Output absolute value of 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 selected, the absolute value of the data type saturates to the most positive representable value. If not selected, the absolute value of the most negative value represented by the data type has no effect.

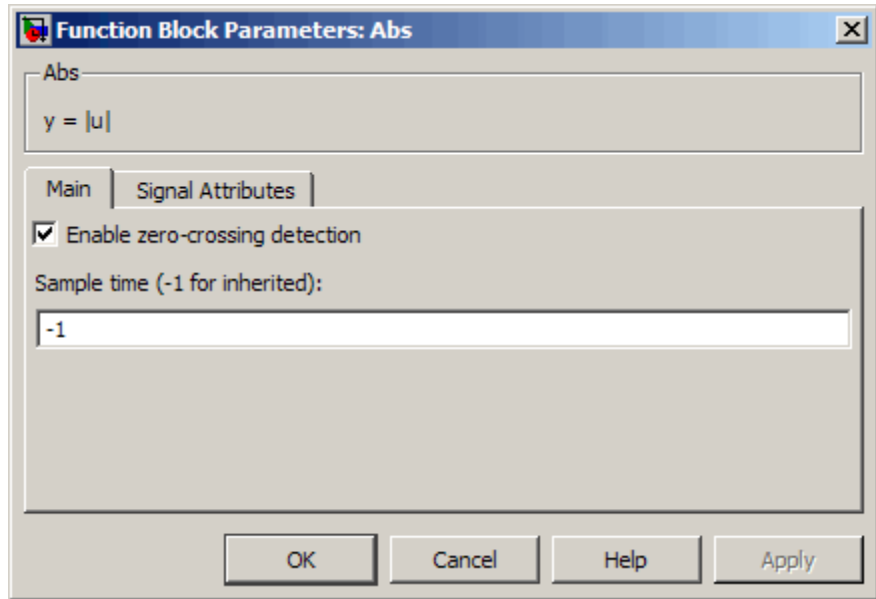
For example, suppose the block input is an 8-bit signed integer. The range of this data type is from -128 to 127, and the absolute value of -128 is not representable. If you select the **Saturate on integer overflow** check box, then the absolute value of -128 is 127. If it is not selected, then the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

**Data Type Support** The Abs block accepts real signals of any numeric data type supported by Simulink software, except Boolean. The Abs block supports real fixed-point data types. The block also accepts complex floating-point inputs.

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

## Parameters and Dialog Box

The **Main** pane of the Abs block dialog box appears as follows:



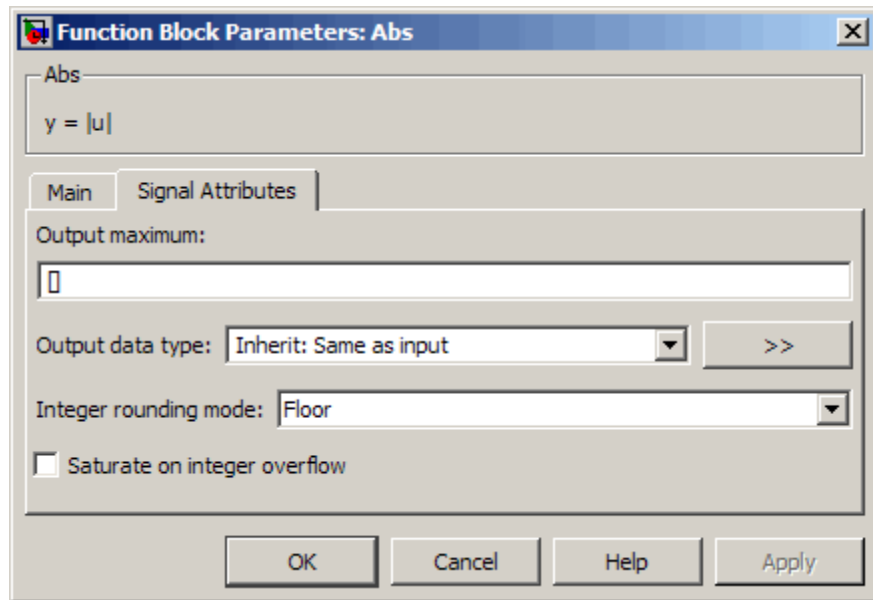
### Enable zero-crossing detection

Select to enable zero-crossing detection. For more information, see “How Blocks Work with Zero-Crossing Detection” in the “How Simulink Works” chapter of the Simulink documentation.

### Sample time (-1 for inherited)

Enter the time interval between sample time hits or specify another appropriate sample time such as continuous. By default, the block inherits its sample time based upon its context within the model. See “Working with Sample Times” in the Simulink documentation.

The **Signal Attributes** pane of the Abs block dialog box appears as follows:



## Output maximum

Specify the maximum value that the block should output. The default value, [], is equivalent to `Inf`. Simulink software uses this value to perform:

- Simulation range checking (see “Checking Signal Ranges”)
- Automatic scaling of fixed-point data types


## Output data type

Specify the output data type. You can set it to:

- A rule that inherits a data type, for example, `Inherit: Inherit via back propagation`
- The name of a built-in data type, for example, `single`
- The name of a data type object, for example, a `Simulink.NumericType` object



- An expression that evaluates to a data type, for example, `fixdt(1,16,0)`

Click the **Show data type assistant** button  to display the **Data Type Assistant**, which helps you set the **Output data type** parameter.

See “Specifying Block Output Data Types” in *Simulink User’s Guide* for more information.

#### **Lock output scaling against changes by the autoscaling tool**

Select to lock scaling of outputs. This parameter is visible only if you enter an expression for the **Output data type** parameter.

#### **Integer rounding mode**

Select the rounding mode for fixed-point operations. For more information, see “Rounding” in the *Simulink® Fixed Point™ User’s Guide*.

#### **Saturate on integer overflow**

Select to have overflows saturate. If 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 127.
- For 16-bit integers, -32768 maps to 32767.
- For 32-bit integers, -2147483648 maps to 2147483647.

Otherwise, 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.

When you select this check box, saturation applies to every internal operation on the block, not just the output or result. In

# Abs

---

general, the code generation process can detect when overflow is not possible, in which case, no saturation code is generated.

## Characteristics

Direct Feedthrough	Yes
Sample Time	Specified in the <b>Sample time</b> parameter
Dimensionalized	Yes
Multidimensionalized	Yes
Zero-Crossing Detection	Yes, if enabled

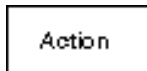
## Purpose

Implement Action subsystems used by `if` and `switch` control flow statements in Simulink software.

## 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.

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

# 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.

---

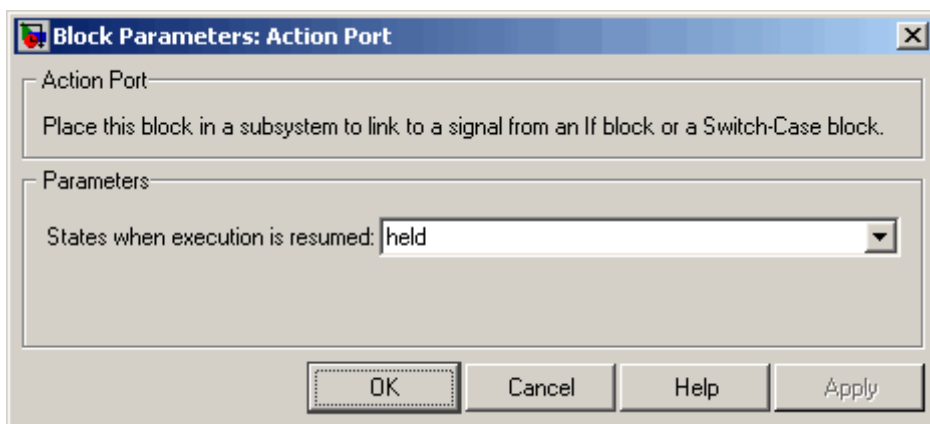
**Note** All blocks in an Action subsystem driven by an If or Switch Case block must run at the same rate as the driving block.

---

## Data Type Support

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

## Parameters and Dialog Box

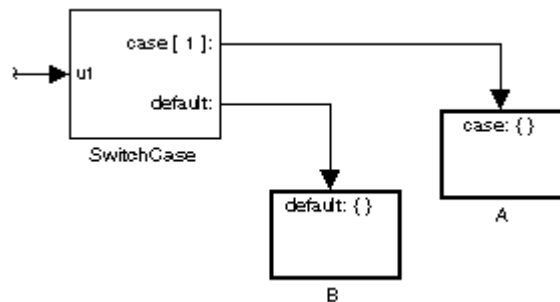


## States when execution is resumed

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

## Action Port

---

reset A's states because its condition, case[1], was not previously false. The same applies to B.

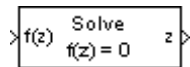
### Characteristics

Sample Time	Inherited from driving If or Switch Case block
-------------	--

**Purpose** Constrain 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 that produces a zero at the input. The output must affect the input through a direct feedback path, that is, the feedback path contains only blocks with direct feedthrough. For example, you can specify algebraic equations for index 1 differential-algebraic systems (DAEs).

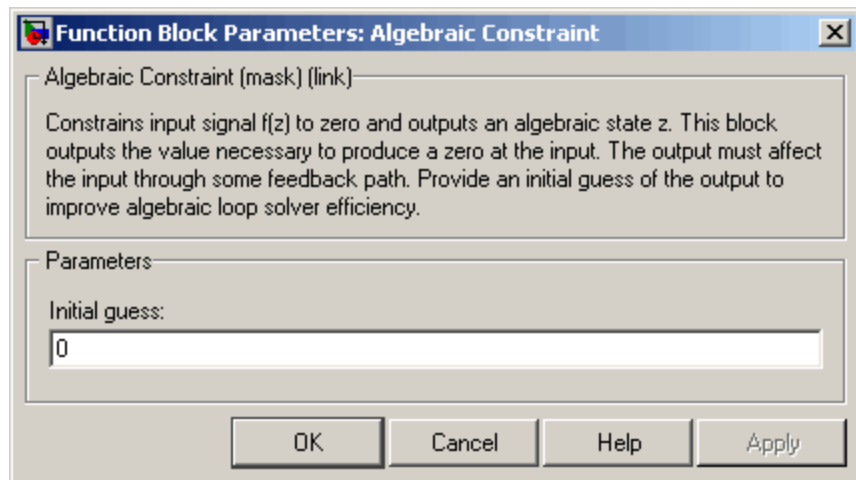
## Algorithm

The Algebraic Constraint block uses a dogleg trust-region algorithm to solve algebraic loops [1], [2].

## 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.

# Algebraic Constraint

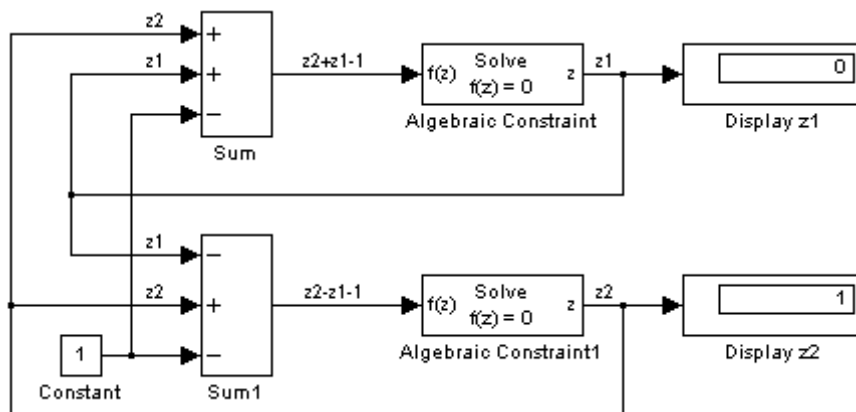
## Example

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:

$$\begin{aligned} z_2 + z_1 &= 1 \\ z_2 - z_1 &= 1 \end{aligned}$$

The solution is  $z_2 = 1, z_1 = 0$ , as the Display blocks show.



## Characteristics

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

## References

[1] Garbow, B. S., K. E. Hillstrom, and J. J. Moré. *User Guide for MINPACK-1*. Argonne, IL: Argonne National Laboratory, 1980.



[2] Rabinowitz, P. H. *Numerical Methods for Nonlinear Algebraic Equations*. New York, NY: Gordon and Breach, 1970.

# Assertion

---

**Purpose** Check whether 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. Use the block parameter dialog box to:

- Specify that the block should display an error message when the assertion fails but allow the simulation to continue.
- Specify an M-code expression to evaluate 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.

---

**Note** For information about how Real-Time Workshop® generated code handles Model Verification blocks, see “Enabling Model Verification Blocks” in the Real-Time Workshop User’s Guide.

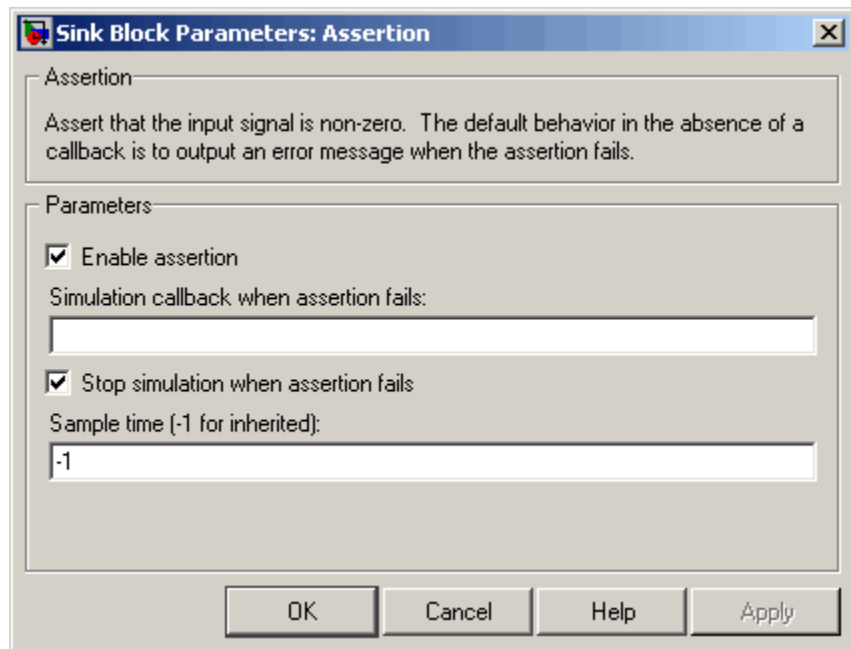
---

## Data Type Support

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

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

## Parameters and Dialog Box



### Enable assertion

Clearing this check box 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 under **Debugging** 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.

# Assertion

---

## Simulation callback when assertion fails

An M-code expression to evaluate when the assertion fails.

## Stop simulation when assertion fails

Selecting this check box 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)

Enter the time interval between sample time hits or specify another appropriate sample time such as continuous. By default, the block inherits its sample time based upon its context within the model. See "Working with Sample Times" in the Simulink documentation.

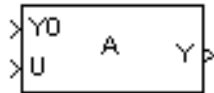
## Characteristics

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

**Purpose** Assign values to specified elements of signal

**Library** Math Operations

## Description



The Assignment block assigns values to specified elements of the signal. 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 U, specifies values to be assigned to Y. The block replaces the specified elements of Y with elements from the data signal.

Based on the value you enter for the **Number of output dimensions** parameter, a table of index options is displayed. Each row of the table corresponds to one of the output dimensions in **Number of output dimensions**. For each dimension, you can define the elements of the signal to work with. Specify a vector signal as a 1-D signal and a matrix signal as a 2-D signal. When you configure the Assignment block for multidimensional signal operations, the block icon changes.

For example, assume a 5-D signal with a one-based index mode. The table in the Assignment block dialog changes to include one row for each dimension. If you define each dimension with the following entries:

- 1  
**Index Option**, select Assign all
- 2  
**Index Option**, select Index vector (dialog)  
**Index**, enter [1 3 5]
- 3  
**Index Option**, select Starting index (dialog)  
**Index**, enter 4
- 4  
**Index Option**, select Starting index (port)

# Assignment

- 5

**Index Option**, select Index vector (port)

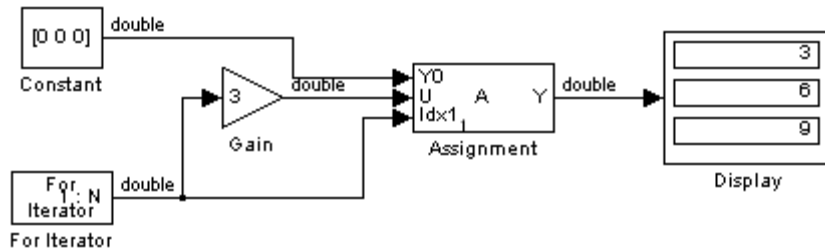
The assigned values will be  $Y(1:\text{end}, [1 \ 3 \ 5], 4:3+\text{size}(U,3), \text{Idx4}:\text{Idx4}+\text{size}(U,4)-1, \text{Idx5})=U$ , where  $\text{Idx4}$  and  $\text{Idx5}$  are the input ports for dimensions 4 and 5.

The Assignment block's data port is labeled U. The rest of this section refers to the data port as U to simplify the explanation of the block's usage.

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

## 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, matrix, or multidimensional 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.



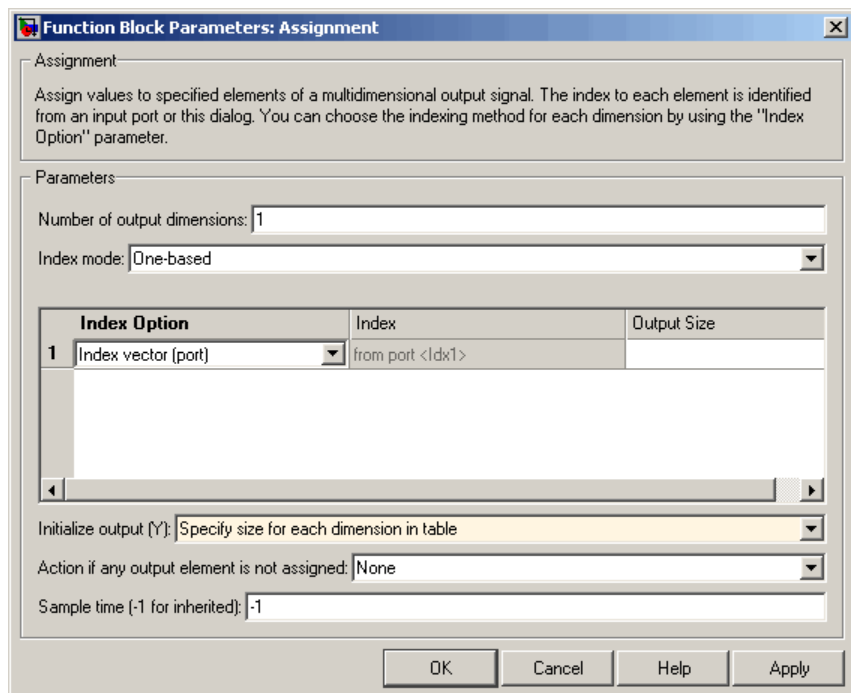
Iterated assignment uses an iterator (For or While) block to generate the indices required by the Assignment block. On the first iteration of an iterated assignment, the Assignment block copies the first input ( $Y0$ ) to the output ( $Y$ ) and assigns the second input ( $U$ ) to the output  $Y(E_1)$ . On successive iterations, the Assignment block simply assigns the current value of  $U$  to  $Y(E_i)$ , i.e., without first copying  $Y0$  to  $Y$ . All of this occurs in a single time step.

## Data Type Support

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

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

## Parameters and Dialog Box



### Number of output dimensions

Enter the number of dimensions of the output signal.

### 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

# Assignment

---

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.

## Index Option

Define, by dimension, how the elements of the signal are to be indexed. From the list, choose:

- Assign all

This is the default. All elements are assigned.

- Index vector (dialog)

Enables the **Index** column. Enter the indices of elements.

- Index vector (port)

Disables the **Index** column. The index port defines the indices of elements.

- Starting index (dialog)

Enables the **Index** column. Enter the starting index of the range of elements to be assigned values.

- Starting index (port)

Disables the **Index** column. The index port defines the starting index of the range of elements to be assigned values.

If you choose Index vector (port) or Starting index (port) for any dimension in the table, you can specify the value for the **Initialize output (Y)** parameter to be one of the following:

- Initialize using input port <Y0>
- Specify size for each dimension in table

Otherwise, Y0 always initializes output port Y.

The **Index** and **Output Size** columns are displayed as relevant.



## Index

If the **Index Option** is **Index vector (dialog)**, enter the index of each element you are interested in.

If the **Index Option** is **Starting index (dialog)**, enter the starting index of the range of elements to be selected. The number of elements from the starting point is determined by the size of this dimension at U.

## Output Size

Enter the width of the block output signal. If you select **Specify size for each dimension in table** for the **Initialize output (Y)** parameter, this column is enabled.

## Initialize output (Y)

Specify how to initialize the output signal. The **Initialize output** parameter appears only if you select **Index vector (port)** or **Starting index (port)** for the **Index Option** parameter.

- Initialize using input port <Y0>

The signal at the input port Y0 initializes the output.

- Specify size for each dimension in table

The block requires you to specify the width of the block's output signal in the **Output Size** parameter. If the output has unassigned elements, the value of those elements is undefined.

## Action if any output element is not assigned

Specifies whether to produce a warning or error message if you have not assigned all output elements. Options include:

- Error
- Warning
- None

## Sample time (-1 for inherited)

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

# Assignment

---

Time” in the “How Simulink Works” chapter of the Simulink documentation.

<b>Characteristics</b>		
Direct Feedthrough		Yes
Sample Time		Specified by Sample time parameter
Scalar Expansion		Yes
Dimensionalized		Yes
Multidimensionalized		Yes
Zero Crossing		No

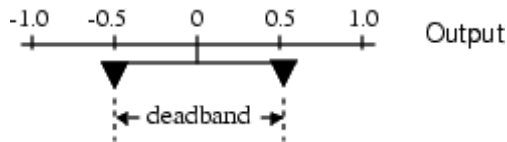
**Purpose** Model behavior of system with play

**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.

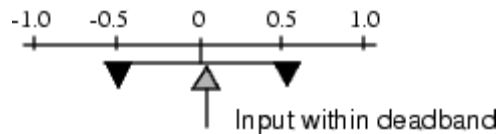
If the initial input is outside the deadband, the **Initial output** parameter value determines whether the block is engaged in a positive or negative direction, and the output at the start of the simulation is the input plus or minus half the deadband width.

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

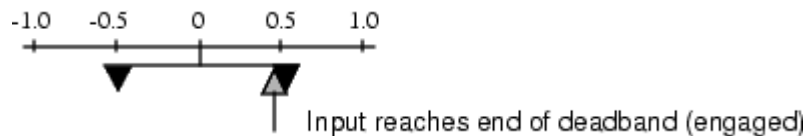
# Backlash

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.

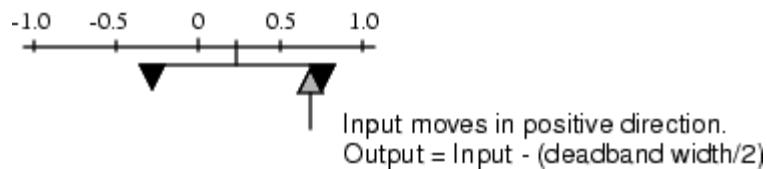
The following figures illustrate the block's operation when the initial input is within the deadband. The first figure shows the relationship between the input and the output while the system is in disengaged mode (and the default parameter values are not changed).



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.

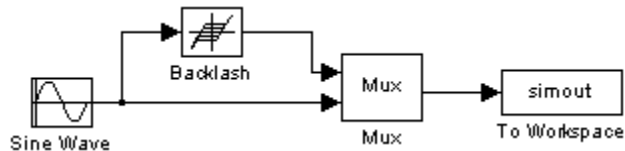


If the input reverses its direction, it disengages from the output. The output remains constant until the input either reaches the opposite end of the deadband or reverses its direction again and engages at the same end of the deadband. Now, as before, movement in the input causes equal movement in the 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:

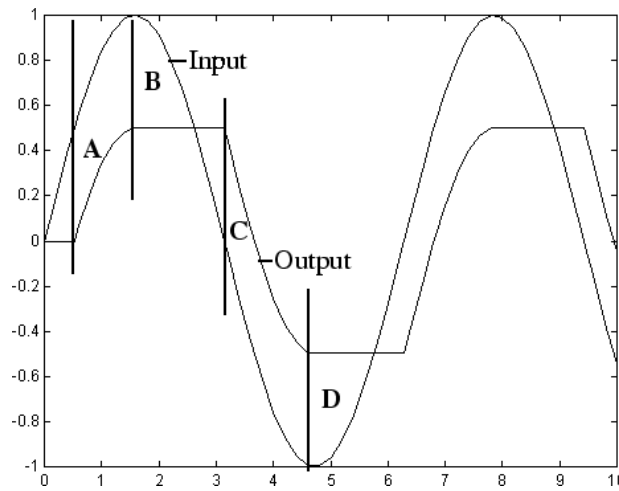
- 5 if the input,  $u$ , is between 4 and 6
- $u + 1$  if  $u < 4$
- $u - 1$  if  $u > 6$

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

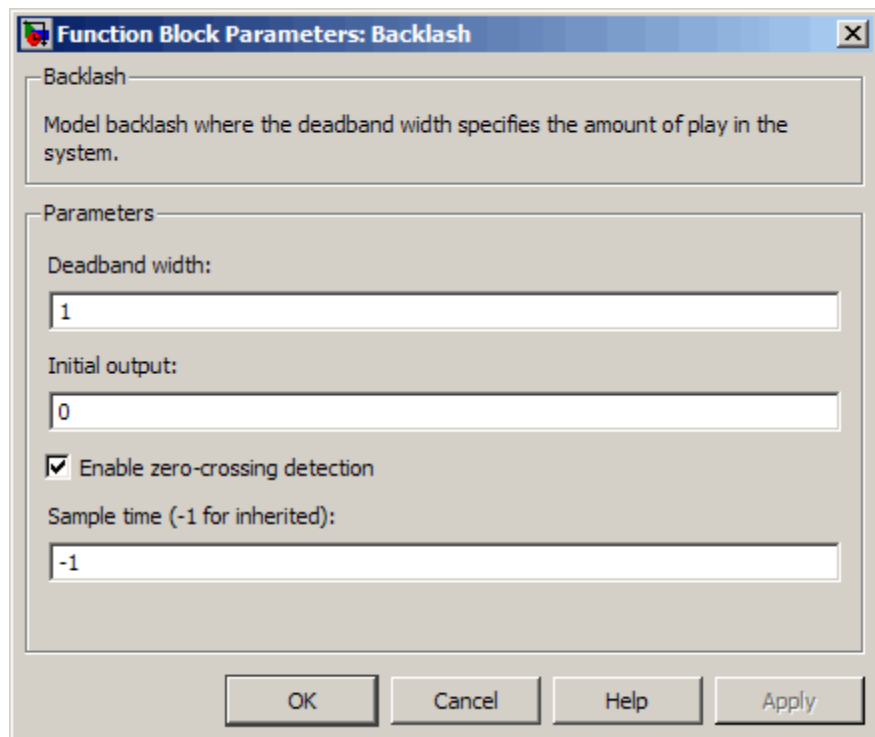


- A** Input engages in positive direction. Change in input causes equal change in output.
- B** Input disengages. Change in input does not affect output.
- C** Input engages in negative direction. Change in input causes equal change in output.
- D** Input disengages. Change in input does not affect output.

## 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 software 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 “How Blocks Work with Zero-Crossing Detection” in the “How Simulink Works” chapter of the Simulink documentation.

# Backlash

---

## Sample time (-1 for inherited)

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

## Characteristics

Direct Feedthrough	Yes
Sample Time	Specified in the <b>Sample time</b> parameter
Scalar Expansion	Yes
Dimensionalized	Yes
Zero-Crossing Detection	Yes, if you select <b>Enable zero-crossing detection</b>



## Purpose

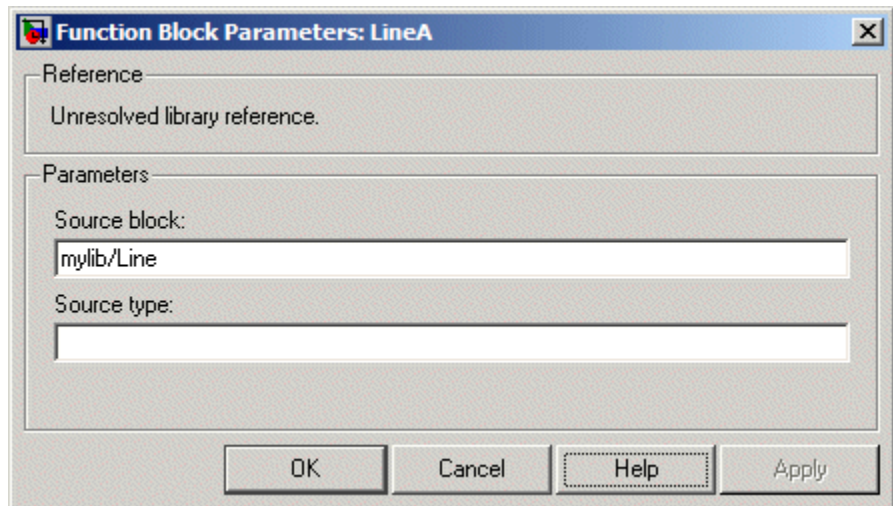
Indicate unresolved reference to library block

## Description

This block indicates an unresolved reference to a library block (see “Creating a Reference Block”). You can use this block’s parameter dialog box to fix the reference to point to the actual location of the library block.



## 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.

# Band-Limited White Noise

---

**Purpose** Introduce white noise into 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 total energy 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 software, 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.

## Algorithm

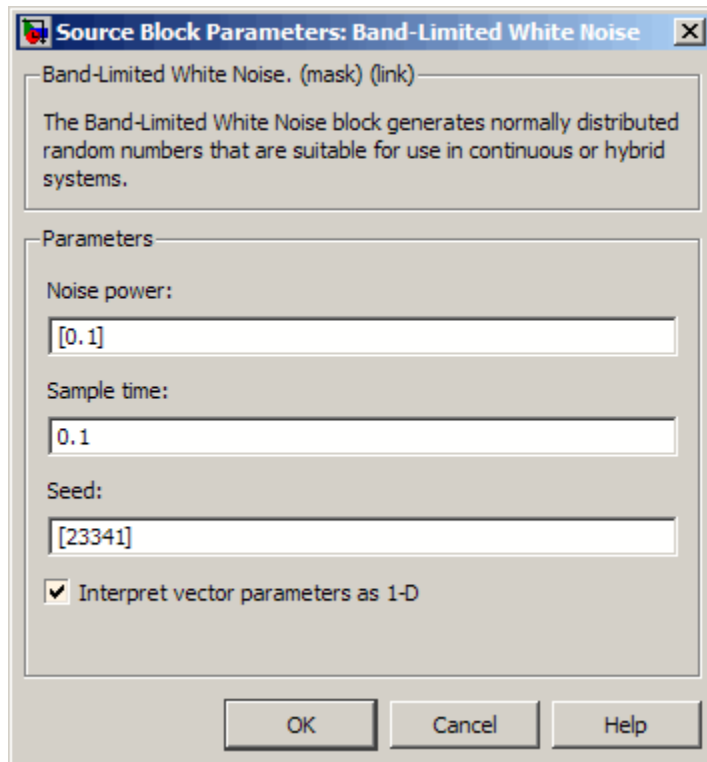
To produce the correct intensity of this noise, the covariance of the noise is scaled to reflect the implicit conversion from a continuous PSD to a discrete noise covariance. The appropriate scale factor is  $1/tc$ , where  $tc$  is the correlation time of the noise. This scaling ensures that the response of a continuous system to the approximate white noise has the same covariance as the system would have to true white noise. Because 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. This block approximates the covariance of white noise as 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 During Simulation” in the “Working with Blocks” chapter of the Simulink documentation.

# Band-Limited White Noise

---

## 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 “How to Specify the Sample Time” in the “How Simulink Works” chapter of the 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 Simulink documentation.

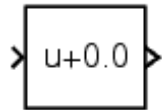
## Characteristics

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

**Purpose** Add bias to input

**Library** Math Operations

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



$$Y = U + Bias$$

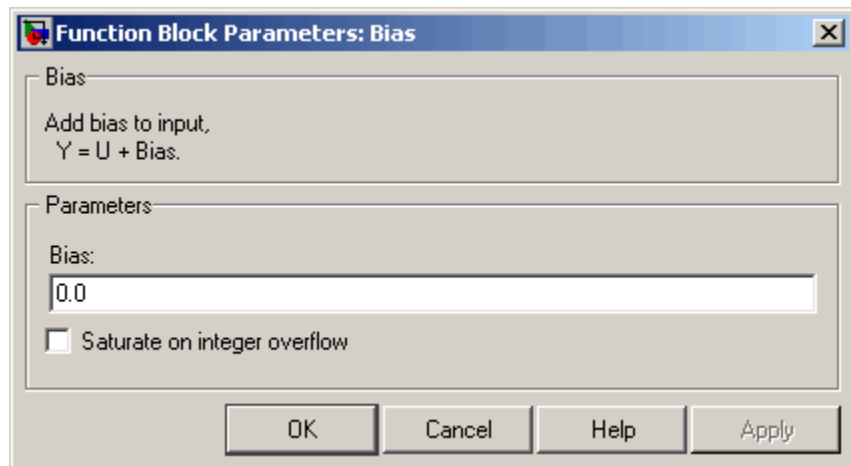
where  $U$  is the block input and  $Y$  is the output.

### Data Type Support

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

For a discussion on the data types supported by Simulink software, see “Data Types Supported by Simulink” in the “Working with Data” chapter of the 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

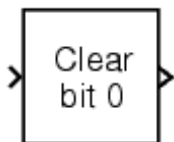
## Purpose

Set specified bit of stored integer to zero

## Library

Logic and Bit Operations

## Description



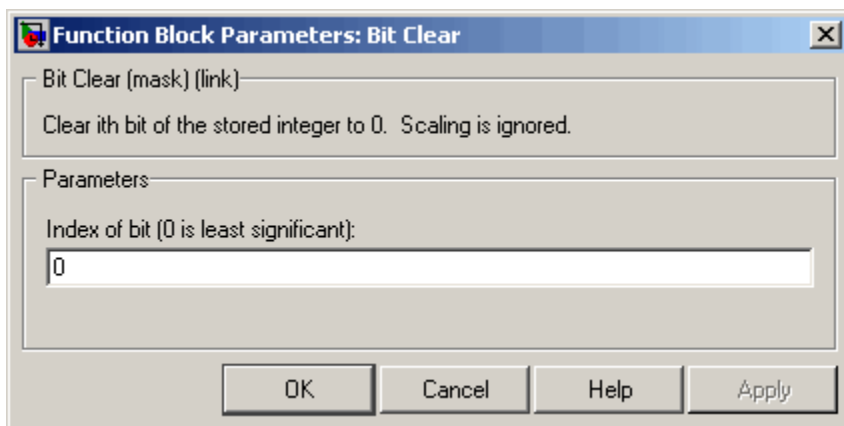
The Bit Clear block sets the specified bit, given by its index, of the stored integer to zero. Scaling is ignored.

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. The block does not support true floating-point data types or enumerated data types.

## 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

# Bit Clear

---

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].

<b>Characteristics</b>	Direct Feedthrough	Yes
	Scalar Expansion	Yes

**See Also**      Bit Set



**Purpose** Set specified bit of stored integer to one

**Library** Logic and Bit Operations

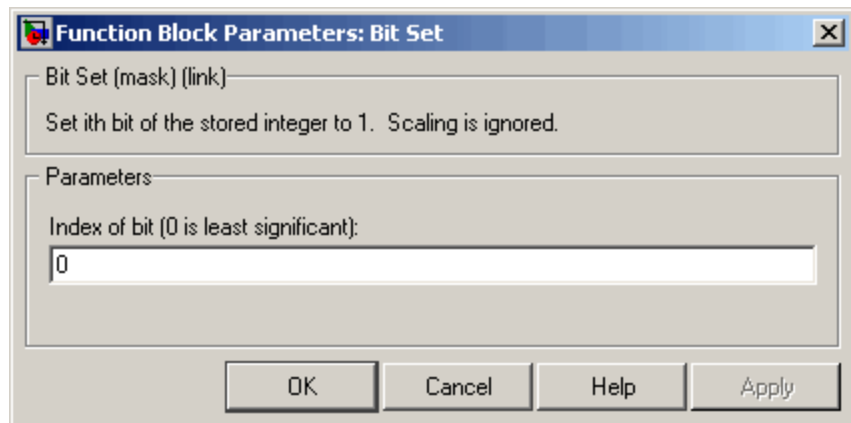
**Description** The Bit Set block sets the specified bit of the stored integer to one. Scaling is ignored.



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. The block does not support true floating-point data types or enumerated data types.

## Parameters and Dialog Box



**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

# Bit Set

---

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].

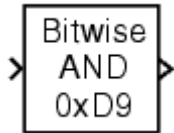
<b>Characteristics</b>	Direct Feedthrough	Yes
	Scalar Expansion	Yes

**See Also**      Bit Clear

**Purpose** Perform specified bitwise operation on 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)

**Restrictions on Block Operations** The Bitwise Operator block does not support shift operations. For shift operations, use the Shift Arithmetic block.

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

# Bitwise Operator

---

## Restrictions on Inputs and Outputs

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.

---

**Tip** 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. All inputs must have the same base data type.

---

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.

---

**Tip** 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.

---

## Bit Set and Bit Clear Operations

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.

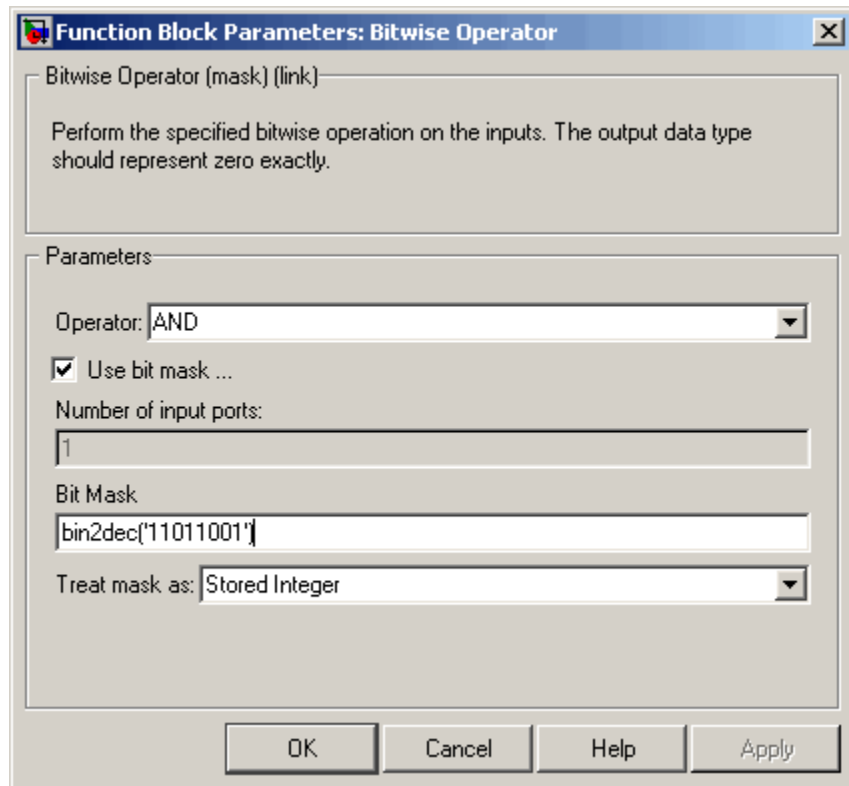
Suppose you want to perform a bit set on the fourth bit of an 8-bit input vector. The bit mask would be 00010000, which you can specify as  $2^4$  in the **Bit mask** parameter. To perform a bit clear, the bit mask would be 11101111, which you can specify as  $2^7+2^6+2^5+2^3+2^2+2^1+2^0$  in the **Bit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

# Bitwise Operator

## 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.

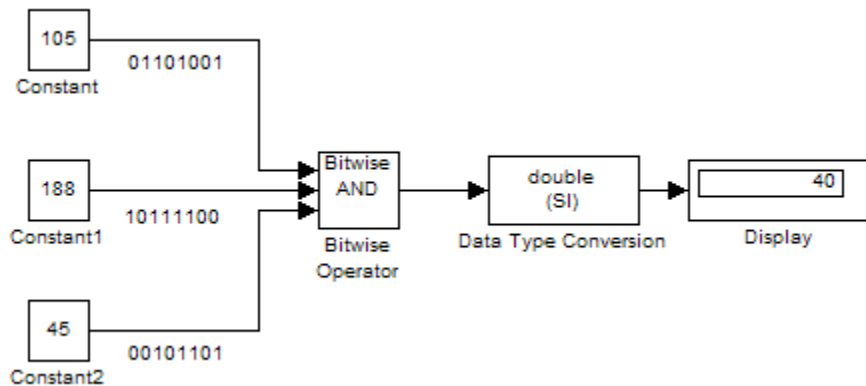
## Treat mask as

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

Based on the encoding scheme described in “Scaling” in 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,  $Q$ .

## Examples

The following fixed-point model shows how the Bitwise Operator block works when inputs are unsigned.



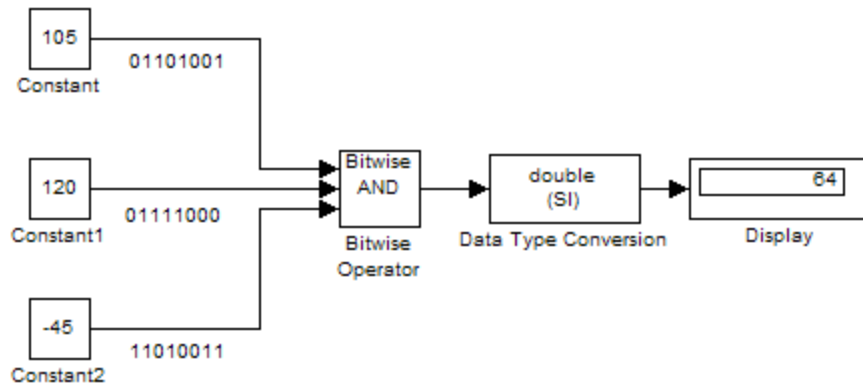
Each Constant block outputs an 8-bit unsigned integer (uint8). The results for all logic operations are shown below.

Operation	Binary Value	Decimal Value
AND	00101000	40
OR	11111101	253

# Bitwise Operator

Operation	Binary Value	Decimal Value
NAND	11010111	215
NOR	00000010	2
XOR	11111000	248
NOT	N/A	N/A

The following fixed-point model shows how the Bitwise Operator block works when inputs are signed.



Each Constant block outputs an 8-bit signed integer (int8). The results for all logic operations are shown below.

Operation	Binary Value	Decimal Value
AND	01000000	64
OR	11111011	-5
NAND	10111111	-65
NOR	00000100	4
XOR	11000010	-62
NOT	N/A	N/A



<b>Characteristics</b>	Direct Feedthrough	Yes
	Scalar Expansion	Yes, of inputs
	Multidimensionalized	Yes

# Block Support Table

---

**Purpose** View data type support for Simulink blocks

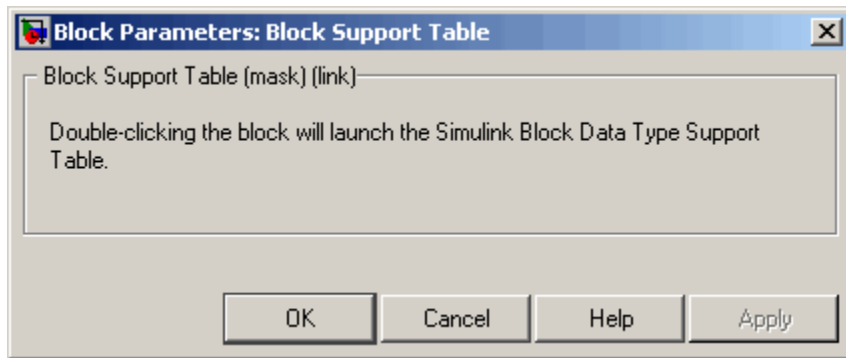
**Library** Model-Wide Utilities

**Description** The Block Support Table block enables you to access a table that summarizes the data types supported by the blocks in the Simulink libraries. Double-click the block to view the table.



**Data Type Support** Not applicable.

**Parameters and Dialog Box**

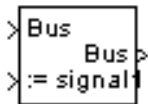


**Characteristics** Not applicable.

**Purpose** Replace specified bus elements

**Library** Signal Routing

## Description



The Bus Assignment block assigns signals connected to its Assignment input ports (`:=`) to specified elements of the bus connected to its Bus input port, replacing the signals previously assigned to those elements. The change does not affect the signals themselves, it affects only the composition of the bus. Signals not replaced are unaffected by the replacement of other signals. See “Using Composite Signals” for information about buses.

Connect the bus to be changed to the first input port. Use the block’s dialog box to specify the bus elements to be replaced. The block displays an assignment input port for each such element. The signal connected to the assignment port must have the same structure, data type, and numeric type as the bus element to which it corresponds.

You cannot use the Bus Assignment block to replace a bus that is nested within another bus. Thus no element selected in the dialog box for replacement can be a bus, and no signal connected to an Assignment port can be a bus.

All signals in a nonvirtual bus must have the same sample time, even if the elements of the associated bus object specify inherited sample times. Any bus operation that would result in a nonvirtual bus that violates this requirement generates an error. All buses and signals input to a Bus Assignment block that modifies a nonvirtual bus must therefore have the same sample time. You can use a Rate Transition block to change the sample time of an individual signal, or of all signals in a bus, to allow the signal or bus to be included in a nonvirtual bus. See “Virtual and Nonvirtual Buses” for more information.

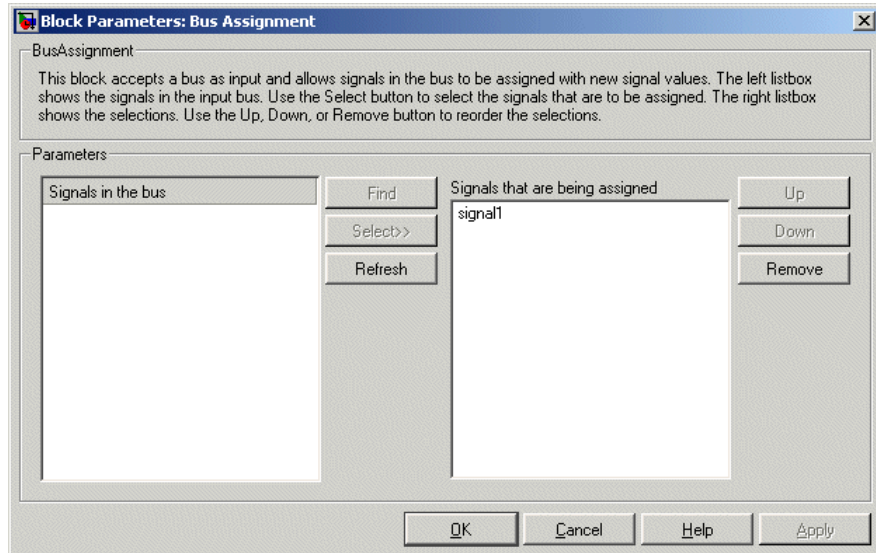
## Data Type Support

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

# Bus Assignment

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

## 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 software opens the subsystem containing the signal source 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.

## Characteristics

Multidimensionalized	Yes
----------------------	-----

## See Also

- “Using Composite Signals”
- “Using Buses”
- Bus Creator
- Bus Selector
- Bus to Vector
- `Simulink.Bus`
- `Simulink.Bus.cellToObject`
- `Simulink.Bus.createObject`
- `Simulink.BusElement`
- `Simulink.Bus.objectToCell`
- `Simulink.Bus.save`

# Bus Creator

---

**Purpose** Create signal bus

**Library** Signal Routing

## Description



The Bus Creator block combines a set of signals into a bus. 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. See “Using Composite Signals” for information about buses.

The signals in the bus will be order from the top input port to the bottom input port. See “How to Rotate a Block” in the Simulink documentation for a description of the port order for various block orientations.

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.

---

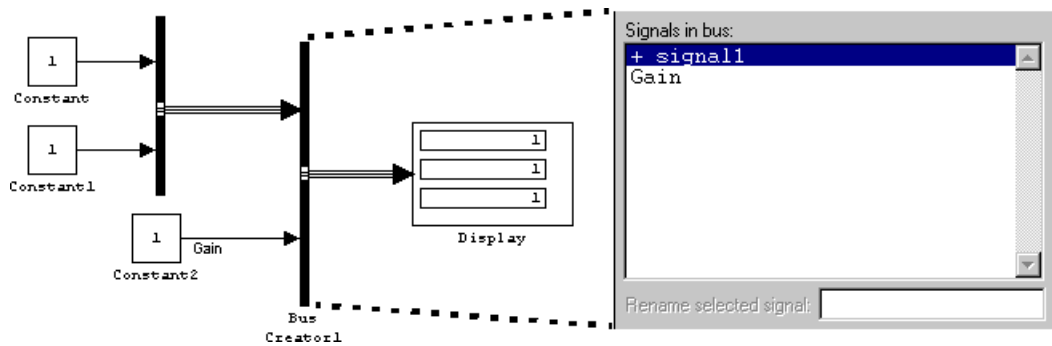
**Note** Simulink software hides the name of a Bus Creator block when you copy it from the Simulink library to a model.

---

## 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 inherits 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 in 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 **Apply** or **OK**.

## Browsing Bus Signals

The **Signals in bus** list on a Bus Creator block's parameter dialog box 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 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 software opens the subsystem containing the signal source, if necessary, and highlights the source's icon.

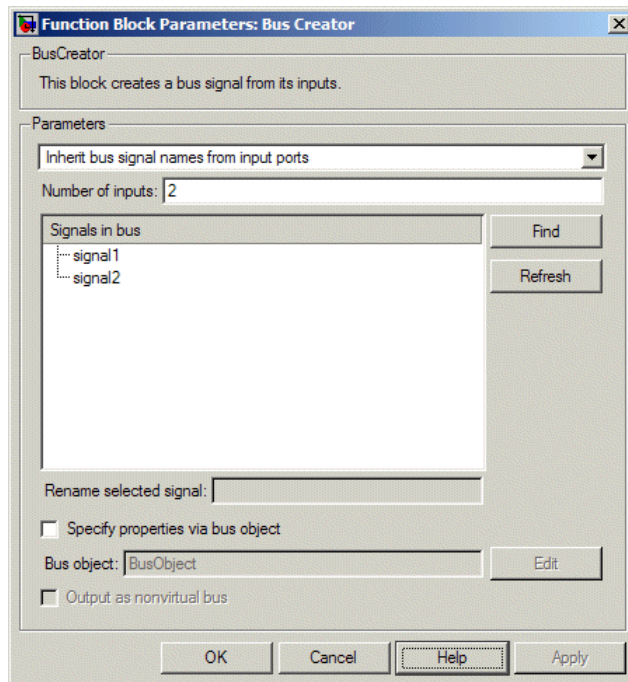
## **Data Type Support**

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

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



## Parameters and Dialog Box



## Signal naming options

Assign input signal names to the corresponding bus signals.

### Settings

**Default:** Inherit bus signal names from input ports

Inherit bus signal names from input ports

Assign input signal names to the corresponding bus signals.

Require input signal names to match signals below

Inputs must have the names listed in the **Signals in bus** list.

### Dependencies

Selecting Require input signal names to match signals below enables **Rename selected signal**.

### Command-Line Information

See “Block-Specific Parameters” on page 8-96 for the command-line information.

### See Also

See the Bus Creator block reference page for more information.

## **Number of inputs**

Specify the number of input ports on this block.

### **Settings**

**Default:** 2

To bundle a group of signals, enter the number of signals in the group.

### **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

### **See Also**

See the Bus Creator block reference page for more information.

## Signals in bus

Show the signals in the output bus.

### Settings

When you modify the **Number of inputs** parameter, click **Refresh** to update the list of signals.

### Tips

- 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.

### Command-Line Information

See “Block-Specific Parameters” on page 8-96 for the command-line information.

### See Also

See the Bus Creator block reference page for more information.

## **Rename selected signal**

List 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.

### **Settings**

**Default:** ''

Edit this field to change the name of the currently selected signal.

### **Dependencies**

This parameter is enabled when you select **Require input signal names to match signals below** as the **Parameters**; and `signal1` or `signal2` as the **Signals in bus**.

### **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

### **See Also**

See the Bus Creator block reference page for more information.

## Specify properties via bus object

Use a bus object to define the structure of the bus created by this block.

### Settings

**Default:** Off



On

Use a bus object to define the structure of the bus created by this block.



Off

Do not use a bus object to define the structure of the bus created by this block.

### Tips

Selecting this parameter is required when creating a nonvirtual bus, and optional when creating a virtual bus.

### Command-Line Information

See “Block-Specific Parameters” on page 8-96 for the command-line information.

### See Also

See the Bus Creator block reference page for more information.

## Bus object

Specify the name of the bus object used to define the structure of the bus created by this block.

## Settings

**Default:** BusObject

The default value is a dummy bus object name. Type in the name of the bus object you want to use. If you need to create or change a bus object, click **Edit** to the left of the **Bus object** field to open the Simulink Bus Editor. See “Using the Bus Editor” for more information.

## Tips

At the beginning of a simulation or when you update the model’s diagram, Simulink software checks whether the signals connected to this Bus Creator block have the specified structure. If not, Simulink software displays an error message.

## Dependencies

This parameter is enabled by **Specify properties via bus object** .

## Command-Line Information

See “Block-Specific Parameters” on page 8-96 for the command-line information.

## See Also

See the Bus Creator block reference page for more information.

## Output as nonvirtual bus

Output a nonvirtual bus.

### Settings

**Default:** Off

- On  
Output a nonvirtual bus.
- Off  
Output a virtual bus.

### Tips

- 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.
- All signals in a nonvirtual bus must have the same sample time, even if the elements of the associated bus object specify inherited sample times. Any bus operation that would result in a nonvirtual bus that violates this requirement generates an error. Therefore, if you select this option all signals entering the Bus Creator block must have the same sample time. You can use a Rate Transition block to change the sample time of an individual signal, or of all signals in a bus, to allow the signal or bus to be included in a nonvirtual bus.

### Dependencies

This parameter is enabled by **Specify properties via bus object** .

### Command-Line Information

See “Block-Specific Parameters” on page 8-96 for the command-line information.

### See Also

- See the Bus Creator block reference page for more information.
- See “Virtual and Nonvirtual Buses” for more information.



<b>Characteristics</b>	Multidimensionalized	Yes
------------------------	----------------------	-----

## See Also

- “Using Composite Signals”
- “Using Buses”
- Bus Assignment
- Bus Selector
- Bus to Vector
- Simulink.Bus
- Simulink.Bus.cellToObject
- Simulink.Bus.createObject
- Simulink.BusElement
- Simulink.Bus.objectToCell
- Simulink.Bus.save

# Bus Selector

---

**Purpose** Select signals from 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 specified elements as separate signals or as a new bus. See “Using Composite Signals” for information about buses.

When the block outputs separate elements, it outputs each element from a separate port from top to bottom of the block. See “How to Rotate a Block” for a description of the port order for various block orientations. See “Using Composite Signals” for information about buses.

---

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

---

---

### Caution

The MathWorks recommends not using Bus Selector blocks in library blocks, because such use complicates changing the library blocks and increases the likelihood of errors. See “Buses and Libraries” for more information.

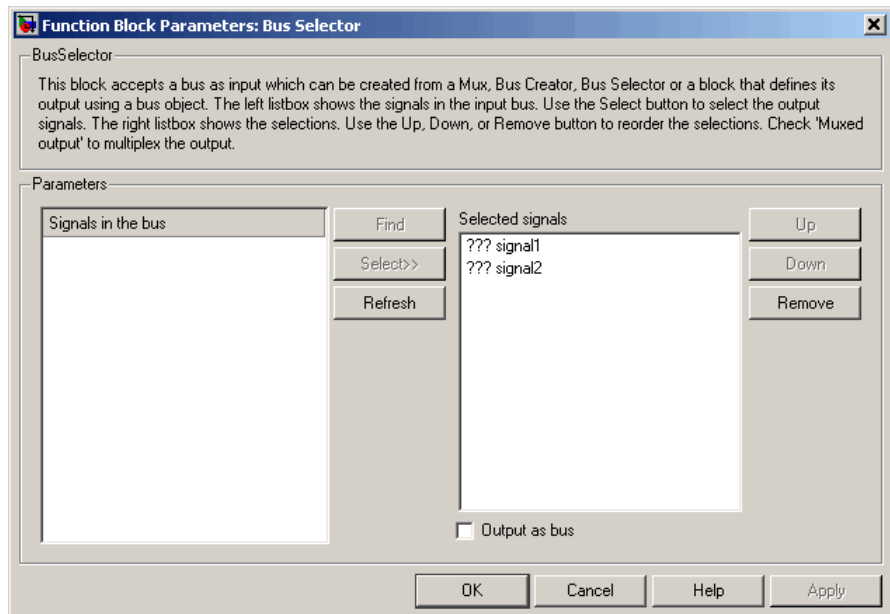
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## Data Type Support

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

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

## Parameters and Dialog Box



# Bus Selector

---

## Signals in the bus

Shows the signals in the input bus.

## Settings

To refresh the display to reflect modifications to the bus connected to the block, click **Refresh**.

## Tips

- Use **Select>>** to select signals to output.
- To find the source of any signal entering the block, select the signal in the list and click **Find**. The Simulink software opens the subsystem containing the signal source, and highlights the source's icon.

## Command-Line Information

See “Block-Specific Parameters” on page 8-96 for the command-line information.

## See Also

See the Bus Selector block reference page for more information.

## **Selected signals**

Shows the signals to be output.

### **Settings**

**Default:** signal1,signal2

You can change the list by using the **Up**, **Down**, and **Remove** buttons.

### **Tips**

- 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 (???).

### **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

### **See Also**

See the Bus Selector block reference page for more information.

# Bus Selector

---

## Output as bus

Output the selected elements as a bus.

### Settings

**Default:** Off

On

Output the selected elements as a bus.

Off

Output the selected elements as standalone signals, each from an output port that is labeled with the corresponding element's name.

### Tips

The output bus is virtual if the input bus is virtual, or nonvirtual if the input bus is nonvirtual.

### Command-Line Information

See “Block-Specific Parameters” on page 8-96 for the command-line information.

### See Also

- See the Bus Selector block reference page for more information.
- See “Virtual and Nonvirtual Buses” for more information.

## Characteristics

Multidimensionalized	Yes
----------------------	-----

## See Also

- “Using Composite Signals”
- “Using Buses”
- Bus Assignment
- Bus Creator
- Bus to Vector
- Simulink.Bus

- `Simulink.Bus.cellToObject`
- `Simulink.Bus.createObject`
- `Simulink.BusElement`
- `Simulink.Bus.objectToCell`
- `Simulink.Bus.save`

# Bus to Vector

---

**Purpose** Convert virtual bus to vector

**Library** Signal Attributes

## Description



The Bus to Vector block converts a virtual bus signal to a vector signal. The input bus signal must consist of scalar, 1-D, or either row or column vectors having the same data type, signal type, and sampling mode. If the input bus contains row or column vectors, this block outputs a row or column vector, respectively; otherwise, it outputs a 1-D array.

Use the Bus to Vector block only to replace an implicit bus-to-vector conversion with an equivalent explicit conversion. See “Bus signal treated as vector” and “Correcting Buses Used as Muxes” for more information.

---

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

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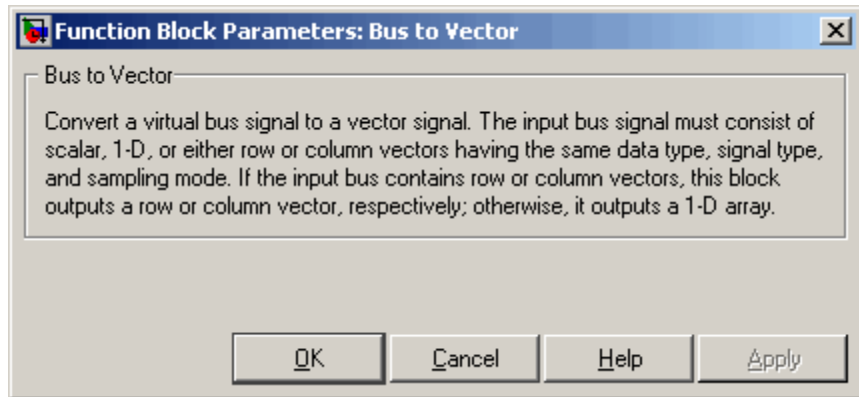
## Data Type Support

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

For a discussion of the data types supported by Simulink software, refer to “Data Types Supported by Simulink” in the “Working with Data” chapter of the Simulink documentation.



## Parameters and Dialog Box



This block has no user-accessible parameters.

## Characteristics

Multidimensionalized	Yes
----------------------	-----

## See Also

- “Using Composite Signals”
- “Using Buses”
- Avoiding Mux/Bus Mixtures
- Bus Assignment
- Bus Creator
- Bus Selector
- Simulink.BlockDiagram.addBusToVector
- Simulink.Bus
- Simulink.Bus.cellToObject
- Simulink.Bus.createObject
- Simulink.BusElement
- Simulink.Bus.objectToCell

## Bus to Vector

---

- Simulink.Bus.save

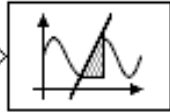
## Purpose

Check that absolute value of difference between successive samples of discrete signal is less than 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. Use the block parameter dialog box 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.

---

**Note** For information about how Real-Time Workshop generated code handles Model Verification blocks, see “Enabling Model Verification Blocks” in the Real-Time Workshop User’s Guide.

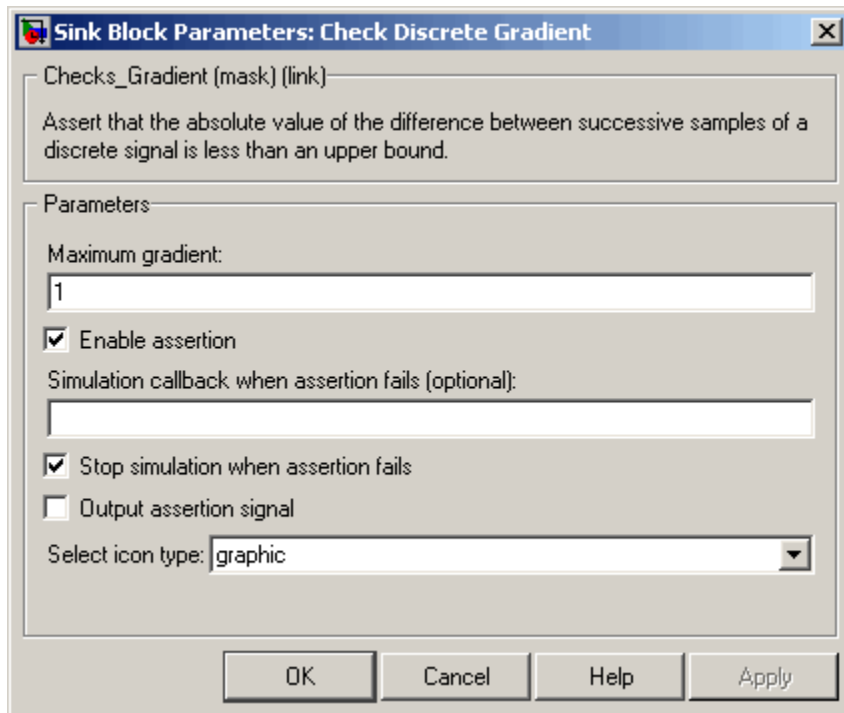
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## Data Type Support

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

# Check Discrete Gradient

## Parameters and Dialog Box



### Maximum gradient

Upper bound on the gradient of the discrete input signal.

### Enable assertion

Clearing this check box 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-code expression to evaluate when the assertion fails.

## Stop simulation when assertion fails

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

## Output assertion signal

Selecting this check box 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** check box on the **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
Multidimensionalized	Yes
Zero Crossing	No

# Check Dynamic Gap

---

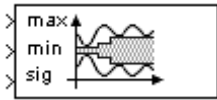
## Purpose

Check that gap of possibly varying width occurs in range of 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.

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**Note** For information about how Real-Time Workshop generated code handles Model Verification blocks, see “Enabling Model Verification Blocks” in the Real-Time Workshop User’s Guide.

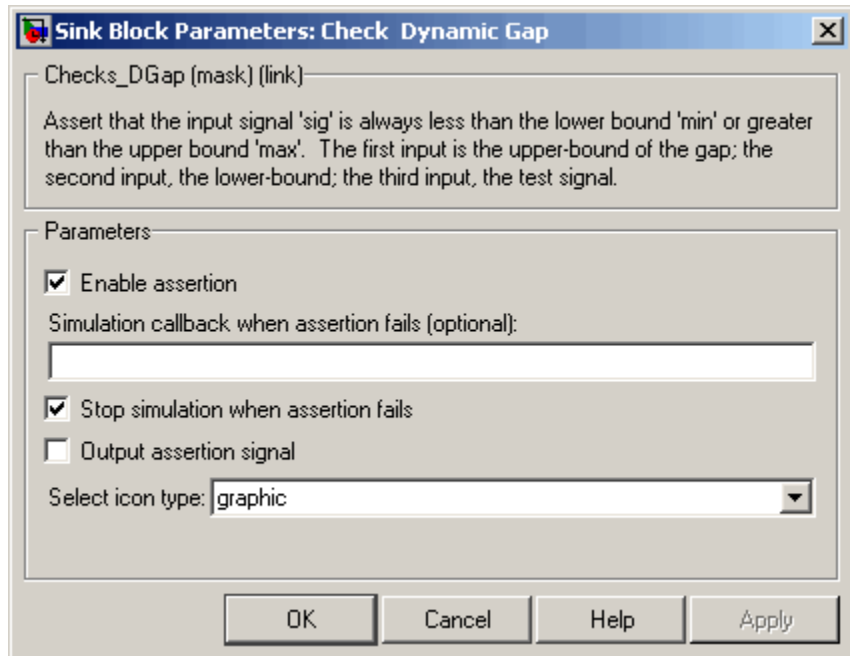
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## Data Type Support

The Check Dynamic Gap block accepts input signals of any dimensions and of any numeric data type supported by Simulink software. 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 software, see “Data Types Supported by Simulink” in the “Working with Data” chapter of the Simulink documentation.

## Parameters and Dialog Box



### Enable assertion

Clearing this check box 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-code expression to evaluate when the assertion fails.

# Check Dynamic Gap

---

## Stop simulation when assertion fails

Selecting this check box 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

Selecting this check box 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** check box on the **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

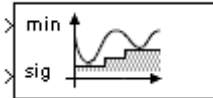
Direct Feedthrough	No
Sample Time	Inherited from driving block
Scalar Expansion	No
Dimensionalized	Yes
Multidimensionalized	Yes
Zero Crossing	No



**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.

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**Note** For information about how Real-Time Workshop generated code handles Model Verification blocks, see “Enabling Model Verification Blocks” in the Real-Time Workshop User’s Guide.

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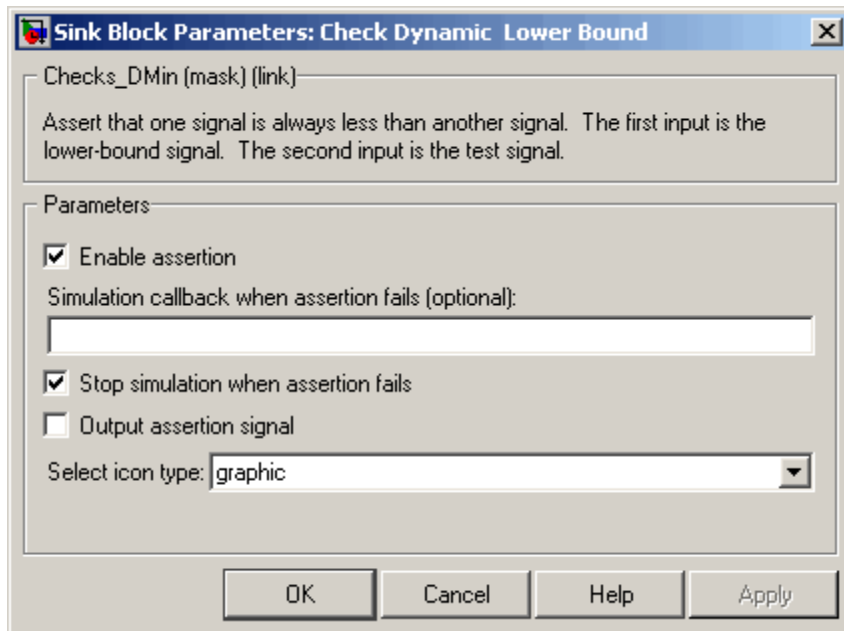
## Data Type Support

The Check Dynamic Lower Bound block accepts input signals of any numeric data type supported by Simulink software. 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 software, see “Data Types Supported by Simulink” in the “Working with Data” chapter of the Simulink documentation.

# Check Dynamic Lower Bound

## Parameters and Dialog Box



### Enable assertion

Clearing this check box 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-code expression to evaluate when the assertion fails.

### Stop simulation when assertion fails

Selecting this check box 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.

# Check Dynamic Lower Bound

Otherwise, the block displays a warning message in the MATLAB Command Window and continues the simulation.

## Output assertion signal

Selecting this check box 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 the `Implement logic signals as boolean data` check box on the **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
Multidimensionalized	Yes
Zero Crossing	No

# Check Dynamic Range

---

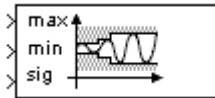
## Purpose

Check that signal falls inside 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.

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**Note** For information about how Real-Time Workshop generated code handles Model Verification blocks, see “Enabling Model Verification Blocks” in the Real-Time Workshop User’s Guide.

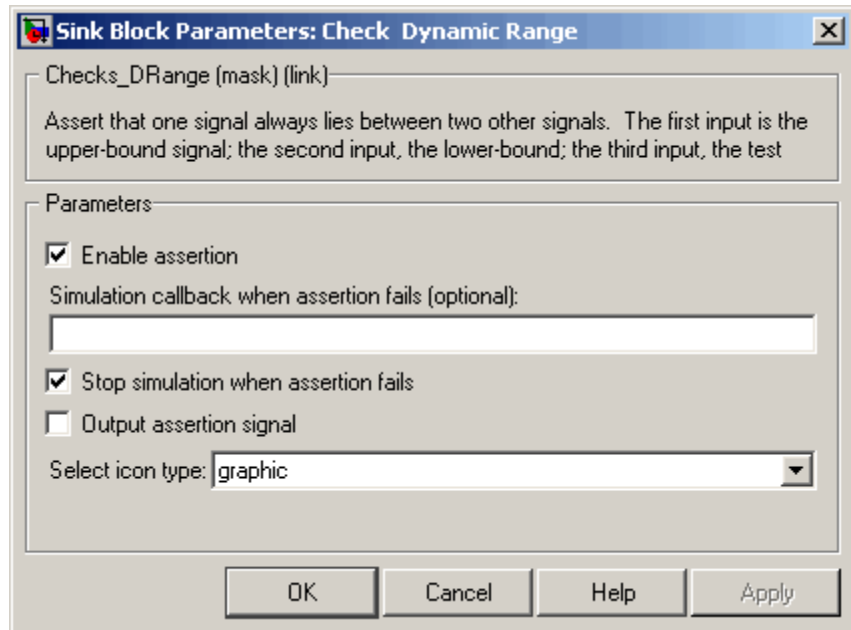
---

## Data Type Support

The Check Dynamic Range block accepts input signals of any dimensions and of any numeric data type supported by Simulink software. 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 software, see “Data Types Supported by Simulink” in the “Working with Data” chapter of the Simulink documentation.

## Parameters and Dialog Box



### Enable assertion

Clearing this check box 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-code expression to evaluate when the assertion fails.

# Check Dynamic Range

---

## Stop simulation when assertion fails

Selecting this check box 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

Selecting this check box 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** check box on the **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
Multidimensionalized	Yes
Zero Crossing	No

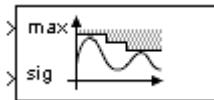
## Purpose

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.

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**Note** For information about how Real-Time Workshop generated code handles Model Verification blocks, see “Enabling Model Verification Blocks” in the Real-Time Workshop User’s Guide.

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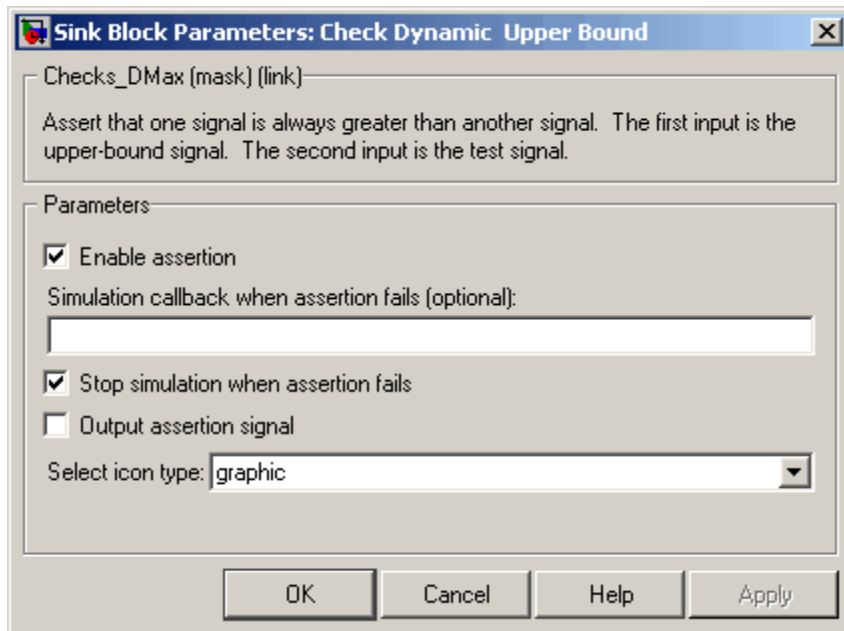
## Data Type Support

The Check Dynamic Upper Bound block accepts input signals of any dimensions and of any numeric data type supported by Simulink software. 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 software, see “Data Types Supported by Simulink” in the “Working with Data” chapter of the Simulink documentation.

# Check Dynamic Upper Bound

## Parameters and Dialog Box



### Enable assertion

Clearing this check box 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-code expression to evaluate when the assertion fails.

### Stop simulation when assertion fails

Selecting this check box 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.



# Check Dynamic Upper Bound

Otherwise, the block displays a warning message in the MATLAB Command Window and continues the simulation.

## Output assertion signal

Selecting this check box 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 the `Implement logic signals as boolean data` check box on the **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
Multidimensionalized	Yes
Zero Crossing	No

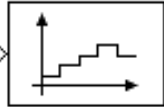
# Check Input Resolution

---

**Purpose** Check that input signal has 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.

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**Note** For information about how Real-Time Workshop generated code handles Model Verification blocks, see “Enabling Model Verification Blocks” in the Real-Time Workshop User’s Guide.

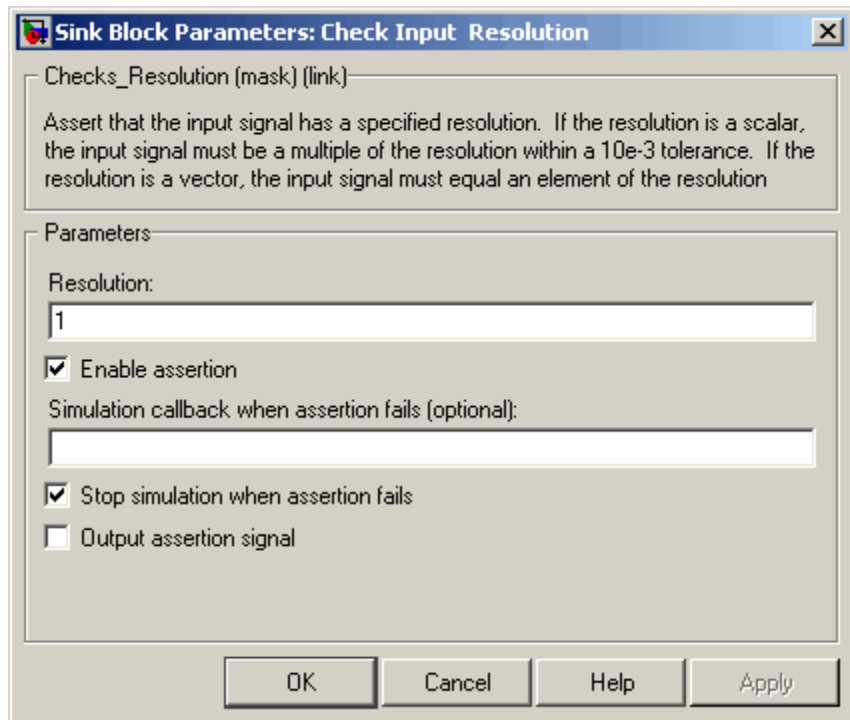
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**Data Type Support**

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 software, see “Data Types Supported by Simulink” in the “Working with Data” chapter of the Simulink documentation.

## Parameters and Dialog Box



### Resolution

Resolution that the input signal must have.

### Enable assertion

Clearing this check box 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-code expression to evaluate when the assertion fails.

# Check Input Resolution

---

## Stop simulation when assertion fails

Selecting this check box 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

Selecting this check box 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** check box on the **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
Multidimensionalized	Yes
Zero Crossing	No

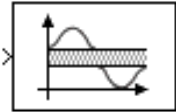
## Purpose

Check that gap exists in 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.

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**Note** For information about how Real-Time Workshop generated code handles Model Verification blocks, see “Enabling Model Verification Blocks” in the Real-Time Workshop User’s Guide.

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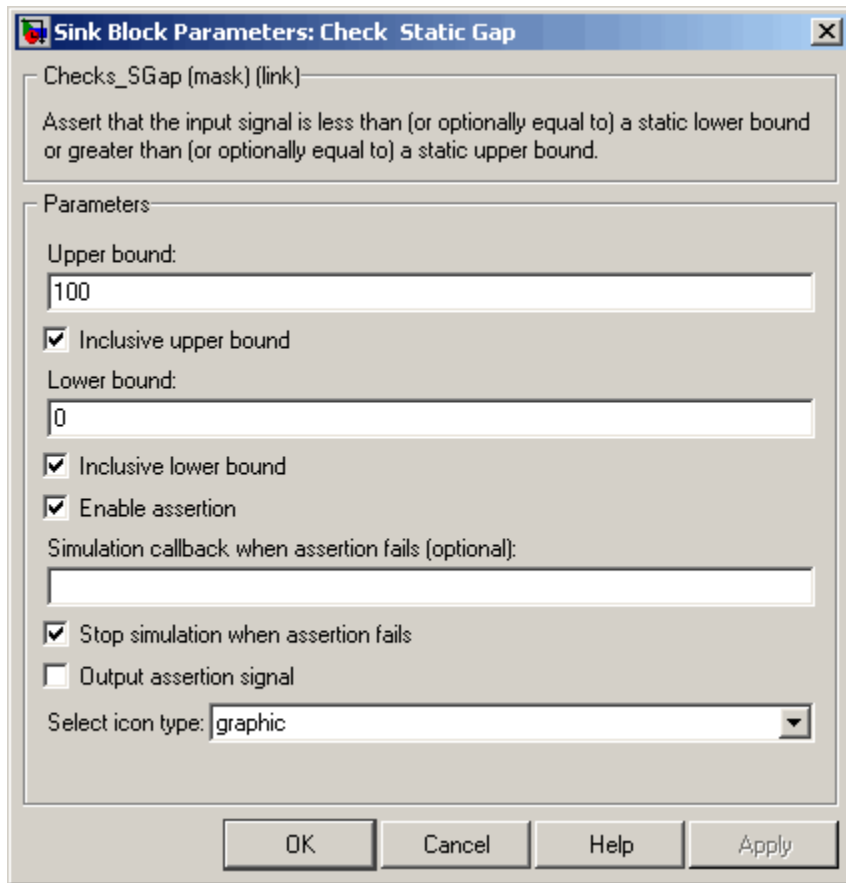
## Data Type Support

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

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

# Check Static Gap

## Parameters and Dialog Box



### Upper bound

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

### Inclusive upper bound

Selecting this check box 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**

Selecting this check box specifies that the gap includes the lower bound.

## **Enable assertion**

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

## **Simulation callback when assertion fails**

An M-code expression to evaluate when the assertion fails.

## **Stop simulation when assertion fails**

Selecting this check box 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**

Selecting this check box 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** check box on the **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

## Check Static Gap

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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
Multidimensionalized	Yes
Zero Crossing	No



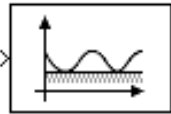
## Purpose

Check that signal is greater than (or optionally equal to) 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. Use the block parameter dialog box 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.

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**Note** For information about how Real-Time Workshop generated code handles Model Verification blocks, see “Enabling Model Verification Blocks” in the Real-Time Workshop User’s Guide.

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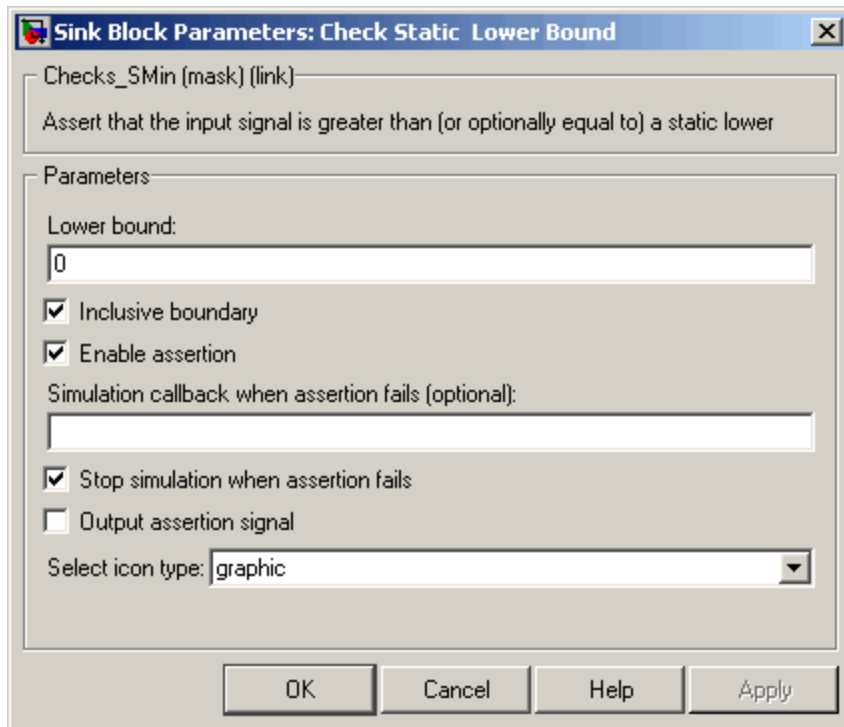
## Data Type Support

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

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

# Check Static Lower Bound

## Parameters and Dialog Box



### Lower bound

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

### Inclusive boundary

Selecting this check box makes the range of valid input amplitudes include the lower bound.

### Enable assertion

Clearing this check box 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-code expression to evaluate when the assertion fails.

### Stop simulation when assertion fails

Selecting this check box causes the Check Static 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

Selecting this check box 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** check box on the **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

## Check Static Lower Bound

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Multidimensionalized	Yes
Zero Crossing	No

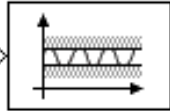
## Purpose

Check that signal falls inside 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. Use the block parameter dialog box 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.

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**Note** For information about how Real-Time Workshop generated code handles Model Verification blocks, see “Enabling Model Verification Blocks” in the Real-Time Workshop User’s Guide.

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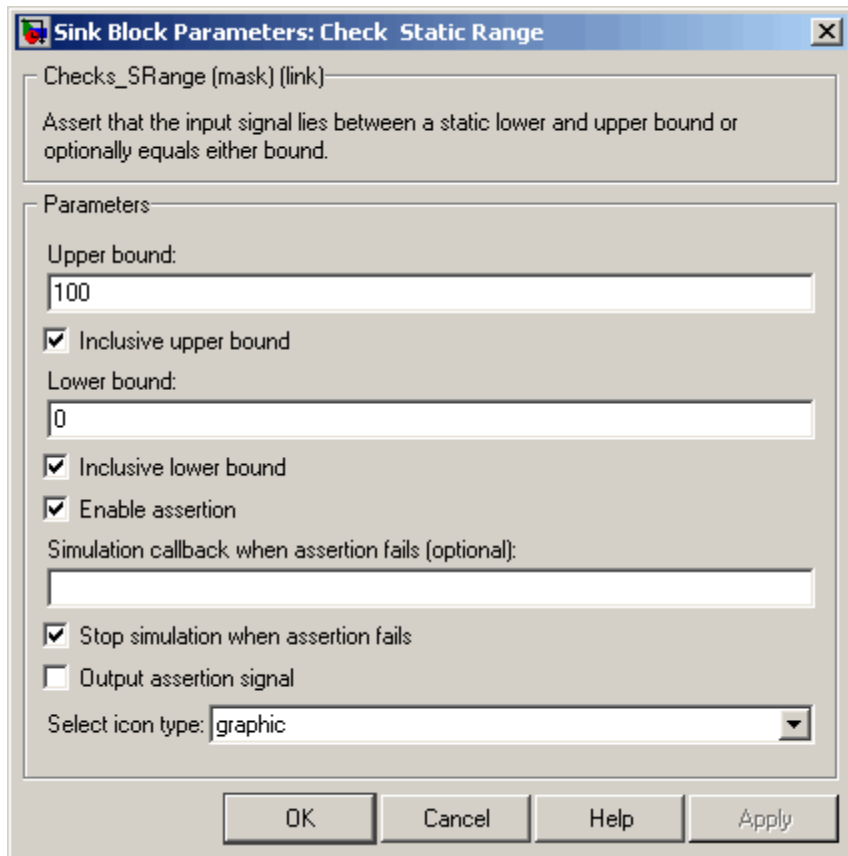
## Data Type Support

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

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

# Check Static Range

## Parameters and Dialog Box



### Upper bound

Upper bound of the range of valid input signal amplitudes.

### Inclusive upper bound

Selecting this check box 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**

Selecting this check box specifies that the valid signal range includes the lower bound.

## **Enable assertion**

Clearing this check box 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-code expression to evaluate when the assertion fails.

## **Stop simulation when assertion fails**

Selecting this check box 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**

Selecting this check box 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** check box on the **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

## Check Static Range

---

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
Multidimensionalized	Yes
Zero Crossing	No



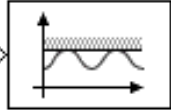
## Purpose

Check that signal is less than (or optionally equal to) static upper 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 upper bound at the current time step. Use the block parameter dialog box 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.

---

**Note** For information about how Real-Time Workshop generated code handles Model Verification blocks, see “Enabling Model Verification Blocks” in the Real-Time Workshop User’s Guide.

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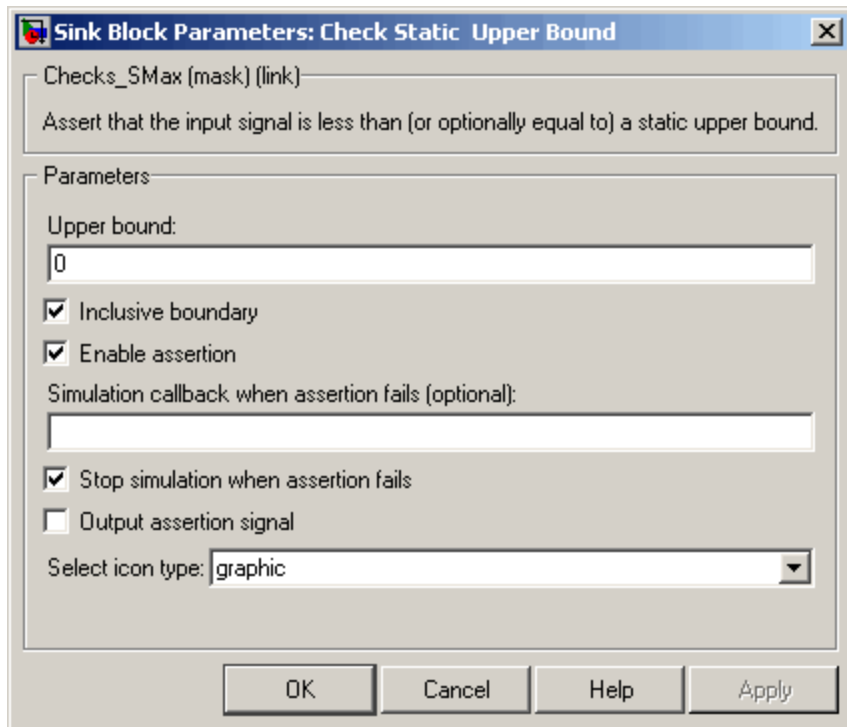
## Data Type Support

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

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

# 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

Selecting this check box makes the range of valid input amplitudes include the upper bound.

### Enable assertion

Clearing this check box 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-code expression to evaluate when the assertion fails.

## Stop simulation when assertion fails

Selecting this check box 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

Selecting this check box 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** check box on the **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

## Check Static Upper Bound

---

Multidimensionalized	Yes
Zero Crossing	No

## Purpose

Generate 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.

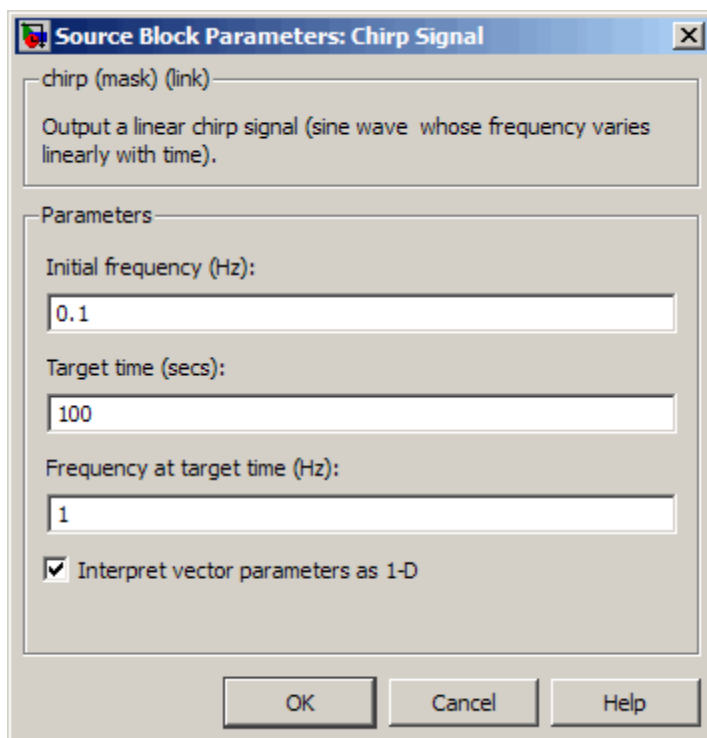
The parameters, **Initial frequency**, **Target time**, and **Frequency at target time**, determine the block's output. You can specify any or all of these variables as scalars or arrays. All the parameters specified as arrays must have the same dimensions. The block expands scalar parameters to have 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** check box. If you select this check box 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.

# Chirp Signal

## Parameters and Dialog Box



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

**Characteristics**

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

# Clock

**Purpose** Display and provide simulation time

**Library** Sources

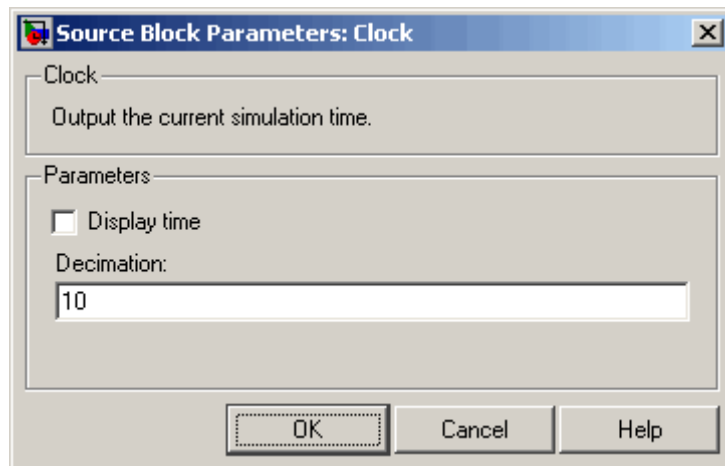
**Description** The Clock block outputs the current simulation time at each simulation step. This block is useful for other blocks that need the simulation time.



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 Simulink software updates the Clock icon when **Display time** is checked. Specify a positive integer (the default is 10). For



example, if the decimation is 1000, then, for a fixed integration step of 1 millisecond, the Clock icon 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 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

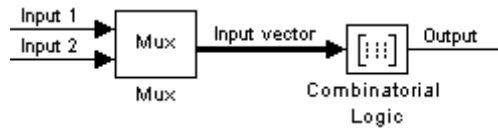
$$\text{number of rows} = 2^{\text{(number of inputs)}}$$

Simulink software returns a row of the matrix by computing the row's index from the input vector elements. Simulink software 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,

$$\text{row index} = 1 + u(m) * 2^0 + u(m-1) * 2^1 + \dots + u(1) * 2^{m-1}$$

## 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.

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

# Combinatorial Logic

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Inputs			Outputs	
a	b	c	c'	s
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

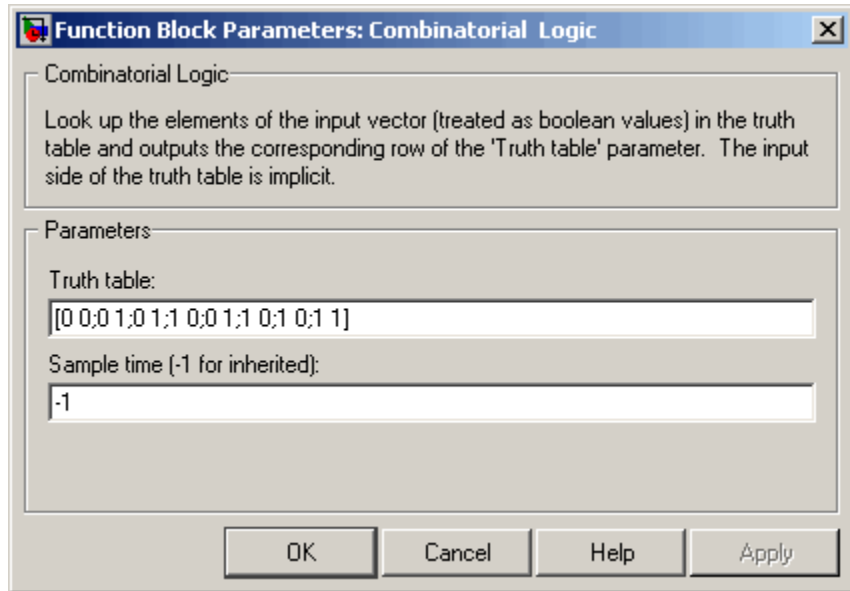
The type of signals accepted by a Combinatorial Logic block depends on whether you selected the Boolean logic signals option (see “Implement logic signals as boolean data (vs. double)” in the “Working with Data” chapter of the Simulink documentation). If this option is enabled, the block accepts real signals of type `Boolean` or `double`. The **Truth table** parameter can have Boolean values (0 or 1) of any data type, including fixed-point data types. 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 “How to Specify the Sample Time” in the “How Simulink Works” chapter of the Simulink documentation.

# Combinatorial Logic

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

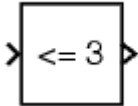
## Purpose

Determine how signal compares to 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.

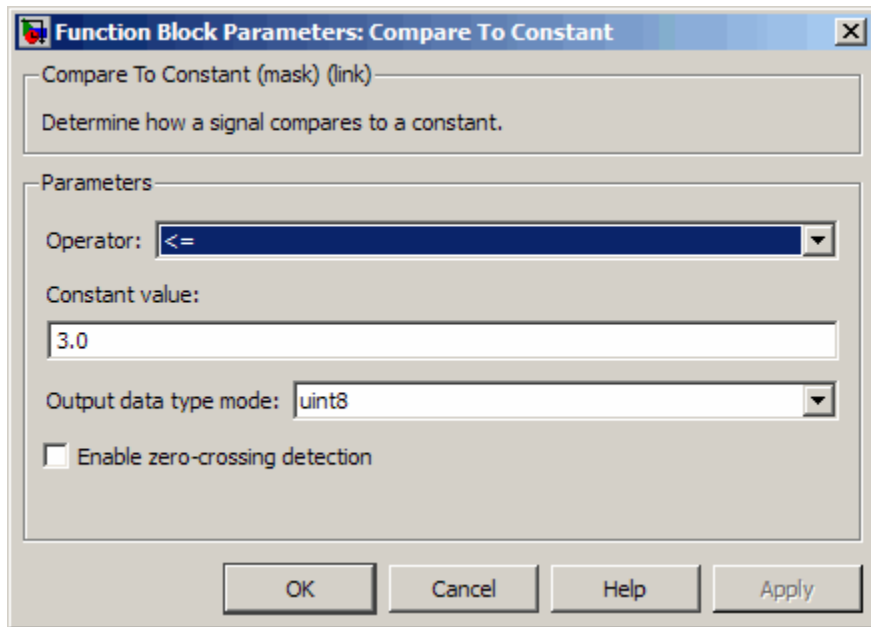
## Data Type Support

The Compare To Constant block accepts inputs of any data type supported by Simulink software, including fixed-point and enumerated data types. The block first converts its **Constant value** parameter to the input data type, and then performs the specified operation. 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 software, see “Data Types Supported by Simulink” in the “Working with Data” chapter of the Simulink User’s Guide.

# Compare To Constant

## 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 “How Blocks Work with Zero-Crossing Detection” in the “How Simulink Works” chapter of the Simulink documentation.



<b>Characteristics</b>	Direct Feedthrough	Yes
	Scalar Expansion	Yes
	Multidimensionalized	Yes
	Zero Crossing	Yes, if enabled.

**See Also**      Compare To Zero

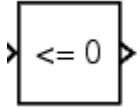
# Compare To Zero

---

**Purpose** Determine how 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:



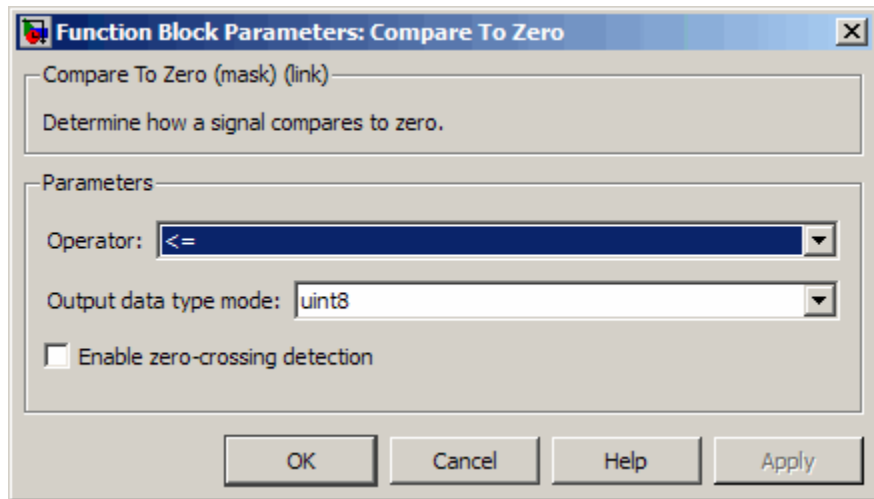
- == — Determine whether the input is equal to zero.
- ~= — Determine whether the input is not equal to zero.
- < — Determine whether the input is less than zero.
- <= — Determine whether the input is less than or equal to zero.
- > — Determine whether the input is greater than zero.
- >= — Determine 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 numeric data type supported by Simulink software, 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 software, see “Data Types Supported by Simulink” in the “Working with Data” chapter of the Simulink User’s Guide.

## 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 “How Blocks Work with Zero-Crossing Detection” in the “How Simulink Works” chapter of the Simulink User’s Guide.

## Characteristics

Direct Feedthrough	Yes
Scalar Expansion	Yes
Zero-Crossing Detection	Yes, if enabled.
Multidimensionalized	Yes

## See Also

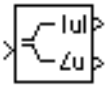
Compare To Constant

# Complex to Magnitude-Angle

**Purpose** Compute magnitude and/or phase angle of complex signal

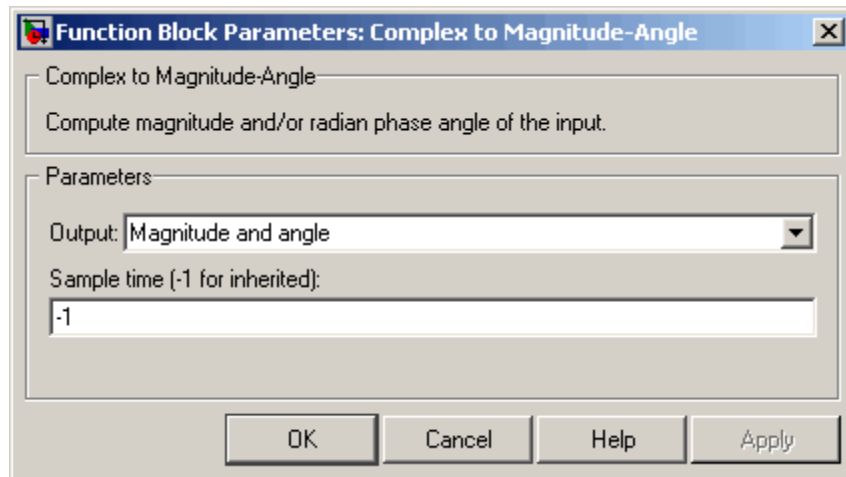
**Library** Math Operations

**Description** The Complex to Magnitude-Angle block accepts a complex-valued signal of type `double` or `single`. 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 the same data type as the block input. 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 “How to Specify the Sample Time” in the “How Simulink Works” chapter of the Simulink documentation.

### **Characteristics**

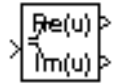
Direct Feedthrough	Yes
Sample Time	Inherited from driving block
Scalar Expansion	No
Dimensionalized	Yes
Multidimensionalized	Yes
Zero Crossing	No

# Complex to Real-Imag

**Purpose** Output real and imaginary parts of complex input signal

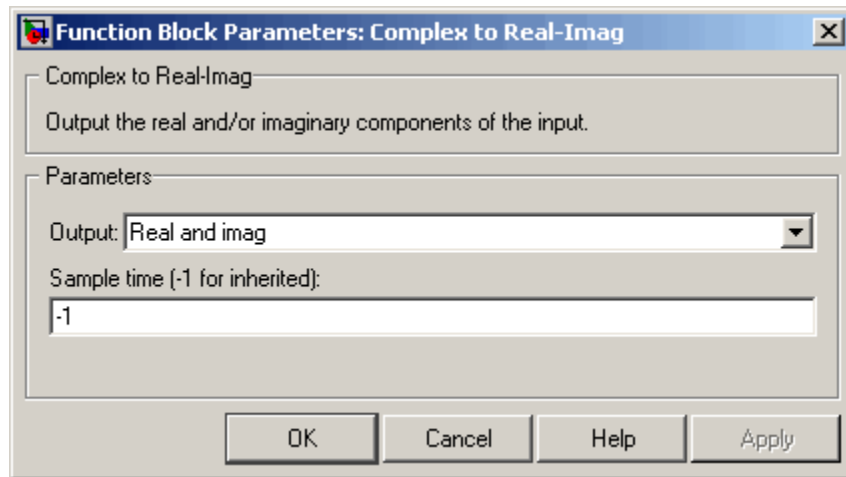
**Library** Math Operations

**Description** The Complex to Real-Imag block accepts a complex-valued signal of any data type supported by Simulink software, 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 software, see “Data Types Supported by Simulink” in the “Working with Data” chapter of the 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 "How to Specify the Sample Time" in the "How Simulink Works" chapter of the Simulink documentation.

## Characteristics

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

# Configurable Subsystem

---

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

**Library** Ports & Subsystems

**Description**



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 software derives the port names for the configurable subsystem by making a unique list from the port names of all the choices. Note that Simulink software uses default port names for non-subsystem block choices.

Note that Simulink software does not allow you to break library links in a configurable subsystem because Simulink software 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

# Configurable Subsystem

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to the configurable subsystem. To propagate this change, do one of the following:

- 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', ...);
```

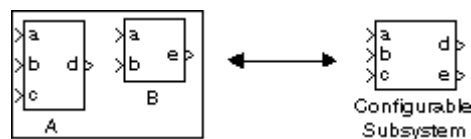
## Mapping I/O Ports

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

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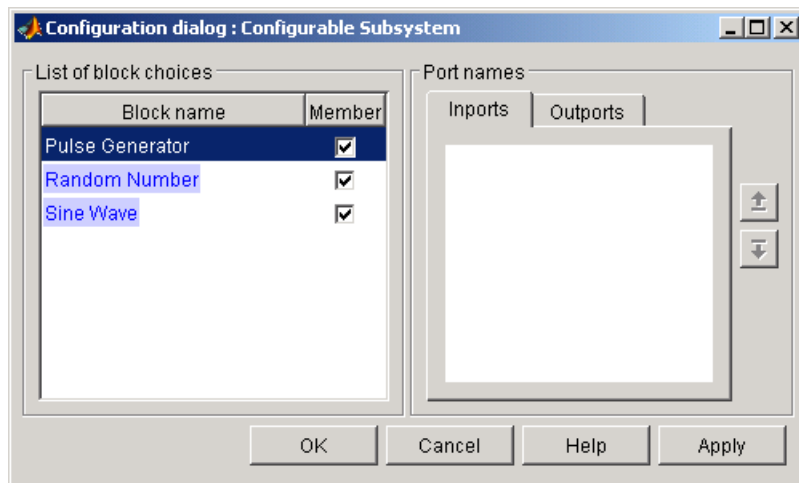
**Note** A Configurable Subsystem block does not provide ports that correspond to non-I/O ports, such as the trigger and enable ports on triggered and enabled subsystems. Thus, you cannot use a Configurable Subsystem block directly to represent blocks that have such ports. You can do so indirectly, however,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

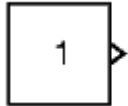
# Constant

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**Purpose** Generate 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).

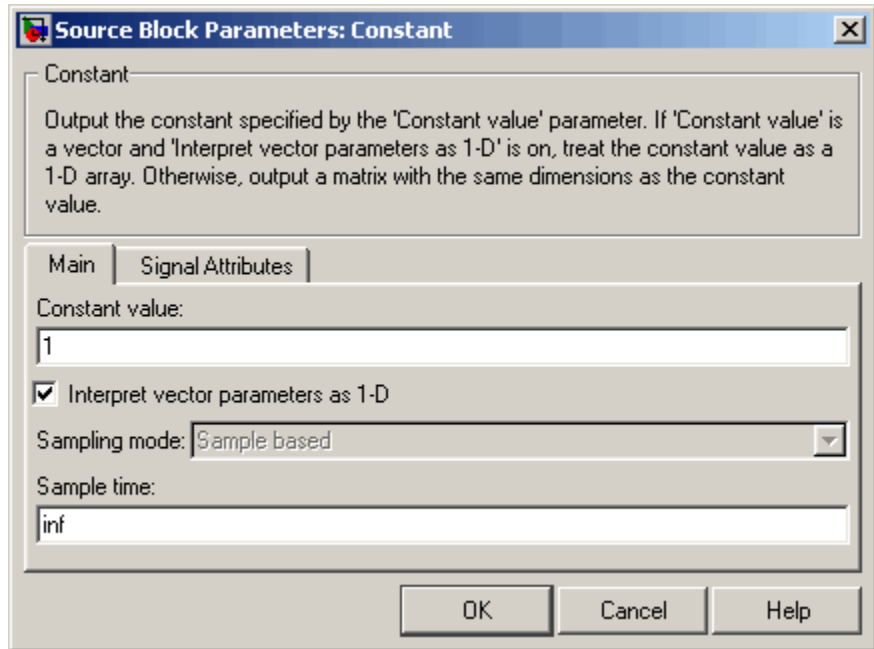
## Data Type Support

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 software, including fixed-point and enumerated data types.

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

## Parameters and Dialog Box

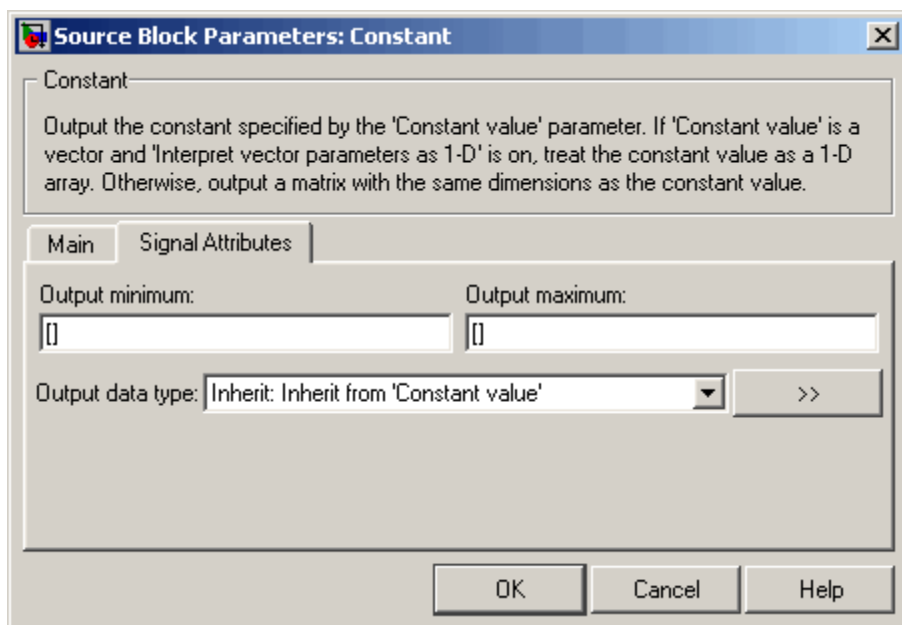
The **Main** pane of the Constant block dialog box appears as follows:



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

The **Signal Attributes** pane of the Constant block dialog appears as follows:

# Constant





## **Show data type assistant**

Display the **Data Type Assistant**.

### **Settings**

The **Data Type Assistant** helps you set the **Output data type** parameter.

See “Specifying Block Output Data Types” in *Simulink User’s Guide* for more information.

### **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

# Constant

---

## Constant value

Specify the constant value output of the block.

### Settings

**Default:** 1

**Minimum:** value from the **Output minimum** parameter

**Maximum:** value from the **Output maximum** parameter

- You can enter any expression that MATLAB evaluates as a matrix, including the Boolean keywords `true` and `false`.
- This parameter is converted from its data type to the specified output data type offline using round toward nearest and saturation.

### Command-Line Information

See “Block-Specific Parameters” on page 8-96 for the command-line information.

## Interpret vector parameters as 1-D

Select this check box to output 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.

### Settings

**Default:** Selected



On

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.



Off

Does not output 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 this check box is cleared, you can interact with the **Sampling mode** parameter.

### Dependencies

This parameter enables **Sampling mode**.

### Command-Line Information

See “Block-Specific Parameters” on page 8-96 for the command-line information.

## Sampling mode

Specify whether the output signal is `Sample based` or `Frame based`.

### Settings

**Default:** `Sample based`

`Sample based`

The output signal is sample-based.

`Frame based`

The output signal is frame-based.

### Tips

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

### Dependencies

This parameter is enabled by clearing **Interpret vector parameters as 1-D**.

Selecting `Sample based` enables the following parameter:

- **Sample time**

Selecting `Frame based` enables the following parameter:

- **Frame period**

### Command-Line Information

See “Block-Specific Parameters” on page 8-96 for the command-line information.

## Sample time

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

## Settings

**Default:** inf

This setting indicates that 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 “How to Specify the Sample Time” in the online documentation for more information.

## Dependencies

This parameter is enabled by **Sampling mode**.

## Command-Line Information

See “Block-Specific Parameters” on page 8-96 for the command-line information.

# Constant

---

## **Frame period**

Specify the interval between frames that the Constant block's output can change during simulation (e.g., as a result of tuning its **Constant value** parameter).

## **Settings**

**Default:** inf

## **Dependency**

This parameter is enabled by **Sampling mode**.

## **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

## Lock output scaling against changes by the autoscaling tool

Select to lock scaling of outputs.

### Settings

**Default:** Off

On

Lock scaling of outputs.

Off

Do not lock scaling of outputs.

### Dependencies

This parameter is enabled when you enter an expression for the **Output data type** or **Data type** parameter.

### Command-Line Information

See “Block-Specific Parameters” on page 8-96 for the command-line information.

## **Output minimum**

Specify the minimum value that the block should output.

### **Settings**

**Default:** []

The default value, [], is equivalent to `-Inf`.

Simulink software uses this value to perform:

- Parameter range checking (see “Checking Parameter Values”) for some blocks
- Simulation range checking (see “Checking Signal Ranges”)
- Automatic scaling of fixed-point data types

### **Tip**

This number must be a double scalar value.

### **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.



## **Output maximum**

Specify the maximum value that the block should output.

### **Settings**

**Default:** []

The default value, [], is equivalent to Inf.

Simulink software uses this value to perform:

- Parameter range checking (see “Checking Parameter Values”) for some blocks
- Simulation range checking (see “Checking Signal Ranges”)
- Automatic scaling of fixed-point data types

### **Tip**

This number must be a double scalar value.

### **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

## Output data type

Specify the output data type.

### Settings

**Default:** Inherit: Inherit via internal rule (Discrete-Time Integrator, Gain, Product, Sum, Switch block), Inherit: Inherit from 'Constant value' (Constant block default), Inherit: Inherit via back propagation (Data Type Conversion block), Inherit: Same as input (Saturation block)

Inherit: Inherit via internal rule

This option appears for some blocks. Simulink software chooses a combination of output scaling and data type that requires the smallest amount of memory consistent with accommodating the calculated 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 software chooses the output data type without regard to hardware constraints. Otherwise, Simulink software 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 `sfixed24`. 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 software displays an error message in the Simulation Diagnostics Viewer.

Inherit: Inherit from 'Constant value'

Use data type of **Constant value** parameter. This option appears for some blocks.

Inherit: Inherit via back propagation

A rule that inherits a data type

**Inherit: Same as input**  
Use data type of sole input signal. This option appears for some blocks.

**Inherit: Same as first input**  
Use data type of first input signal. This option appears for some blocks.

**Inherit: Same as accumulator**  
Output data type same as accumulator data type. This option appears for some blocks.

**double**  
Output data type is double.

**single**  
Output data type is single.

**int8**  
Output data type is int8.

**uint8**  
Output data type is uint8.

**int16**  
Output data type is int16.

**uint16**  
Output data type is uint16.

**int32**  
Output data type is int32.

**uint32**  
Output data type is uint32.

**fixdt(1,16,0)**  
Output data type is fixed point fixdt(1,16,0).

**fixdt(1,16,2<sup>0</sup>,0)**  
Output data type is fixed point fixdt(1,16,2<sup>0</sup>,0).

# Constant

---

<data type expression>

The name of a data type object, for example  
Simulink.NumericType

## **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

## **See Also**

See “Specifying Block Output Data Types” in the *Simulink User’s Guide* for more information.

## Mode

Select the category of data to specify

## Settings

**Default:** Inherit (Constant, Data Type Conversion, Discrete Time Integrator, Gain, Inport, Outport, Product, Saturation, Sum, Switch),  
**Built in** (Logical Operator, Relational Operator)

### Inherit

Inheritance rules for data types. Selecting **Inherit** enables a second menu/text box to the right. Below are the possible values, which can vary by block:

- Inherit from 'Constant value' (Constant block default)
- Inherit via internal rule (Discrete-Time Integrator, Gain, Product, Sum, Switch block default)
- Inherit via back propagation (Data Type Conversion block default)
- auto (Inport, Outport block default)
- Logical (see Configuration Parameters: Optimization)
- Same as first input
- Same as input (Saturation block default)
- Same as accumulator

### Built in

Built-in data types. Selecting **Built in** enables a second menu/text box to the right. Below are the possible values, which can vary by block:

- double (Constant, Data Type Conversion, Discrete-Time Integrator, Gain, Inport, Outport, Product, Saturation, Sum, Switch block default)
- single

# Constant

---

- int8
- uint8
- int16
- uint16
- int32
- uint32
- boolean (Logical Operator, Relational Operator block default)

## Fixed point

Fixed-point data types.

## Enumerated

Enumerated data types. This option is available on some blocks. Selecting Enumerated enables a second menu/text box to the right. Below are the possible values, which can vary by block:

- <class name>

## Expression

Expressions that evaluate to data types. Selecting Expression enables a second menu/text box to the right. Below are the possible values, which can vary by block:

- <data type expression>

## Dependency

This parameter is enabled by the **Show data type assistant** button.

## Command-Line Information

See “Block-Specific Parameters” on page 8-96 for the command-line information.

## See Also

See “Using the Data Type Assistant” in the *Simulink User’s Guide*.

## Signedness

Specify whether you want the fixed-point data to be signed or unsigned.

### Settings

**Default:** Signed

Signed

Specify the fixed-point data to be signed.

Unsigned

Specify the fixed-point data to be unsigned.

### Dependencies

This parameter is enabled by selecting **Mode** > Fixed point.

### Command-Line Information

See “Block-Specific Parameters” on page 8-96 for the command-line information.

### See Also

See “Specifying a Fixed-Point Data Type” in the *Simulink User’s Guide* for more information.

## **Word length**

Specify the bit size of the word that will hold the quantized integer.

### **Settings**

**Default:** 16

**Minimum:** 0

**Maximum:** 32

Large word sizes represent large values with greater precision than small word sizes.

### **Dependencies**

This parameter is enabled by selecting **Mode** > Fixed point.

### **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

### **See Also**

See “Specifying a Fixed-Point Data Type” in the *Simulink User’s Guide* for more information.



## Scaling

Specify the method for scaling your fixed-point data to avoid overflow conditions and minimize quantization errors.

### Settings

**Default:** Best precision (Constant), Binary point (Data Type Conversion, Discrete-Time Integrator, Gain, Inport, Outport, Product, Saturation, Sum, Switch), Integer (Logical Operator, Relational Operator)

Binary point

Specify binary point location.

Slope and bias

Enter slope and bias.

Best precision

Specify best-precision values. This option appears for some blocks.

Integer

Specify integer. This setting has the same result as specifying a binary point location and setting fraction length to 0. This option appears for some blocks.

### Dependencies

This parameter is enabled by selecting **Mode** > Fixed point.

Selecting Binary point enables:

- **Fraction length**
- **Calculate Best-Precision Scaling**

Selecting Slope and bias enables:

- **Slope**
- **Bias**
- **Calculate Best-Precision Scaling**

# Constant

---

## **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

## **See Also**

See “Specifying a Fixed-Point Data Type” in the *Simulink User’s Guide* for more information.

## **Fraction length**

Specify fraction length for fixed-point data type.

### **Settings**

**Default:** 0

Binary points can be positive or negative integers.

### **Dependencies**

This parameter is enabled by selecting **Scaling** > Binary point.

### **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

### **See Also**

See “Specifying a Fixed-Point Data Type” in the *Simulink User’s Guide* for more information.

## **Slope**

Specify slope for the fixed-point data type.

### **Settings**

**Default:** 2<sup>0</sup>

Specify any positive real number.

### **Dependencies**

This parameter is enabled by selecting **Scaling** > Slope and bias.

### **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

### **See Also**

See “Specifying a Fixed-Point Data Type” in the *Simulink User’s Guide* for more information.

**Bias**

Specify bias for the fixed-point data type.

**Settings**

**Default:** 0

Specify any real number.

**Dependencies**

This parameter is enabled by selecting **Scaling** > Slope and bias.

**Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

**See Also**

See “Specifying a Fixed-Point Data Type” in the *Simulink User’s Guide* for more information.

**Characteristics**

Direct Feedthrough	N/A
Sample Time	Specified in the <b>Sample time</b> parameter
Scalar Expansion	No
Dimensionalized	Yes
Multidimensionalized	Yes
Zero Crossing	No

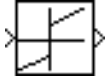
# Coulomb and Viscous Friction

---

**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 block implementation is

$$y = \text{sign}(u) * (\text{Gain} * \text{abs}(u) + \text{Offset})$$

where  $y$  is the output,  $u$  is the input, and  $\text{Gain}$  and  $\text{Offset}$  are block parameters.

The  $\text{Offset}$  corresponds to Coulomb friction. By default, the  $\text{Offset}$  is a vector with four elements: [1 3 2 0]. This default vector tests the same input value against four different offset values. You can specify a vector with a different number of elements, such as one.

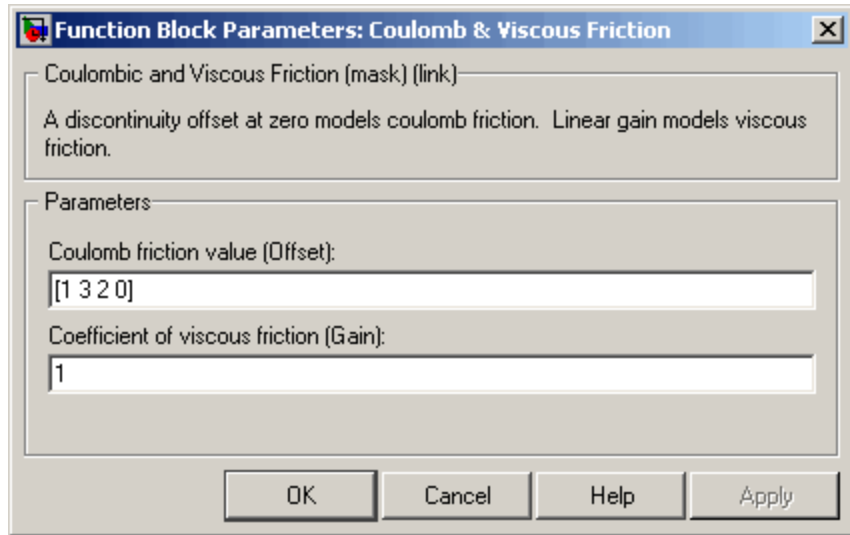
The  $\text{Gain}$  corresponds to the signal gain for nonzero input values. By default, the  $\text{Gain}$  is 1.

The block accepts one input and generates one output. The input can be a scalar, vector, or matrix. For a vector or matrix input, the  $\text{Offset}$  and  $\text{Gain}$  must have the same dimensions as the input or be scalars. For a scalar input, the output will be a scalar, vector, or matrix based on the dimensions of the  $\text{Offset}$  and  $\text{Gain}$ . For example, passing a scalar input to the block when using the default  $\text{Offset}$  produces an output vector with four elements.

## 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 for nonzero input values. The default is 1.

## Characteristics

Direct Feedthrough	Yes
Sample Time	Inherited from driving block
Scalar Expansion	Yes
Dimensionalized	Yes
Zero Crossing	Yes, at the point where Coulomb (static) friction is overcome

# Counter Free-Running

## Purpose

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

## Library

Sources

## Description



The Counter Free-Running block counts up until the maximum possible value,  $2^{N_{\text{bits}}} - 1$ , is reached, where  $N_{\text{bits}}$  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.

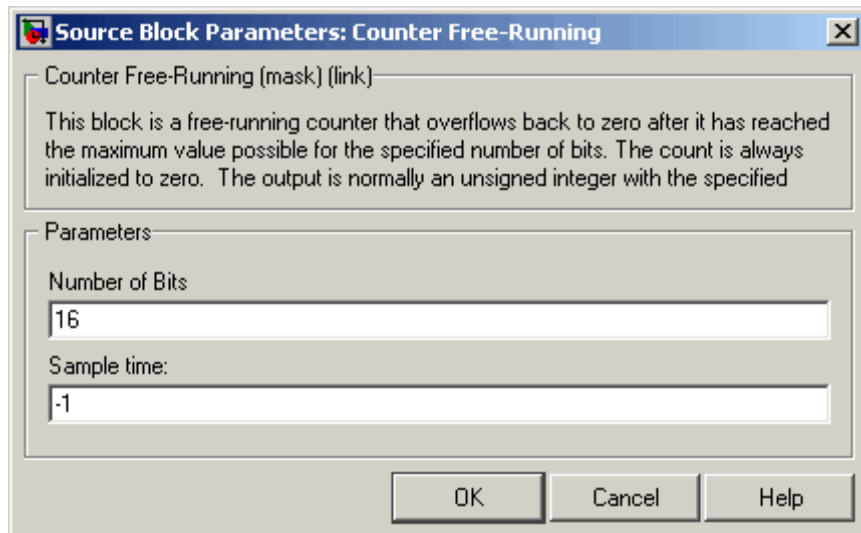
You can specify the sample time with the **Sample time** parameter.

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 Support

The Counter Free-Running block outputs an unsigned integer.

## 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 “How to Specify the Sample Time” in the “How Simulink Works” chapter of the Simulink documentation.

**Characteristics**

Sample Time	Specified in the <b>Sample time</b> parameter
Scalar Expansion	No

**See Also**

Counter Limited

# Counter Limited

**Purpose** Count up and wrap back to zero after outputting 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.

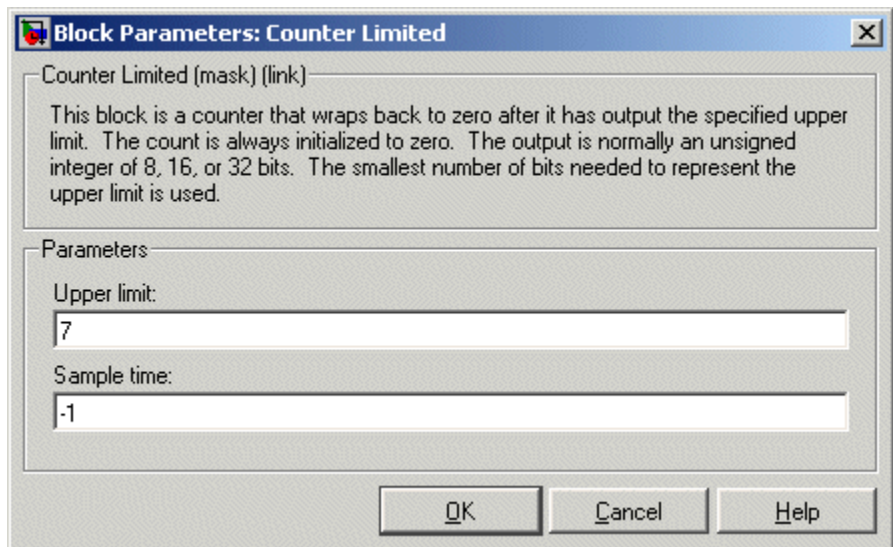
You can specify the sample time with the **Sample time** parameter. A **Sample time** of -1 means that the sample time is inherited.

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 “How to Specify the Sample Time” in the “How Simulink Works” chapter of the Simulink documentation.

**Characteristics**

Sample Time	Specified in the <b>Sample time</b> parameter
Scalar Expansion	No

**See Also**

Counter Free-Running

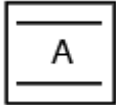
# Data Store Memory

---

**Purpose** Define 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 that specify the same data store name.



The location of the Data Store Memory block that defines a data store determines which Data Store Read and Data Store Write blocks 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.

A Data Store Memory block in a referenced model cannot be accessed by Data Store Read or Data Store Write blocks in either a superior model or a subordinate model.

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.

Obtaining correct results from data stores requires ensuring that data store reads and writes occur in the expected order. See “Ordering Data Store Access” and “Using Data Store Diagnostics” for details.

You can use `Simulink.Signal` objects in addition to or instead of Data Store Memory blocks to define data stores. A data store defined in the base workspace using a signal object is accessible to every model,

including all referenced models. See “Working with Data Stores” for more information.

## **Data Type Support**

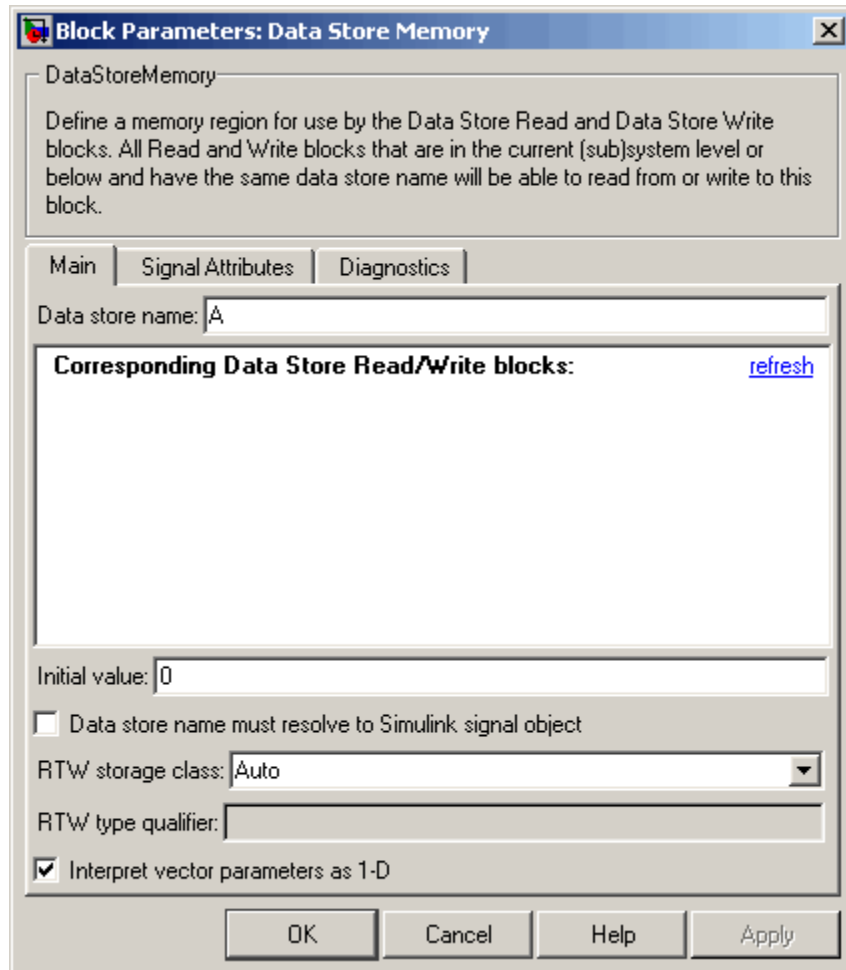
The Data Store Memory block stores real or complex signals of any data type supported by Simulink software, including fixed-point and enumerated data types.

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

# Data Store Memory

## 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. The **Minimum** parameter specifies the minimum value for this parameter, the **Maximum** parameter specifies the maximum value.

## **Data store must resolve to Simulink signal object**

Causes Simulink software, when compiling the model, to search the model and base workspace for a `Simulink.Signal` object having the same name, as described in “Resolving Symbols”. If such an object is not found, Simulink software halts the compilation and displays an error. Otherwise Simulink software 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 software halts model compilation and displays an error.

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

- **Data store name must resolve to Simulink signal object**
- **RTW storage class**
- **RTW type qualifier**

# Data Store Memory

---

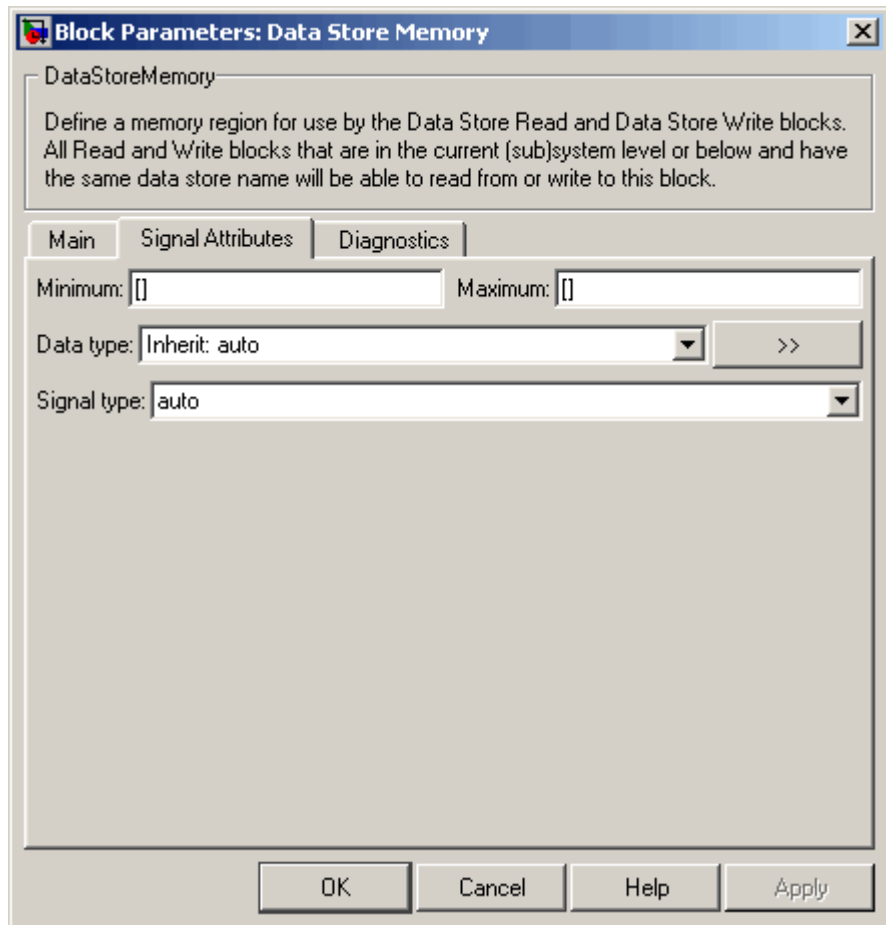
See “Block State Storage and Interfacing” in the Real-Time Workshop documentation for more information.

## **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 Blocks” in the “Working with Signals” chapter of the Simulink documentation.

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





## Minimum

Specify the minimum value that the block should output. The default value, [], is equivalent to  $-\text{Inf}$ . Simulink software uses this value to perform:

- Parameter range checking (see “Checking Parameter Values”)
- Simulation range checking (see “Checking Signal Ranges”)

# Data Store Memory

---

- Automatic scaling of fixed-point data types

## Maximum


Specify the maximum value that the block should output. The default value, [], is equivalent to `Inf`. Simulink software uses this value to perform:

- Parameter range checking (see “Checking Parameter Values”)
- Simulation range checking (see “Checking Signal Ranges”)
- Automatic scaling of fixed-point data types

## Data type

Specify the output data type. You can set it to:

- A rule that inherits a data type, for example, `Inherit: auto`
- The name of a built-in data type, for example, `single`
- The name of a data type object, for example, a `Simulink.NumericType` object
- An expression that evaluates to a data type, for example, `fixdt(1,16,0)`

Click the **Show data type assistant** button  to display the **Data Type Assistant**, which helps you set the **Data type** parameter.

See “Specifying Block Output Data Types” in *Simulink User’s Guide* for more information.

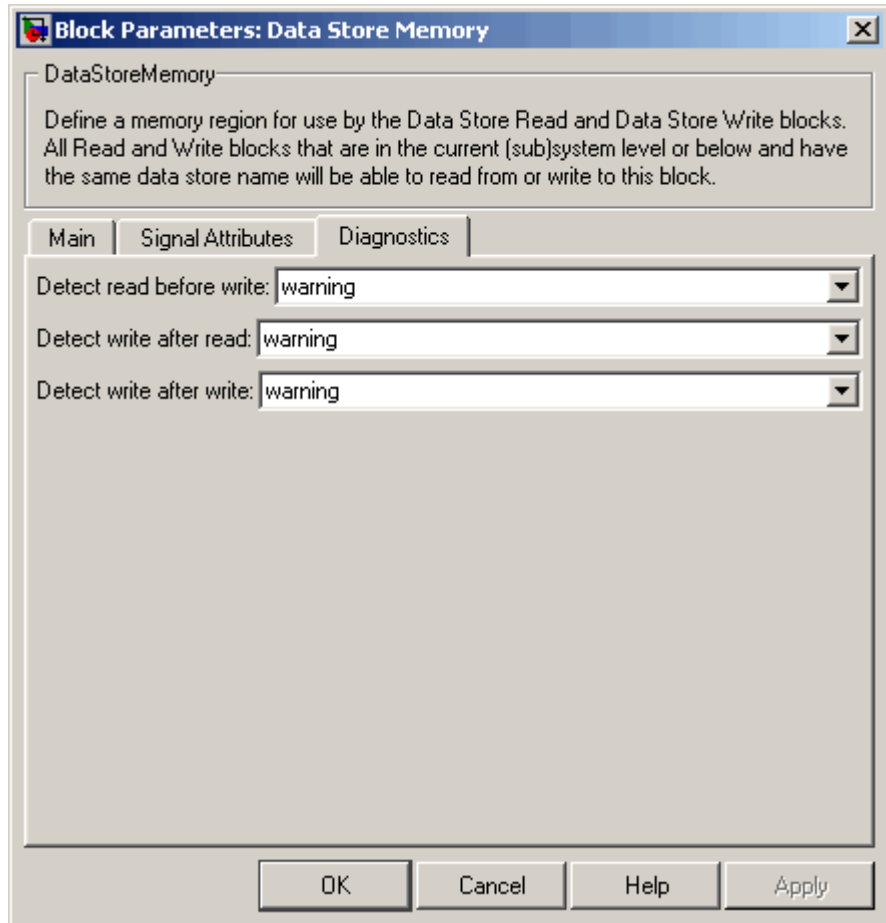
## Lock output scaling against changes by the autoscaling tool

Select to lock scaling of outputs. This parameter is visible only if you enter an expression 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:



### Detect read before write

Select the diagnostic action to take if the model attempts to read data from a data store to which it has not written data in this time step. See also “Detect read before write” in the **Data Store**

# Data Store Memory

---

**Memory Block** section of the **Configuration Parameters > Diagnostics > Data Validity** pane.

**Default:** warning

none

Simulink software takes no action.

warning

Simulink software displays a warning.

error

Simulink software terminates the simulation and displays an error message.

## **Detect write after read**

Select the diagnostic action to take if the model attempts to write data to the data store after previously reading data from it in the current time step. See also “Detect write after read” in the **Data Store Memory Block** section of the **Configuration Parameters > Diagnostics > Data Validity** pane.

**Default:** warning

none

Simulink software takes no action.

warning

Simulink software displays a warning.

error

Simulink software terminates the simulation and displays an error message.

## **Detect write after write**

Select the diagnostic action to take if the model attempts to write data to the data store twice in succession in the current time step. See also “Detect write after write” in the **Data Store Memory**

**Block** section of the **Configuration Parameters > Diagnostics > Data Validity** pane.

**Default:** warning

none

Simulink software takes no action.

warning

Simulink software displays a warning.

error

Simulink software terminates the simulation and displays an error message.

## Characteristics

Sample Time	N/A
Dimensionalized	Yes
Multidimensionalized	Yes

## See Also

- “Working with Data Stores”
- Data Store Memory
- Data Store Read

# Data Store Read

---

**Purpose** Read data from data store

**Library** Signal Routing

**Description** The Data Store Read block copies data from the named data store to its output. More than one Data Store Read block can read from the same data store.



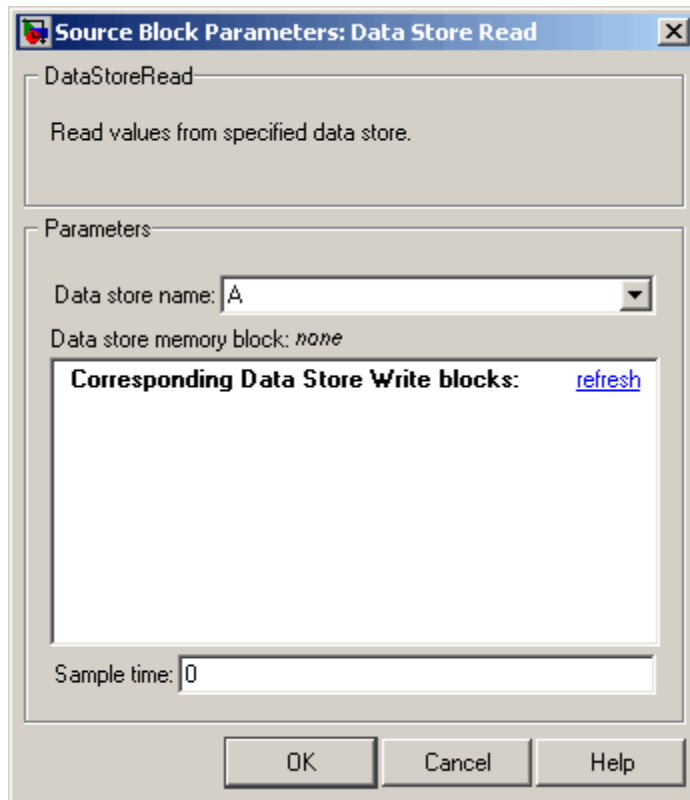
The data store from which the data is read is determined by the location of the Data Store Memory block or signal object that defines the data store. For more information, see “Working with Data Stores” and Data Store Memory.

Obtaining correct results from data stores requires ensuring that data store reads and writes occur in the expected order. See “Ordering Data Store Access” and “Using Data Store Diagnostics” for details.

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

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

## 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 software compiles the model containing this block, Simulink software searches the model upwards from this block's level for a Data Store Memory block having the specified

# Data Store Read

---

data store name. If Simulink software does not find such a block, it searches the model workspace and the MATLAB workspace for a `Simulink.Signal` object having the same name. See “Resolving Symbols” for more information about the search path.

If Simulink software 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 software 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 “How to Specify the Sample Time” for more information.

## Characteristics

Sample Time	Specified in the <b>Sample time</b> parameter
Dimensionalized	Yes
Multidimensionalized	Yes

## See Also

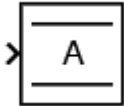
- “Working with Data Stores”
- Data Store Memory
- Data Store Read



**Purpose** Write data to 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 block 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.

Obtaining correct results from data stores requires ensuring that data store reads and writes occur in the expected order. See “Ordering Data Store Access” and “Using Data Store Diagnostics” for details.

## Data Type Support

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

For a discussion on the data types supported by Simulink software, see “Data Types Supported by Simulink” in the “Working with Data” chapter of the 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,

# Data Store Write

---

select a name from the pull-down list or enter the name directly in the edit field.

When Simulink software compiles the model containing this block, Simulink software searches the model upwards from this block's level for a Data Store Memory block having the specified data store name. If Simulink software does not find such a block, it searches the model workspace and the MATLAB workspace for a `Simulink.Signal` object having the same name. See “Resolving Symbols” for more information about the search path.

If Simulink software 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 software 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 “How to Specify the Sample Time” for more information.

<b>Characteristics</b>	Sample Time	Specified in the <b>Sample time</b> parameter
	Dimensionalized	Yes
	Multidimensionalized	Yes

**See Also**

- “Working with Data Stores”
- Data Store Memory
- Data Store Read

# Data Type Conversion

---

**Purpose** Convert input signal to specified data type

**Library** Signal Attributes

**Description** The Data Type Conversion block converts an input signal of any Simulink software data type to the data type and scaling specified by the block's **Output data type** parameter. 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.

Suppose that 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 **Integer rounding mode** parameter to Floor and clear the **Saturate on integer overflow** check box.

## Working with Enumerated Signals

You can use a Data Type Conversion block to cast signal of an enumerated type to a signal of any numeric type, provided that the underlying integers of all enumerated values input to the block are within the range of the numeric type. Otherwise, an error occurs during simulation.

You can use a Data Type Conversion block to cast a signal of any integer type to a signal of an enumerated type, provided that every value input to the Data Type Conversion block is the underlying integer of some value in the enumerated type. Otherwise, an error occurs during simulation.

You cannot use a Data Type Conversion block to cast a non-integer numeric signal an enumerated signal. You cannot cast a complex signal

# Data Type Conversion

---

to an enumerated signal regardless of the data types of its real and imaginary parts. See “Using Enumerated Data” for information about enumerated data types in Simulink.

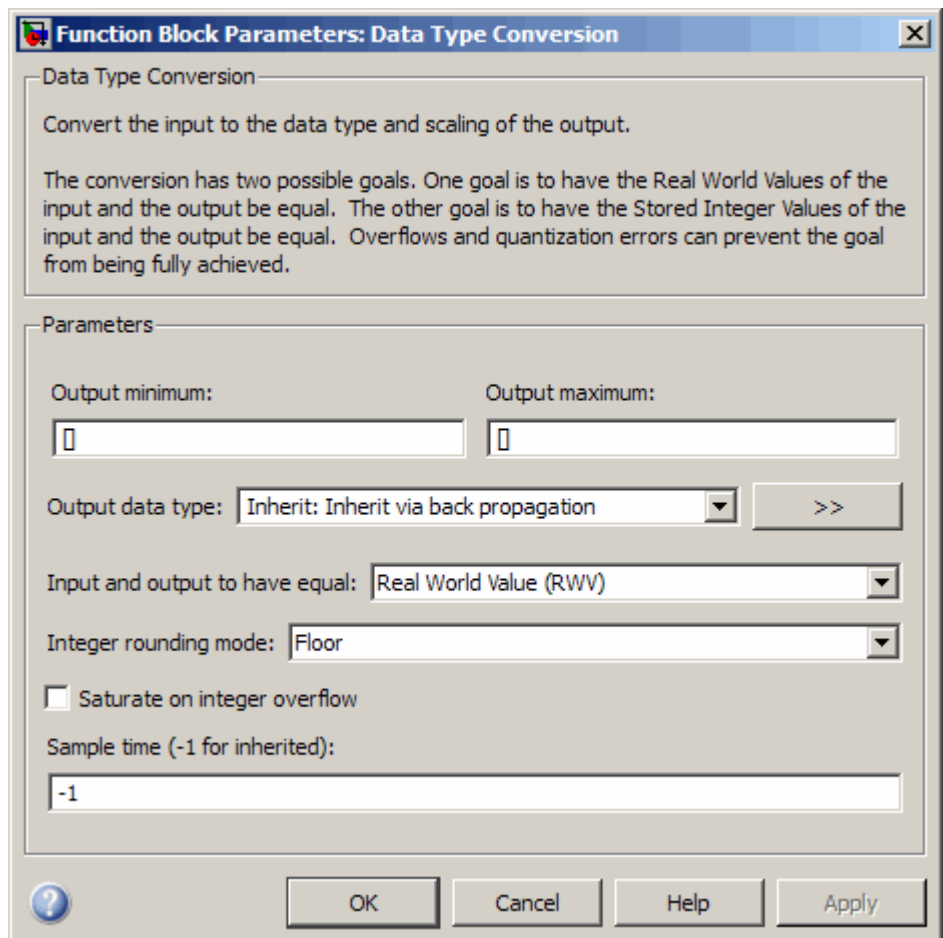
When you generate code for a Data Type Conversion block that casts to an enumerated type, the code uses safe casting if the block’s **Saturate on integer overflow** option is selected. If the option is cleared, the code does not use safe casting to enumerated types. See “Enumerated Type Safe Casting” for more information.

## Data Type Support

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

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

## Parameters and Dialog Box



# Data Type Conversion

---

## **Show data type assistant**

Display the **Data Type Assistant**.

## **Settings**

The **Data Type Assistant** helps you set the **Output data type** parameter.

See “Specifying Block Output Data Types” in *Simulink User’s Guide* for more information.

## **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.



## **Lock output scaling against changes by the autoscaling tool**

Select to lock scaling of outputs.

### **Settings**

**Default:** Off

On

Lock scaling of outputs.

Off

Do not lock scaling of outputs.

### **Dependencies**

This parameter is enabled when you enter an expression for the **Output data type** or **Data type** parameter.

### **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

# Data Type Conversion

---

## **Input and output to have equal**

Specify which type of input and output should be equal.

### **Settings**

**Default:** Real World Value (RWV)

Real World Value (RWV)

Specifies the goal of making the Real World Value (RWV) of the input equal to the Real World Value (RWV) of the output.

Stored Integer (SI)

Specifies the goal of making the Stored Integer (SI) value of the input equal to the Stored Integer (SI) value of the output.

### **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

## Integer rounding mode

Select the rounding mode for fixed-point operations.

### Settings

**Default:** Floor

#### Ceiling

Round both positive and negative numbers toward positive infinity.

#### Convergent

Round number to the nearest representable value. In the case of a tie, round to the nearest even stored value.

#### Floor

Round both positive and negative numbers toward negative infinity.

#### Nearest

Round number to the nearest representable value. In the case of a tie, round toward positive infinity.

#### Round

Round number to the nearest representable value. In the case of a tie, round positive numbers toward positive infinity and round negative numbers toward negative infinity.

#### Simplest

This option provides for an optimization of the rounding code for several blocks.

#### Zero

Round number toward zero.

## Command-Line Information

See “Block-Specific Parameters” on page 8-96 for the command-line information.

### See Also

For more information, see “Rounding” in the *Simulink Fixed Point User’s Guide*.

# Data Type Conversion

---

## Saturate on integer overflow

Specify whether overflows saturate.

### Settings

**Default:** Off

On  
Overflows saturate.

Off  
Overflows do not saturate.

### Tips

- When you select this check box, saturation applies to every internal operation on the block, not just the output or result.
- In general, the code generation process can detect when overflow is not possible, in which case, no saturation code is generated.

### Command-Line Information

See “Block-Specific Parameters” on page 8-96 for the command-line information.

## **Sample time (-1 for inherited)**

Enter the discrete interval between sample time hits or specify another appropriate sample time such as continuous or inherited.

### **Settings**

**Default:** -1

By default, the block inherits its sample time based upon the context of the block within the model. To set a different sample time, enter a valid sample time based upon the table in “Types of Sample Time”.

See also “How to Specify the Sample Time” in the online documentation for more information.

### **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

# Data Type Conversion

---

## **Output minimum**

Specify the minimum value that the block should output.

### **Settings**

**Default:** []

The default value, [], is equivalent to `-Inf`.

Simulink software uses this value to perform:

- Parameter range checking (see “Checking Parameter Values”) for some blocks
- Simulation range checking (see “Checking Signal Ranges”)
- Automatic scaling of fixed-point data types

### **Tip**

This number must be a double scalar value.

### **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

## **Output maximum**

Specify the maximum value that the block should output.

### **Settings**

**Default:** []

The default value, [], is equivalent to Inf.

Simulink software uses this value to perform:

- Parameter range checking (see “Checking Parameter Values”) for some blocks
- Simulation range checking (see “Checking Signal Ranges”)
- Automatic scaling of fixed-point data types

### **Tip**

This number must be a double scalar value.

### **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

# Data Type Conversion

---

## Output data type

Specify the output data type.

### Settings

**Default:** Inherit: Inherit via internal rule (Discrete-Time Integrator, Gain, Product, Sum, Switch block), Inherit: Inherit from 'Constant value' (Constant block default), Inherit: Inherit via back propagation (Data Type Conversion block), Inherit: Same as input (Saturation block)

Inherit: Inherit via internal rule

This option appears for some blocks. Simulink software chooses a combination of output scaling and data type that requires the smallest amount of memory consistent with accommodating the calculated 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 software chooses the output data type without regard to hardware constraints. Otherwise, Simulink software 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 `sfixed24`. 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 software displays an error message in the Simulation Diagnostics Viewer.

Inherit: Inherit from 'Constant value'

Use data type of **Constant value** parameter. This option appears for some blocks.

Inherit: Inherit via back propagation

A rule that inherits a data type



Inherit: Same as input

Use data type of sole input signal. This option appears for some blocks.

Inherit: Same as first input

Use data type of first input signal. This option appears for some blocks.

Inherit: Same as accumulator

Output data type same as accumulator data type. This option appears for some blocks.

double

Output data type is double.

single

Output data type is single.

int8

Output data type is int8.

uint8

Output data type is uint8.

int16

Output data type is int16.

uint16

Output data type is uint16.

int32

Output data type is int32.

uint32

Output data type is uint32.

fixdt(1,16,0)

Output data type is fixed point fixdt(1,16,0).

fixdt(1,16,2<sup>0</sup>,0)

Output data type is fixed point fixdt(1,16,2<sup>0</sup>,0).

# Data Type Conversion

---

<data type expression>

The name of a data type object, for example  
Simulink.NumericType

## **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

## **See Also**

See “Specifying Block Output Data Types” in the *Simulink User’s Guide* for more information.

## Mode

Select the category of data to specify

### Settings

**Default:** Inherit (Constant, Data Type Conversion, Discrete Time Integrator, Gain, Inport, Outport, Product, Saturation, Sum, Switch),  
**Built in** (Logical Operator, Relational Operator)

#### Inherit

Inheritance rules for data types. Selecting **Inherit** enables a second menu/text box to the right. Below are the possible values, which can vary by block:

- Inherit from 'Constant value' (Constant block default)
- Inherit via internal rule (Discrete-Time Integrator, Gain, Product, Sum, Switch block default)
- Inherit via back propagation (Data Type Conversion block default)
- auto (Inport, Outport block default)
- Logical (see Configuration Parameters: Optimization)
- Same as first input
- Same as input (Saturation block default)
- Same as accumulator

#### Built in

Built-in data types. Selecting **Built in** enables a second menu/text box to the right. Below are the possible values, which can vary by block:

- double (Constant, Data Type Conversion, Discrete-Time Integrator, Gain, Inport, Outport, Product, Saturation, Sum, Switch block default)
- single

# Data Type Conversion

---

- int8
- uint8
- int16
- uint16
- int32
- uint32
- boolean (Logical Operator, Relational Operator block default)

## Fixed point

Fixed-point data types.

## Enumerated

Enumerated data types. This option is available on some blocks. Selecting Enumerated enables a second menu/text box to the right. Below are the possible values, which can vary by block:

- <class name>

## Expression

Expressions that evaluate to data types. Selecting Expression enables a second menu/text box to the right. Below are the possible values, which can vary by block:

- <data type expression>

## Dependency

This parameter is enabled by the **Show data type assistant** button.

## Command-Line Information

See “Block-Specific Parameters” on page 8-96 for the command-line information.

## See Also

See “Using the Data Type Assistant” in the *Simulink User’s Guide*.

## Signedness

Specify whether you want the fixed-point data to be signed or unsigned.

### Settings

**Default:** Signed

#### Signed

Specify the fixed-point data to be signed.

#### Unsigned

Specify the fixed-point data to be unsigned.

## Dependencies

This parameter is enabled by selecting **Mode** > Fixed point.

## Command-Line Information

See “Block-Specific Parameters” on page 8-96 for the command-line information.

## See Also

See “Specifying a Fixed-Point Data Type” in the *Simulink User’s Guide* for more information.

# Data Type Conversion

---

## **Word length**

Specify the bit size of the word that will hold the quantized integer.

### **Settings**

**Default:** 16

**Minimum:** 0

**Maximum:** 32

Large word sizes represent large values with greater precision than small word sizes.

### **Dependencies**

This parameter is enabled by selecting **Mode** > Fixed point.

### **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

### **See Also**

See “Specifying a Fixed-Point Data Type” in the *Simulink User’s Guide* for more information.

## Scaling

Specify the method for scaling your fixed-point data to avoid overflow conditions and minimize quantization errors.

### Settings

**Default:** Best precision (Constant), Binary point (Data Type Conversion, Discrete-Time Integrator, Gain, Inport, Outport, Product, Saturation, Sum, Switch), Integer (Logical Operator, Relational Operator)

Binary point

Specify binary point location.

Slope and bias

Enter slope and bias.

Best precision

Specify best-precision values. This option appears for some blocks.

Integer

Specify integer. This setting has the same result as specifying a binary point location and setting fraction length to 0. This option appears for some blocks.

### Dependencies

This parameter is enabled by selecting **Mode** > Fixed point.

Selecting Binary point enables:

- **Fraction length**
- **Calculate Best-Precision Scaling**

Selecting Slope and bias enables:

- **Slope**
- **Bias**
- **Calculate Best-Precision Scaling**

# Data Type Conversion

---

## **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

## **See Also**

See “Specifying a Fixed-Point Data Type” in the *Simulink User’s Guide* for more information.



## **Fraction length**

Specify fraction length for fixed-point data type.

### **Settings**

**Default:** 0

Binary points can be positive or negative integers.

### **Dependencies**

This parameter is enabled by selecting **Scaling** > Binary point.

### **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

### **See Also**

See “Specifying a Fixed-Point Data Type” in the *Simulink User’s Guide* for more information.

# Data Type Conversion

---

## **Slope**

Specify slope for the fixed-point data type.

## **Settings**

**Default:** 2<sup>0</sup>

Specify any positive real number.

## **Dependencies**

This parameter is enabled by selecting **Scaling** > Slope and bias.

## **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

## **See Also**

See “Specifying a Fixed-Point Data Type” in the *Simulink User’s Guide* for more information.

## **Bias**

Specify bias for the fixed-point data type.

## **Settings**

**Default:** 0

Specify any real number.

## **Dependencies**

This parameter is enabled by selecting **Scaling** > Slope and bias.

## **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

## **See Also**

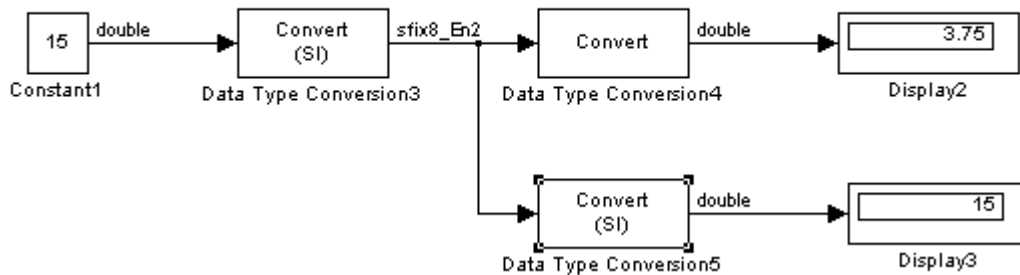
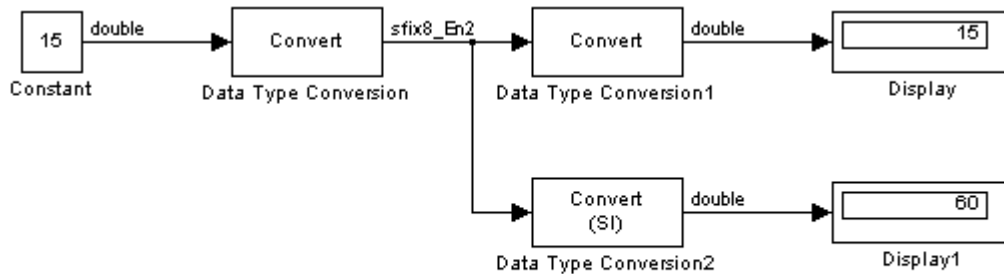
See “Specifying a Fixed-Point Data Type” in the *Simulink User’s Guide* for more information.

## **Examples**

### **Example 1 – Real World Values Versus Stored Integers**

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

# Data Type Conversion



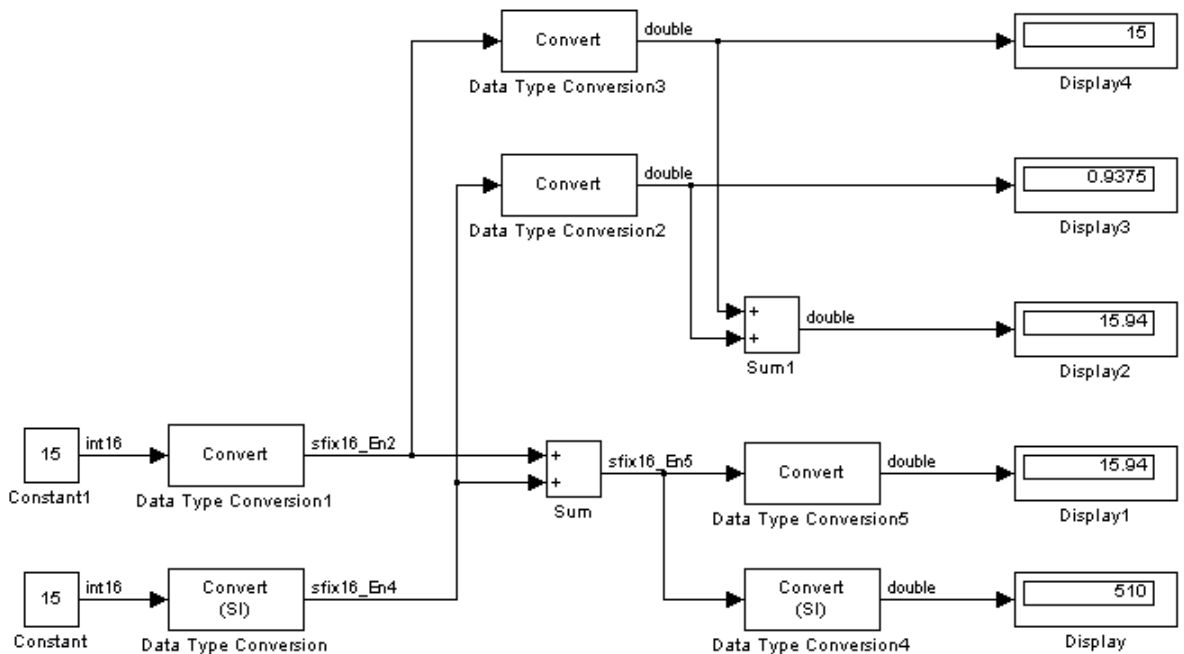
In the top model, the Data Type Conversion block treats the input as a real-world value, and maps that value to an 8-bit signed generalized fixed-point data type with a scaling of  $2^{-2}$ . When the value is then output from the Data Type Conversion1 block as a real-world value, the scaling and data 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.

# Data Type Conversion

---

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.

```
/* 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
Multidimensionalized	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 input is used as the reference signal and the second input is converted to the reference type by inheriting the data type and scaling information. (See “How to Rotate a Block” in the Simulink User’s Guide for a description of the port order for various block orientations.) 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.

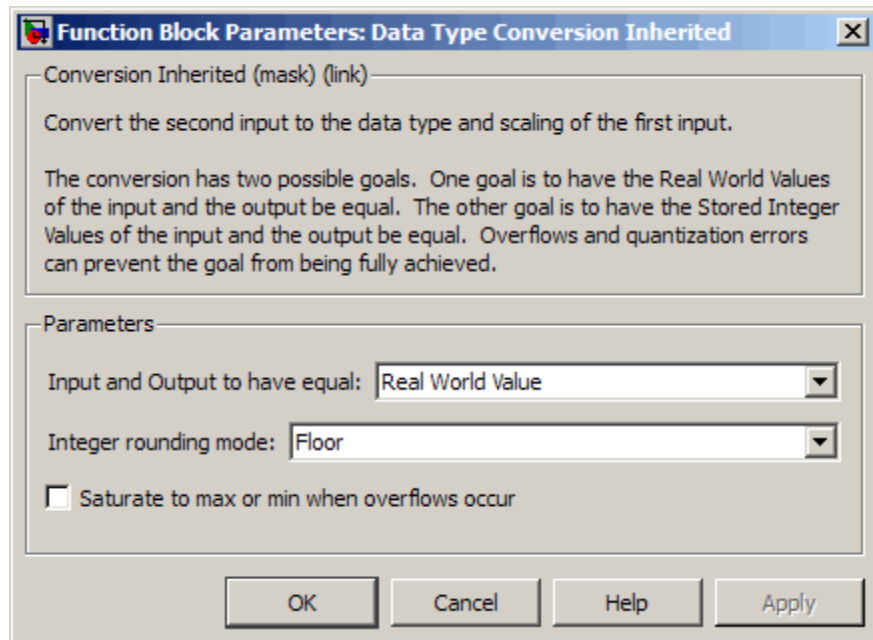
## Data Type Support

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

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

# Data Type Conversion Inherited

## Parameters and Dialog Box



### 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.

### Integer rounding mode

Select the rounding mode for fixed-point operations. For more information, see “Rounding” in the *Simulink Fixed Point User’s Guide*.

### Saturate to max or min when overflows occur

Select to have overflows saturate.

## Characteristics

Direct Feedthrough	Yes
--------------------	-----



**See Also**      [Data Type Conversion](#)

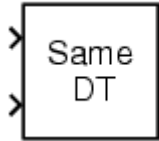
# Data Type Duplicate

---

**Purpose** Force all inputs to 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.

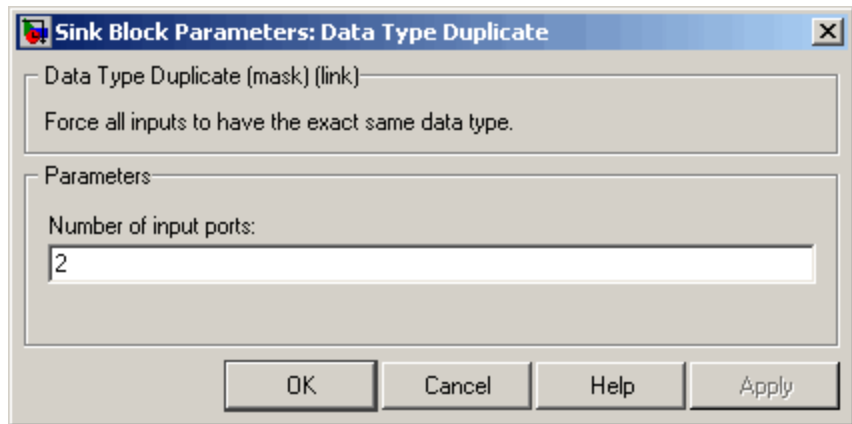
The Data Type Duplicate block is typically used such that one signal to the block controls the data type for all other blocks. The other blocks are set to inherit their data types via backpropagation.

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 software, including fixed-point and enumerated data types.

## Parameters and Dialog Box



### Number of input ports

Number of input ports.

## Characteristics

Scalar Expansion	Yes
States	0

# Data Type Propagation

---

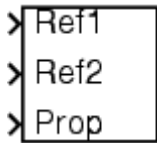
## Purpose

Set data type and scaling of propagated signal based on information from 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 **Output data type** parameter configured to **Inherit: 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 “Parameters and Dialog Box” on page 2-211.

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 “Parameters and Dialog Box” on page 2-211.

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 vice 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.

# Data Type Propagation

---

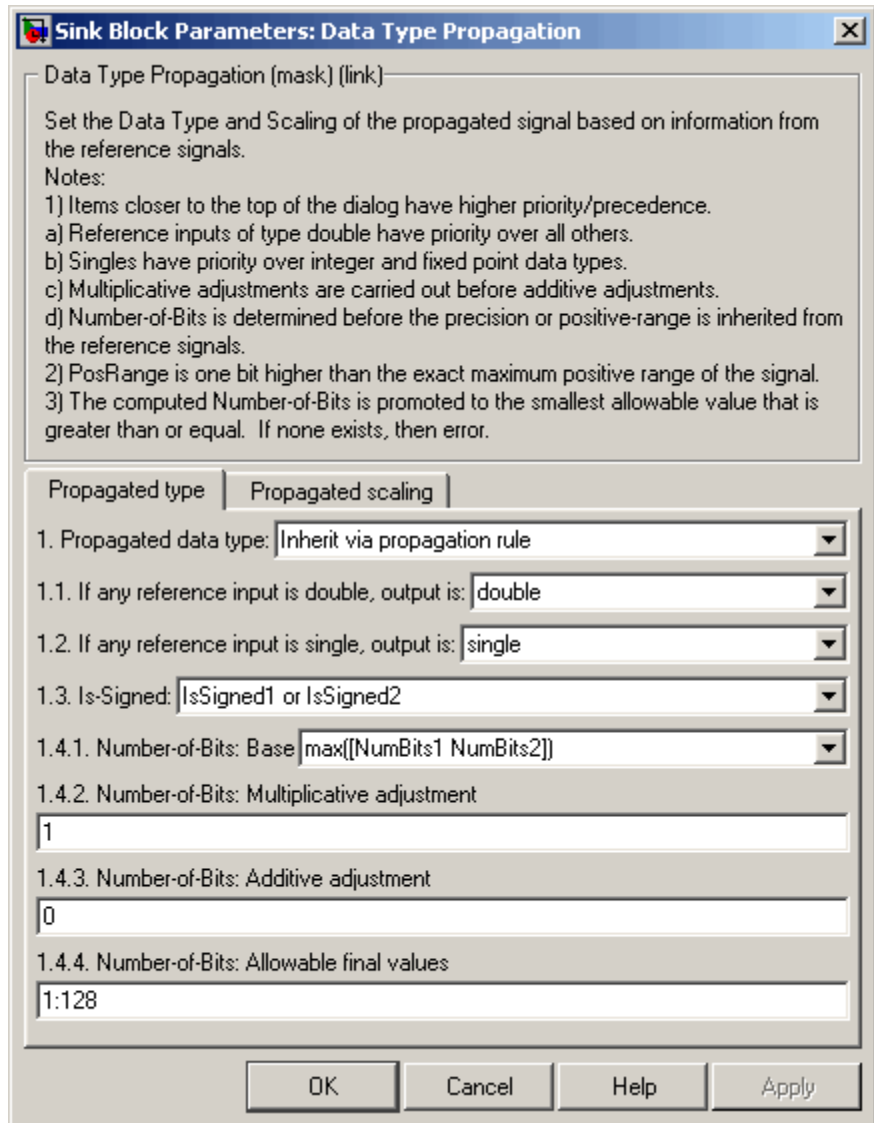
- Single-precision reference inputs have precedence over integer and fixed-point data types.
- Multiplicative adjustments are carried out before additive adjustments.
- The number of bits is determined before the precision or positive range is inherited from the reference inputs.

## Data Type Support

The Data Type Propagation block accepts signals of any data type supported by Simulink software, including fixed-point and enumerated data types. For a discussion on the data types supported by Simulink software, see “Data Types Supported by Simulink” in the “Working with Data” chapter of the Simulink documentation.

## Parameters and Dialog Box

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



# Data Type Propagation

---

## 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 vice versa.

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

## 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
<code>NumBits1</code>	The number of bits for Prop is given by the number of bits for Ref1.
<code>NumBits2</code>	The number of bits for Prop is given by the number of bits for Ref2.
<code>max([NumBits1 NumBits2])</code>	The number of bits for Prop is given by the reference signal with largest number of bits.
<code>min([NumBits1 NumBits2])</code>	The number of bits for Prop is given by the reference signal with smallest number of bits.
<code>NumBits1+NumBits2</code>	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 User's Guide* for more information about the base data type.

This parameter is visible only 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

# Data Type Propagation

---

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 visible only 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 might overflow. To prevent overflow, you can associate guard bits with the propagated data type. To associate four guard bits, you specify the value 4.

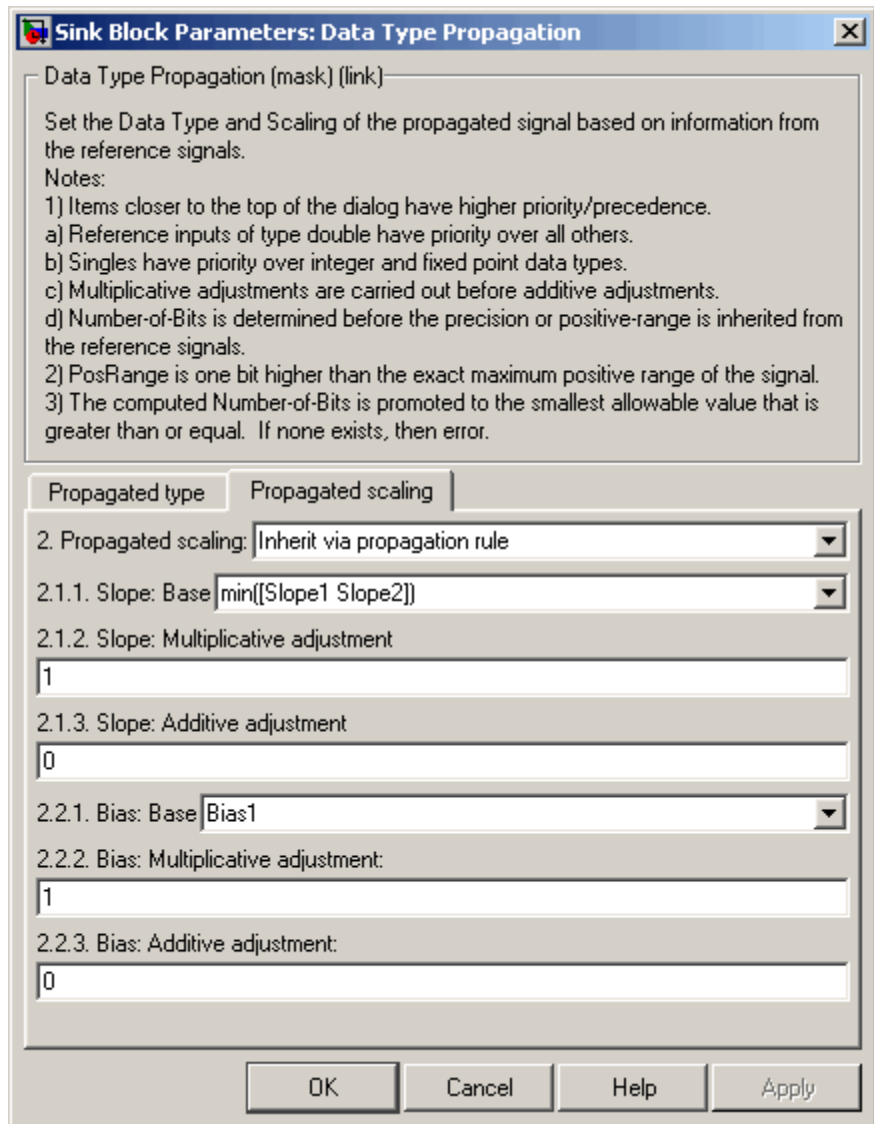
This parameter is visible only if `Inherit` via propagation rule is selected for the **Propagated data type** parameter list.

## **Number-of-bits: Allowable final values**

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 visible only 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, inherit the scaling from the reference signals, or calculate the scaling to obtain best precision.

## Propagated scaling (Slope or [Slope Bias])

Specify the scaling as either a slope or a slope and bias.

This parameter is visible only if `Specify via dialog` is selected for the **Propagated scaling** parameter list.

## 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 visible only 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.

Parameter Value	Description
$Slope1 * Slope2$	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.

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 visible only 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  $2^{-3}$ .

# Data Type Propagation

---

This parameter is visible only 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 visible only 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 as follows:

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.
$\max(\text{Bias1}, \text{Bias2})$	The bias of Prop is given by the maximum bias of the reference signals.
$\min(\text{Bias1}, \text{Bias2})$	The bias of Prop is given by the minimum bias of the reference signals.
$\text{Bias1} * \text{Bias2}$	The bias of Prop is given by the product of the reference signal biases.
$\text{Bias1} / \text{Bias2}$	The bias of Prop is given by the ratio of the Ref1 bias to the Ref2 bias.
$\text{Bias1} + \text{Bias2}$	The bias of Prop is given by the sum of the reference biases.
$\text{Bias1} - \text{Bias2}$	The bias of Prop is given by the difference of the reference biases.

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

**Characteristics**

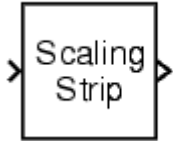
Direct Feedthrough	Yes
Scalar Expansion	Yes

# Data Type Scaling Strip

**Purpose** Remove scaling and map to built in integer

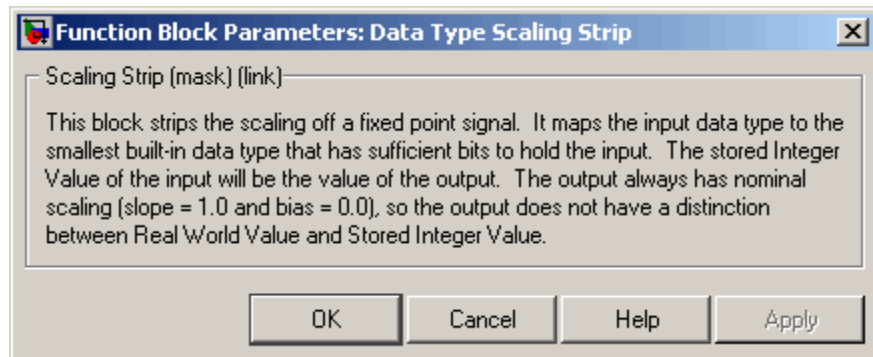
**Library** Signal Attributes

**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 numeric data type supported by Simulink software, including fixed-point data types.

## Parameters and Dialog Box



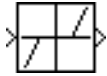
<b>Characteristics</b>	Direct Feedthrough	Yes
	Scalar Expansion	Yes
	Multidimensionalized	Yes



**Purpose** Provide region of zero output

**Library** Discontinuities

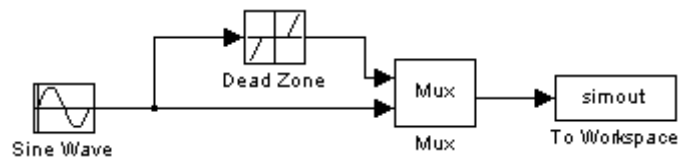
## Description



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.

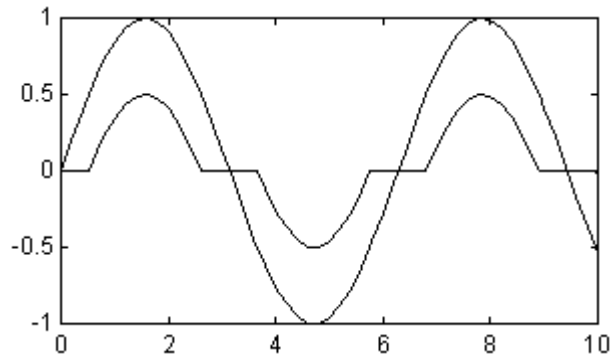
This sample model uses lower and upper limits of -0.5 and +0.5, with a sine wave as input.



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.

# Dead Zone

---

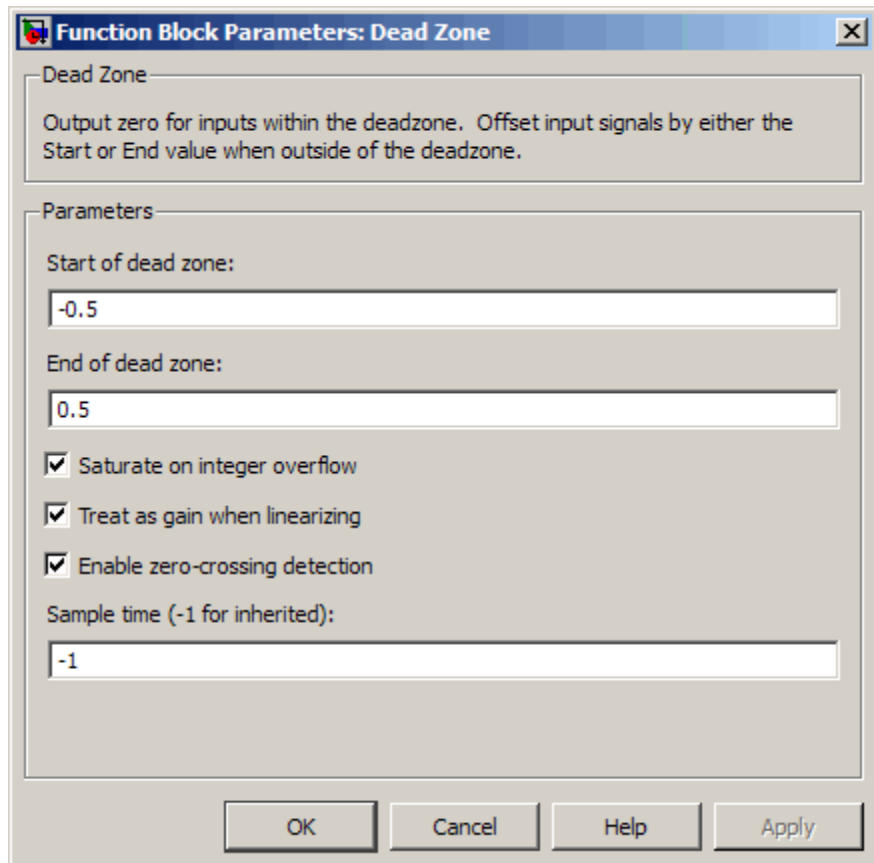


## Data Type Support

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

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

## Parameters and Dialog Box



### Start of dead zone

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

### 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.

# Dead Zone

---

When you select this check box, saturation applies to every internal operation on the block, not just the output or result. In general, the code generation process can detect when overflow is not possible, in which case, no saturation code is generated.

## **Treat as gain when linearizing**

The linearization commands in Simulink software 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 “How Blocks Work with Zero-Crossing Detection” in the “How Simulink Works” chapter of the 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 Simulink documentation.

## **Characteristics**

Direct Feedthrough	Yes
Sample Time	Specified in the <b>Sample time</b> parameter
Scalar Expansion	Yes, of parameters
Dimensionalized	Yes
Zero-Crossing Detection	Yes, if enabled

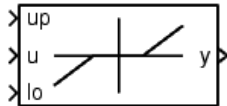
## **See Also**

Dead Zone Dynamic

**Purpose** Set inputs within 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

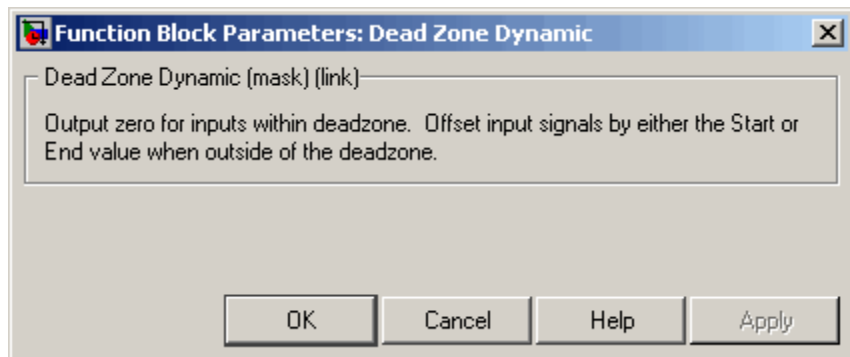
- The input within the bounds is set to zero.
- The input below the lower limit is shifted down by the lower limit.
- The input above the upper limit is shifted down by the upper limit.

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 numeric data type supported by Simulink software, including fixed-point data types.

## Parameters and Dialog Box



## Characteristics

Direct Feedthrough	Yes
Scalar Expansion	Yes

# Dead Zone Dynamic

---

**See Also**

Dead Zone

**Purpose**

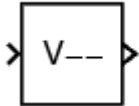
Decrease real world value of signal by one

**Library**

Additional Math & Discrete / Additional Math: Increment - Decrement

**Description**

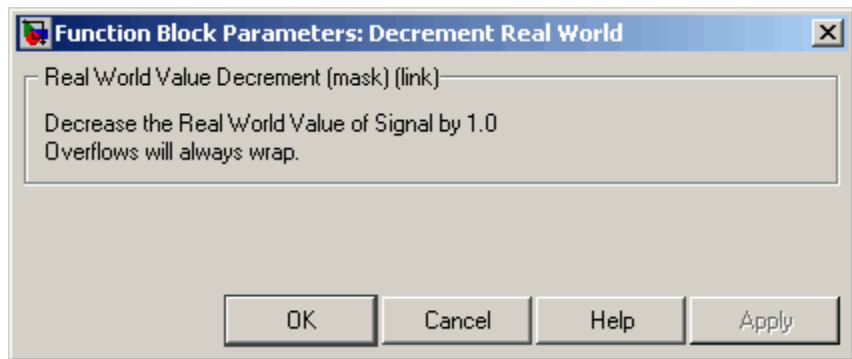
The Decrement Real World block decreases the real world value of the signal by one. Overflows always wrap.



**Data Type Support**

The Decrement Real World block accepts signals of any numeric data type supported by Simulink software, 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

# Decrement Stored Integer

## Purpose

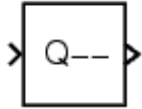
Decrease stored integer value of signal by one

## Library

Additional Math & Discrete / Additional Math: Increment - Decrement

## Description

The Decrement Stored Integer block decreases the stored integer value of a signal by one.

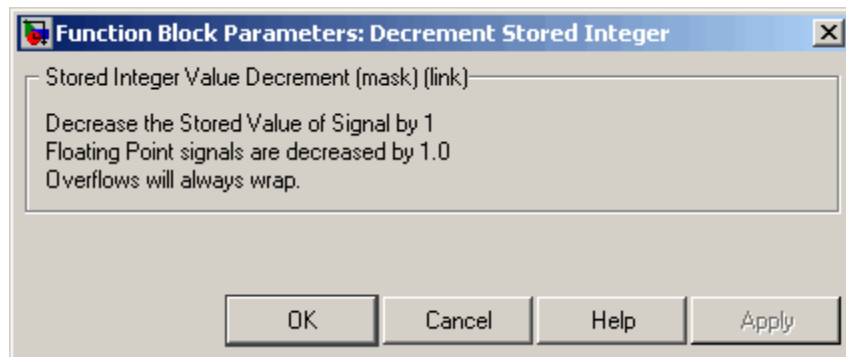


Floating-point signals are also decreased by one, and overflows always wrap.

## Data Type Support

The Decrement Stored Integer block accepts signals of any numeric data type supported by Simulink software, 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



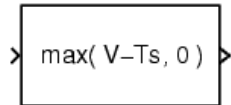
## Purpose

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

## Library

Additional Math & Discrete / Additional Math: Increment - Decrement

## Description

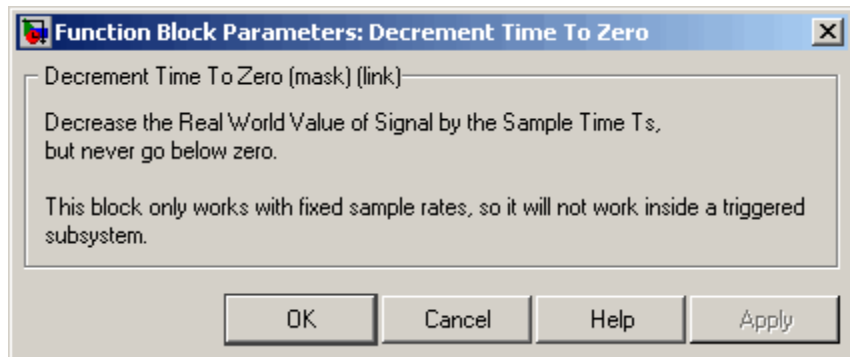


The Decrement Time To Zero block decreases the real-world value of the signal by the sample time,  $T_s$ . The output will never go below zero. This block only works with fixed sample rates.

## Data Type Support

The Decrement Time To Zero block accepts signals of any numeric data type supported by Simulink software, including fixed-point data types.

## Parameters and Dialog Box



## Characteristics

Direct Feedthrough	Yes
Scalar Expansion	No

## See Also

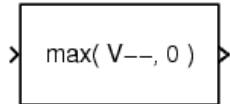
Decrement Real World, Decrement Stored Integer, Decrement To Zero

# Decrement To Zero

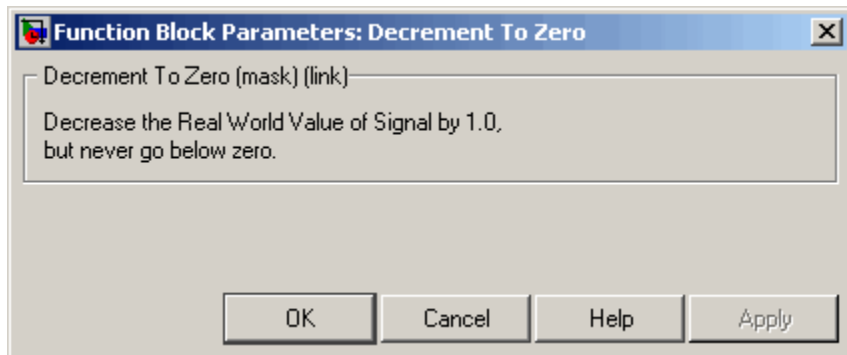
**Purpose** Decrease real-world value of signal by one, but only to zero

**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.



**Data Type Support** The Decrement To Zero block accepts signals of any numeric data type supported by Simulink software, including fixed-point data types.



## Parameters and Dialog Box

<b>Characteristics</b>	Direct Feedthrough	Yes
	Scalar Expansion	No

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

**Purpose** Extract and output elements of vector signal

**Library** Signal Routing

## Description



The Demux block extracts the components of an input signal and outputs the components as separate signals. The output signals are ordered from top to bottom output port. See “How to Rotate a Block” for a description of the port order for various block orientations. To avoid adding clutter to a model, Simulink software hides the name of a Demux block when you copy it from the Simulink library to a model. See “Mux Signals” for information about creating and decomposing vectors.

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 mode 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 a bus signal.

---

**Note** The MathWorks discourages enabling **Bus selection mode** and using a Demux block to extract elements of a bus signal. Muxes and buses should not be intermixed in new models. See “Avoiding Mux/Bus Mixtures” for more information.

---

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

# Demux

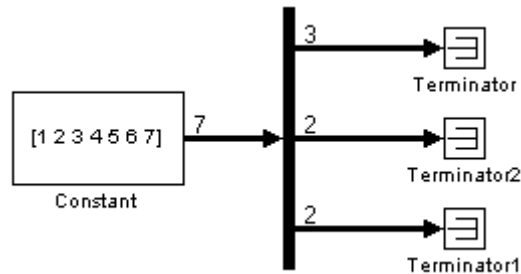
the block's output ports. The block determines the size of its outputs from the size of the input signal and the value of the **Number of outputs** parameter.

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	
$p < n$ $n \bmod p = 0$	$p$ 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.
$p < n$ $n \bmod p = m$	$m$ 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.
$[p_1 \ p_2 \ \dots \ p_m]$ $p_1+p_2+\dots+p_m=n$ $p_i > 0$	$m$ vector signals having widths $p_1, p_2, \dots, p_m$	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.

Parameter Value	Block outputs...	Comments
$[p_1 \ p_2 \ \dots \ p_m]$ $p_1 + p_2 + \dots + p_m = n$ some or all $p_i = -1$	m vector signals	If $p_i$ 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.
$[p_1 \ p_2 \ \dots \ p_m]$ $p_1 + p_2 + \dots + p_m \neq n$ $p_i = > 0$	Error	

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.

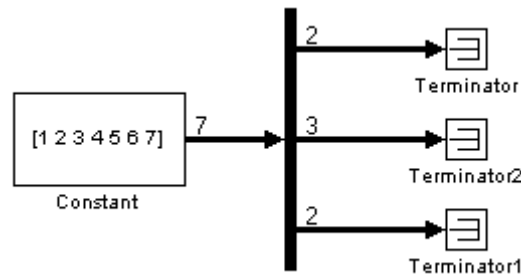


You can use -1 in a vector expression to indicate that the block should dynamically size the corresponding port. For example, the expression  $[-1, \ 3 \ -1]$  causes the block to output three signals in which the second signal always has three elements while the sizes of the first and third signals 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

# Demux

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.

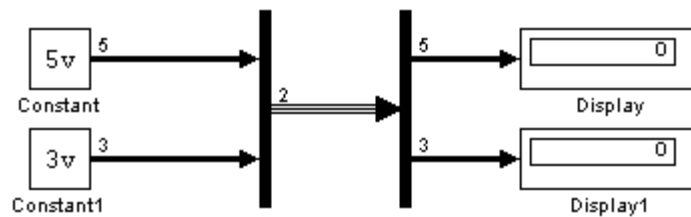


## Specifying the Number of Outputs in Bus Selection Mode

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.

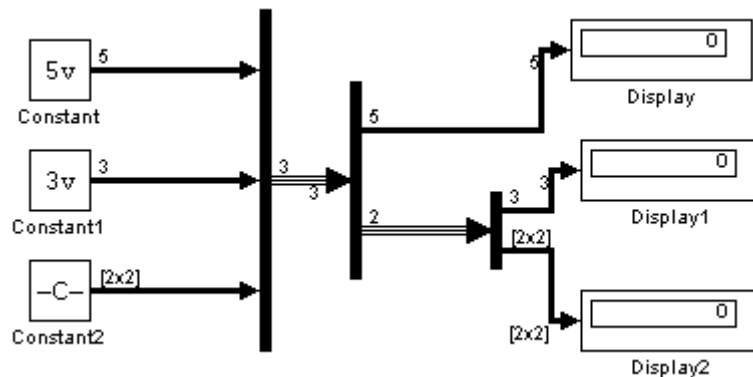


- Vector each of whose elements specifies the number of signals to output on the corresponding port

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.

# Demux

---

---

**Note** The MathWorks discourages enabling **Bus selection mode** and using a Demux block to extract elements of a bus signal. Muxes and buses should not be intermixed in new models. See “Avoiding Mux/Bus Mixtures” for more information.

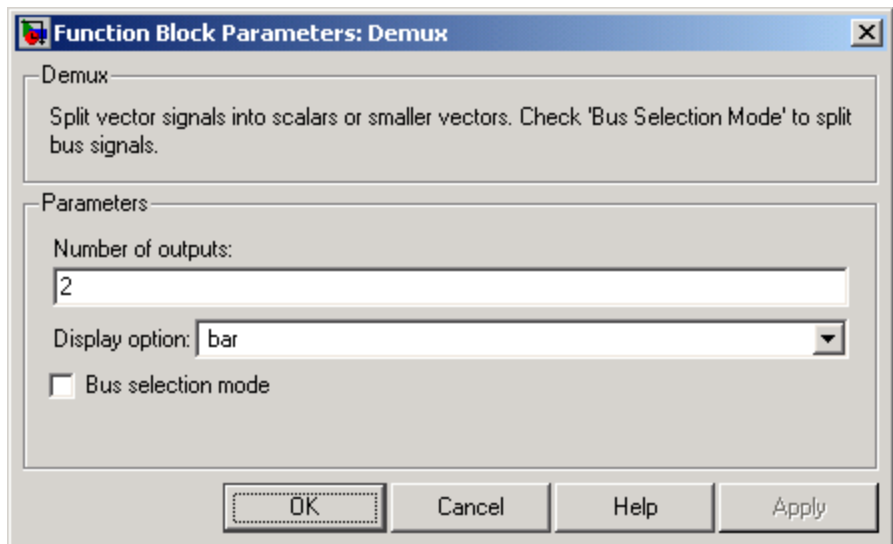
---

## Data Type Support

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

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

## Parameters and Dialog Box





## **Number of outputs**

Specify the number and dimensions of outputs.

### **Settings**

**Default:** 2

This block interprets this parameter depending on the **Bus selection mode** parameter. See the block description for more information.

### **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

### **See Also**

See the Demux block reference page for more information.

## Display option

Select options to display the Demux block. The options are

### Settings

**Default:** bar

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.



## Command-Line Information

See “Block-Specific Parameters” on page 8-96 for the command-line information.

### See Also

See the Demux block reference page for more information.

## Bus selection mode

Enable bus selection mode.

### Settings

**Default:** Off

- On  
Enable bus selection mode.
- Off  
Disable bus selection mode.

### Tips

The MathWorks discourages enabling **Bus selection mode** and using a Demux block to extract elements of a bus signal. Muxes and buses should not be intermixed in new models. See “Avoiding Mux/Bus Mixtures” for more information.

### Command-Line Information

See “Block-Specific Parameters” on page 8-96 for the command-line information.

# Derivative

---

**Purpose** Output time derivative of 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

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

See “Circuit Model” in *Simulink User’s Guide* for an example on choosing the best-form mathematical model to avoid using Derivative blocks in your models.

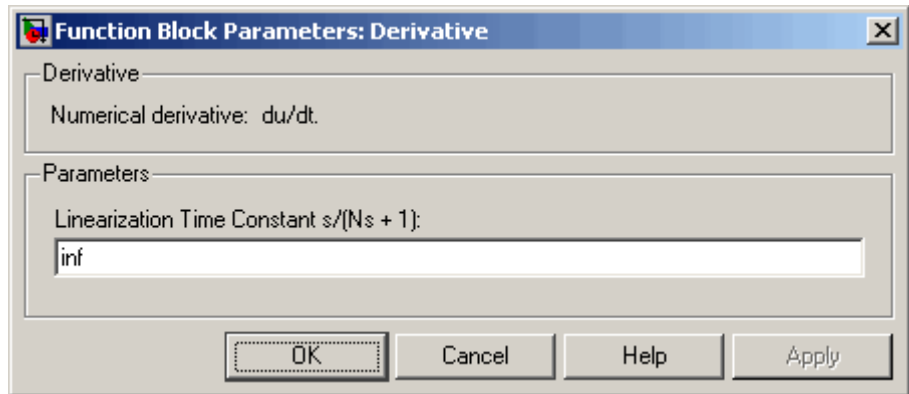
Using `linmod` to linearize a model that contains a Derivative block can be troublesome. To improve the accuracy of linearizations of this block, use the optional linearization parameter within the block dialog box. Additionally, for more information about how to avoid problems

linearizing Derivative blocks, see Linearizing Models in the “Analyzing Simulation Results” chapter of the Simulink documentation.

## 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.

# Derivative

---

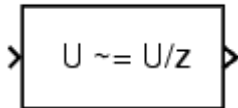
<b>Characteristics</b>	Direct Feedthrough	Yes
	Sample Time	Continuous
	Scalar Expansion	N/A
	States	$2^{*}[1+(\text{number of input elements})]$
	Dimensionalized	Yes
	Zero Crossing	No

**See Also**      Discrete Derivative

**Purpose** Detect change in signal's value

**Library** Logic and Bit Operations

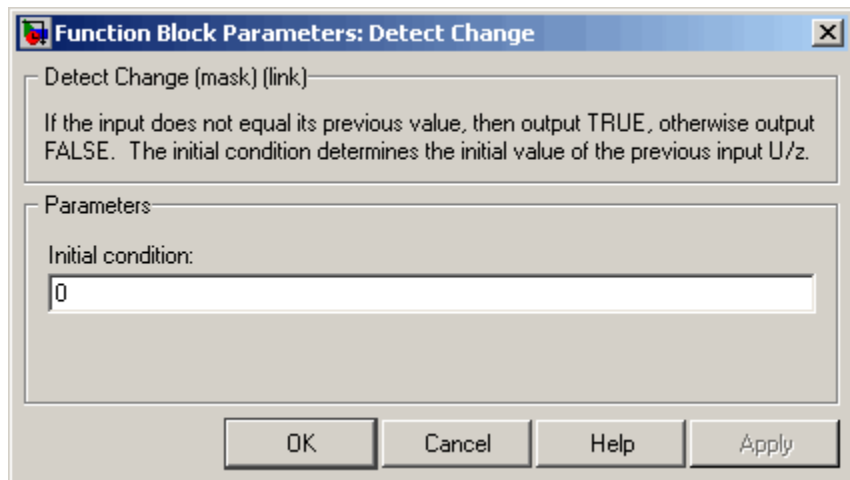
**Description** The Detect Change block determines if an input does not equal its previous value where



- 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 software, including fixed-point and enumerated data types. The block output is uint8.

## Parameters and Dialog Box



### Initial condition

Set the initial condition for the previous input U/z.

# Detect Change

---

<b>Characteristics</b>	Direct Feedthrough	Yes
	Scalar Expansion	Yes

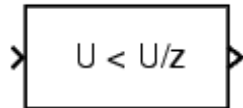
**See Also** Detect Decrease, Detect Fall Negative, Detect Fall Nonpositive, Detect Increase, Detect Rise Nonnegative, Detect Rise Positive



**Purpose** Detect decrease in signal's value

**Library** Logic and Bit Operations

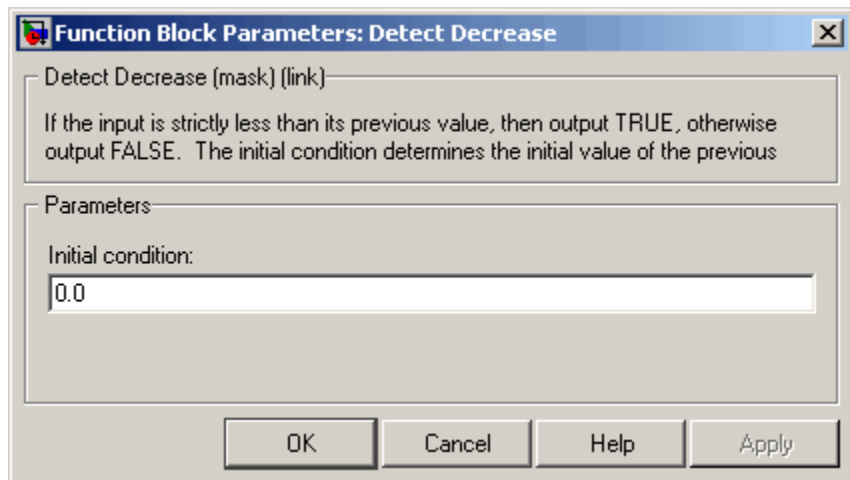
**Description** The Detect Decrease block determines if an input is strictly less than its previous value where



- 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 software, including fixed-point and enumerated data types. The block output is `uint8`.

## Parameters and Dialog Box



### Initial condition

Set the initial condition for the previous input  $U/z$ .

# Detect Decrease

---

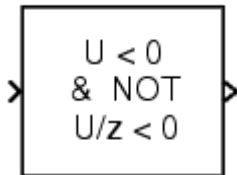
<b>Characteristics</b>	Direct Feedthrough	Yes
	Scalar Expansion	Yes

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

**Purpose** Detect falling edge when signal's value decreases to 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



- 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 numeric data type supported by Simulink software, including fixed-point data types. The block output is `uint8`.

**Parameters and Dialog Box**

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

<b>Characteristics</b>	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 falling edge when signal's value decreases to nonpositive value, and its previous value was strictly positive

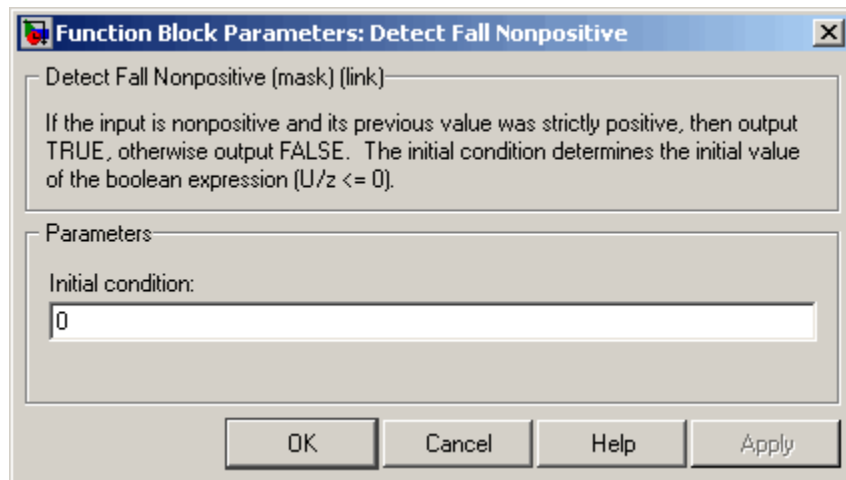
**Library** Logic and Bit Operations

**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 numeric data type supported by Simulink software, including fixed-point data types. The block output is `uint8`.

## Parameters and Dialog Box



### Initial condition

Set the initial condition of the Boolean expression  $U/z \leq 0$ .

<b>Characteristics</b>	Direct Feedthrough	Yes
	Scalar Expansion	Yes

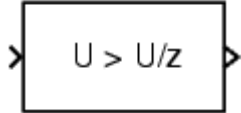
**See Also** Detect Change, Detect Decrease, Detect Fall Negative, Detect Increase, Detect Rise Nonnegative, Detect Rise Positive

# Detect Increase

**Purpose** Detect increase in signal's value

**Library** Logic and Bit Operations

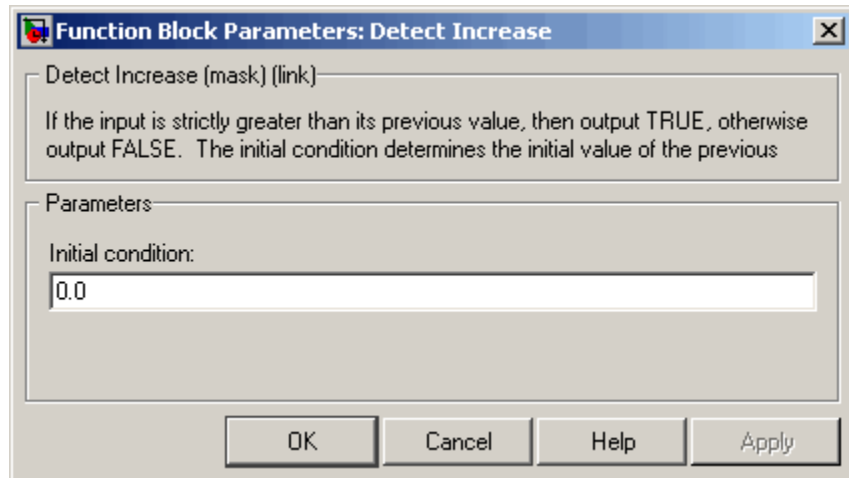
**Description** The Detect Increase block determines if an input is strictly greater than its previous value where



- 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 software, including fixed-point and enumerated data types. The block output is `uint8`.

## Parameters and Dialog Box



### Initial condition

Set the initial condition for the previous input  $U/z$ .

<b>Characteristics</b>	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

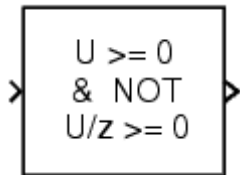
Detect rising edge when signal's value increases to nonnegative value, and its previous value was strictly negative

## 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

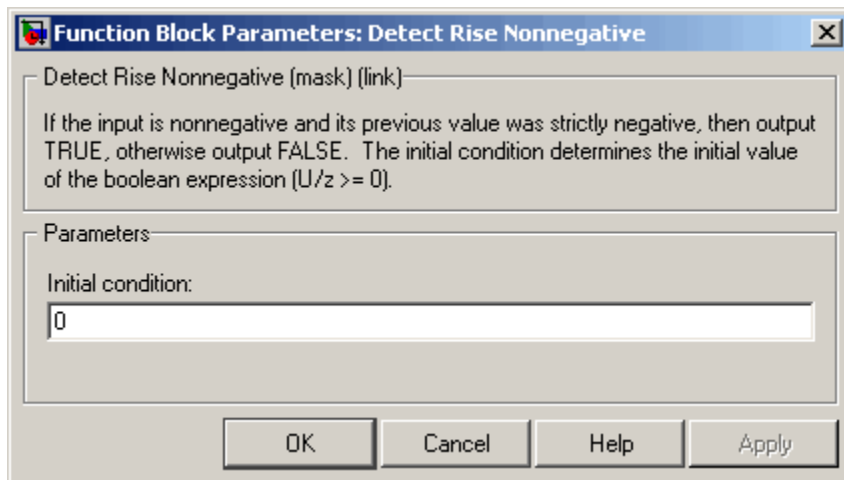


- The output is true (equal to 1), when the input signal is greater than or equal to zero, and its previous value was less than zero.
- The output is false (equal to 0), when the input signal is less than zero, or if nonnegative, its previous value was greater than or equal to zero.

## Data Type Support

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

## Parameters and Dialog Box





**Initial condition**

Set the initial condition of the Boolean expression  $U/z \geq 0$ .

**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

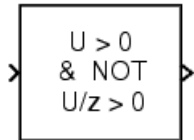
## Purpose

Detect rising edge when signal's value increases to strictly positive value, and its previous value was nonpositive

## Library

Logic and Bit Operations

## Description



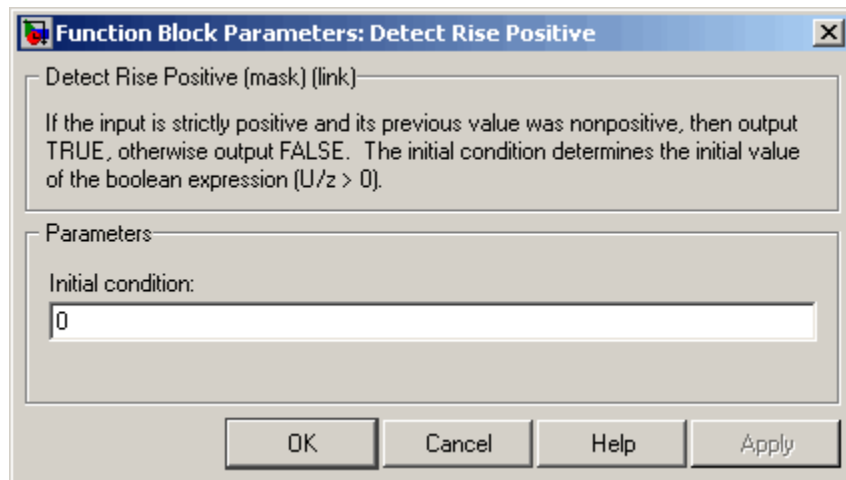
The Detect Rise Positive block determines if the input is strictly positive, and its previous value was nonpositive where

- 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 numeric data type supported by Simulink software, including fixed-point data types. The block output is uint8.

## Parameters and Dialog Box



### Initial condition

Set the initial condition of the Boolean expression  $U/z > 0$ .

<b>Characteristics</b>	Direct Feedthrough	Yes
	Scalar Expansion	Yes

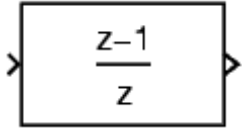
**See Also** Detect Change, Detect Decrease, Detect Fall Negative, Detect Fall Nonpositive, Detect Increase, Detect Rise Nonnegative

# Difference

**Purpose** Calculate change in signal over one time step

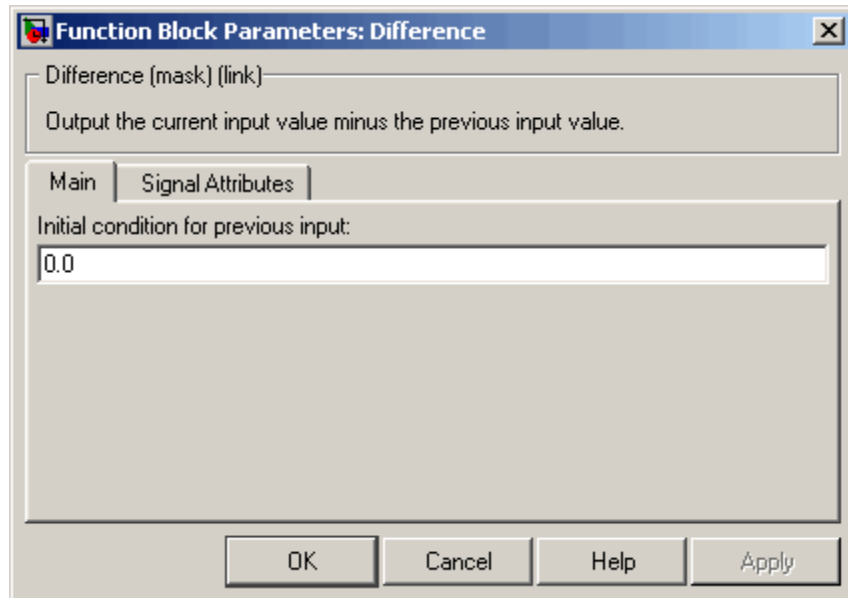
**Library** Discrete

**Description** The Difference block outputs the current input value minus the previous input value.



**Data Type Support** The Difference block accepts signals of any numeric data type supported by Simulink software, including fixed-point data types.

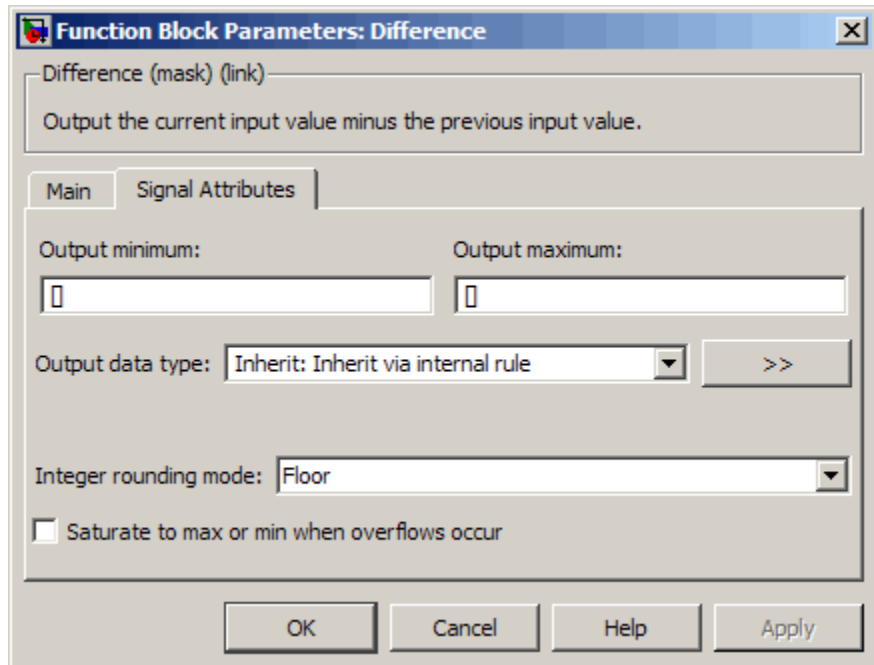
**Parameters and Dialog Box** The **Main** pane of the Difference block dialog box appears as follows:



## Initial condition for previous output

Set the initial condition for the previous output.

The **Signal Attributes** pane of the Difference block dialog box appears as follows:



## Output minimum

Specify the minimum value that the block should output. The default value, [ ], is equivalent to  $-\text{Inf}$ . Simulink software uses this value to perform:

- Simulation range checking (see “Checking Signal Ranges”)
- Automatic scaling of fixed-point data types

## Output maximum


Specify the maximum value that the block should output. The default value, [], is equivalent to `Inf`. Simulink software uses this value to perform:

- Simulation range checking (see “Checking Signal Ranges”)
- Automatic scaling of fixed-point data types

## Output data type

Specify the output data type. You can set it to:

- A rule that inherits a data type, for example, `Inherit: Inherit via back propagation`
- The name of a built-in data type, for example, `single`
- The name of a data type object, for example, a `Simulink.NumericType` object
- An expression that evaluates to a data type, for example, `fixdt(1,16,0)`

Click the **Show data type assistant** button  to display the **Data Type Assistant**, which helps you set the **Output data type** parameter.

See “Specifying Block Output Data Types” in the *Simulink User’s Guide* for more information.

## Lock output scaling against changes by the autoscaling tool

Select to lock scaling of outputs. This parameter is visible only if you enter an expression for the **Output data type** parameter.

## Integer rounding mode

Select the rounding mode for fixed-point operations. For more information, see “Rounding” in the *Simulink Fixed Point User’s Guide*.

## Saturate to max or min when overflows occur

If selected, fixed-point overflows saturate.

<b>Characteristics</b>	Direct Feedthrough	Yes
	Scalar Expansion	Yes, of inputs and gain

# Digital Clock

---

**Purpose** Output simulation time at specified sampling interval

**Library** Sources

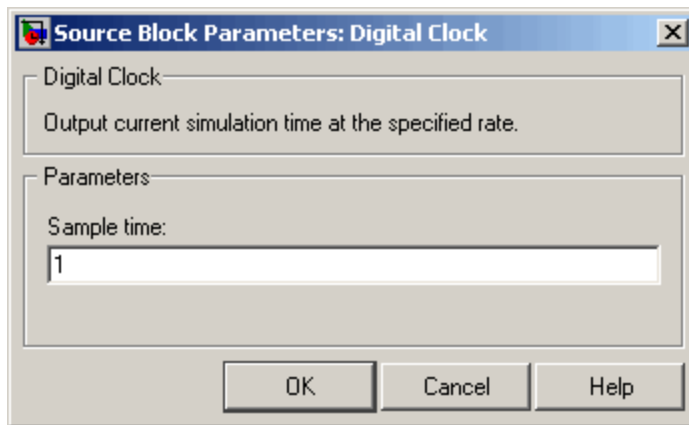
**Description** The Digital Clock block outputs the simulation time only at the specified sampling interval. At other times, the output is held at the previous value.



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 Simulink documentation.



## Characteristics

Sample Time	Specified in the <b>Sample time</b> parameter
Scalar Expansion	No
Dimensionalized	No
Zero Crossing	No

# Direct Lookup Table (n-D)

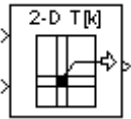
## Purpose

Index into N-dimensional table to retrieve element, column, or 2-D matrix

## Library

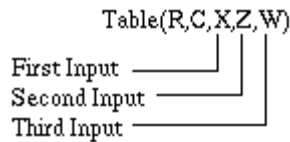
Lookup Tables

## 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.

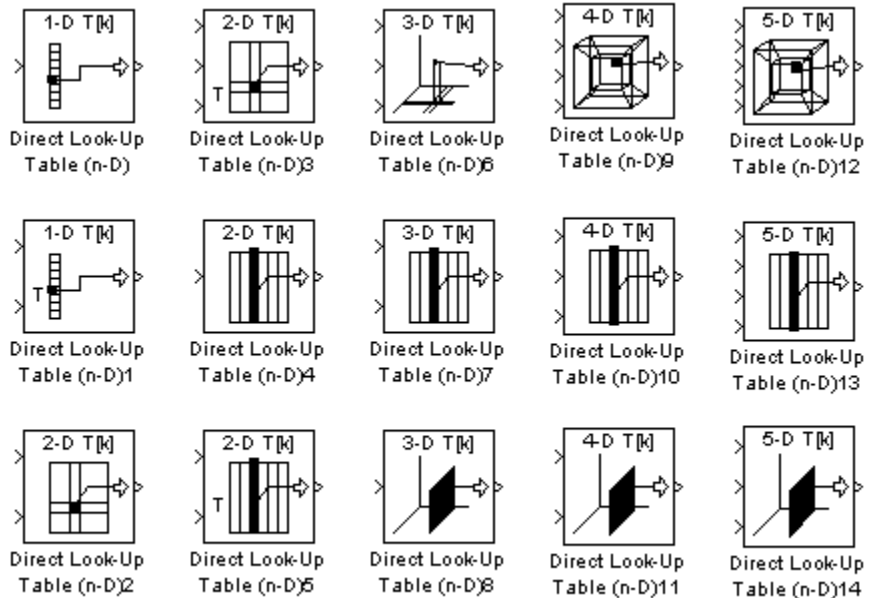
You define a set of output values as the **Table data** parameter. You specify what object the inputs select from the table: an element, a column, or a 2-D matrix. The first input specifies the zero-based index to the first dimension higher than the number of dimensions in the output, the next input 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. (See “Changing a Block’s Orientation” in the Simulink documentation for a description of the port order for various block orientations.)

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).

# Direct Lookup Table (n-D)



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

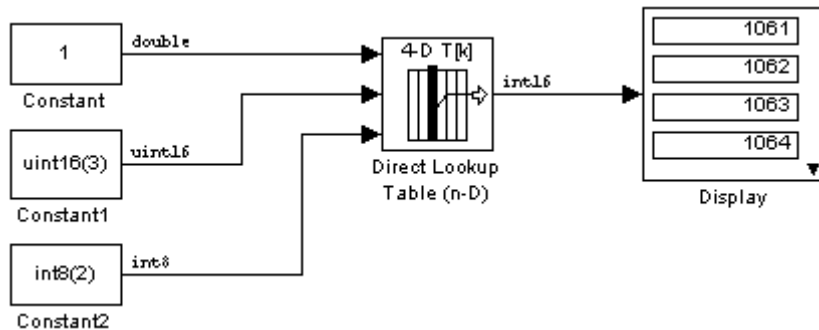
```
Inputs select this object from table: "Column"
Table data: int16(a)
```

# Direct Lookup Table (n-D)

where `a` is a 4-D array of linearly increasing numbers calculated using MATLAB functions.

```
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 using the following MATLAB command (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

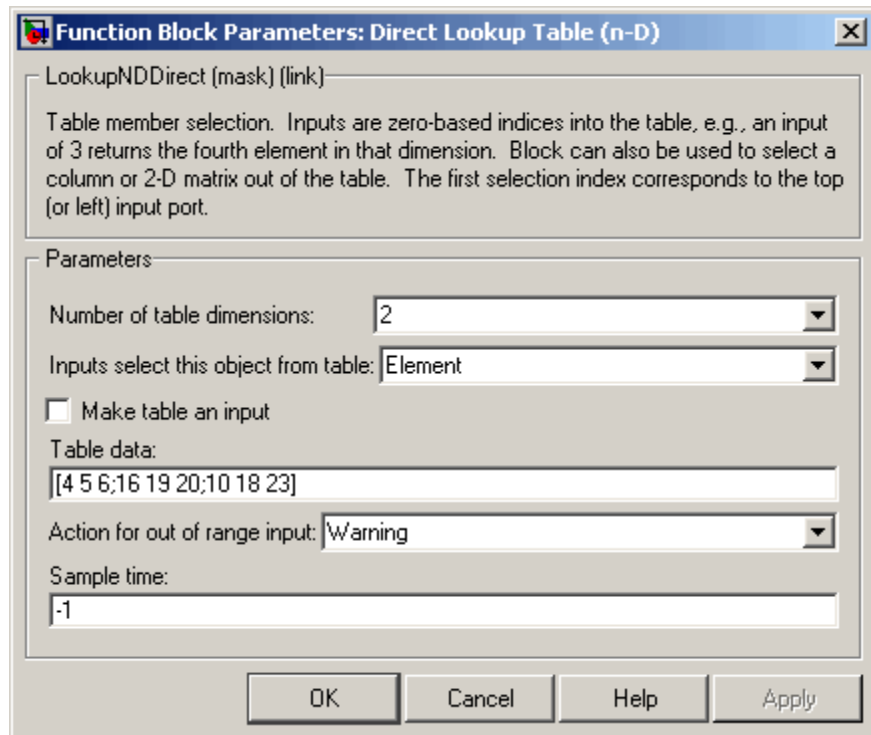
The Direct Lookup Table (n-D) block accepts signals of any numeric data type supported by Simulink software, including fixed-point types. For a discussion on the data types supported by Simulink software, see “Data Types Supported by Simulink” in the “Working with Data” chapter of the Simulink documentation.

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 check 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.

---

**Tip** If you select this check box, use only 1-D or 2-D table data, because this block does not support multidimensional signals.

---

## 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 software, see “Multidimensional Arrays” in the

# Direct Lookup Table (n-D)

---

MATLAB online documentation. (This field appears only if you clear the **Make table an input** check box.)

## Action for out of range input

None, Warning, Error.

## Sample time

The time interval between samples. To inherit the sample time, set this parameter to -1. See “How to Specify the Sample Time” in the Simulink documentation for more information.

## Characteristics

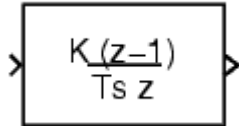
Direct Feedthrough	Yes
Sample Time	Specified in the <b>Sample time</b> parameter
Scalar Expansion	For scalar lookups only (not when returning a column or a 2-D matrix from the table)
Dimensionalized	For scalar lookups only (not when returning a column or a 2-D matrix from the table)
Zero Crossing	No



**Purpose** Compute 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  $u(t_n)$  and  $y(t_n)$  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.

### Guidelines for Usage in Triggered Subsystems

When you use the Discrete Derivative block in triggered subsystems, follow these guidelines:

- When the **Sample time type** parameter of the trigger port is **triggered**, verify that your model does not trigger the subsystem at the first time step.

If your model triggers the subsystem at the first time step, the Discrete Derivative block generates a divide-by-zero warning message. This behavior occurs because the time step at  $t = 0$  is zero.

- When the **Sample time type** parameter of the trigger port is **periodic**, your model can trigger the subsystem at any time step.

### Data Type Support

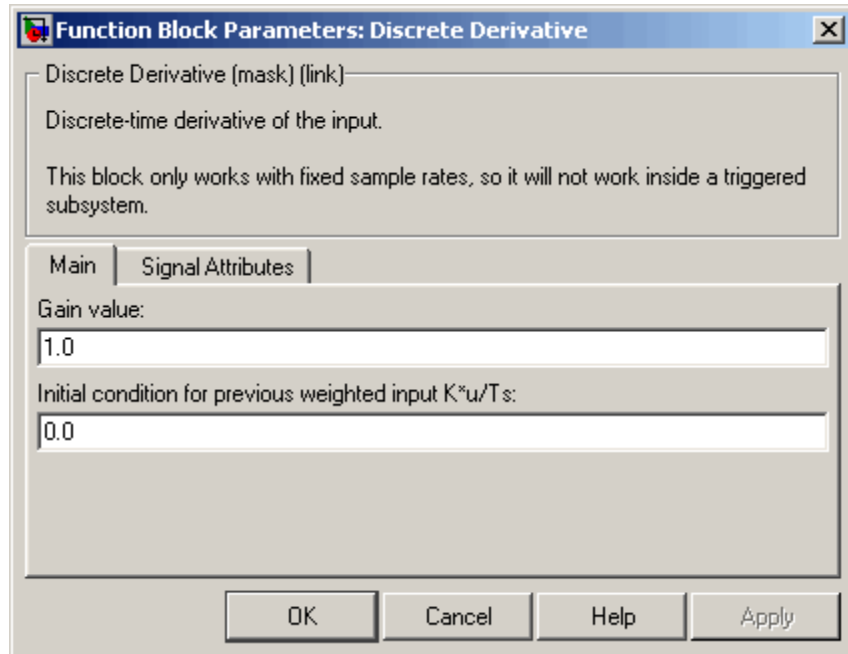
The Discrete Derivative block supports all numeric Simulink data types, including fixed-point data types.

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

# Discrete Derivative

## Parameters and Dialog Box

The **Main** pane of the Discrete Derivative block dialog box appears as follows:



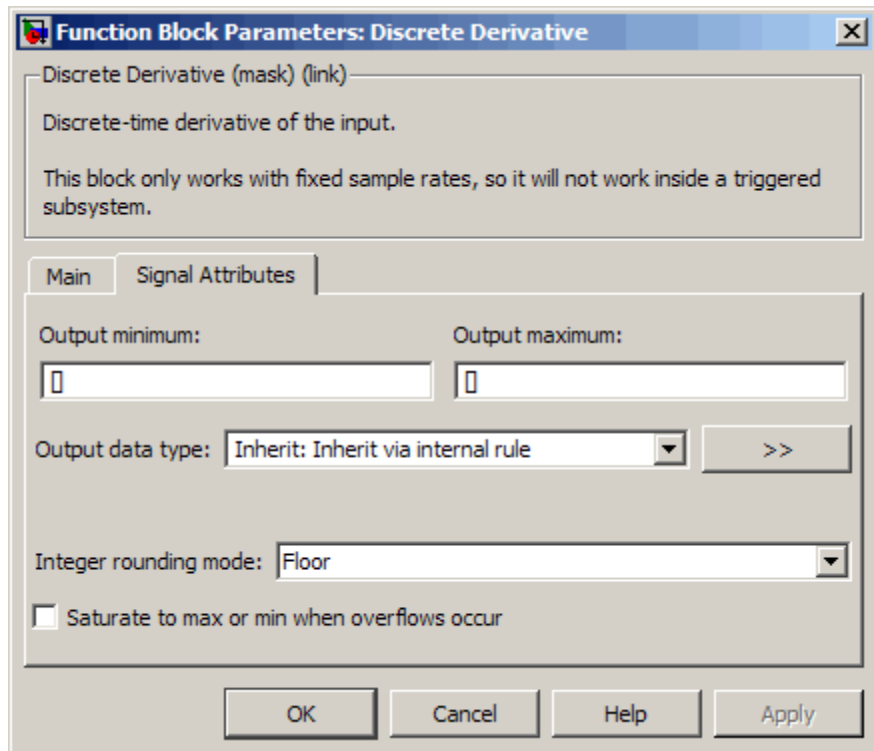
### Gain value

Scaling factor used to weight the block's input at the current time step.

### Initial condition for previous weighted input $K \cdot u / T_s$

Set the initial condition for the previous scaled input.

The **Signal Attributes** pane of the Discrete Derivative block dialog box appears as follows:



## Output minimum

Specify the minimum value that the block should output. The default value, [], is equivalent to  $-\text{Inf}$ . Simulink software uses this value to perform:

- Simulation range checking (see “Checking Signal Ranges”)
- Automatic scaling of fixed-point data types

## Output maximum

Specify the maximum value that the block should output. The default value, [], is equivalent to  $\text{Inf}$ . Simulink software uses this value to perform:

# Discrete Derivative


---

- Simulation range checking (see “Checking Signal Ranges”)
- Automatic scaling of fixed-point data types

## Output data type

Specify the output data type. You can set it to:

- A rule that inherits a data type, for example, `Inherit: Inherit via back propagation`
- The name of a built-in data type, for example, `single`
- The name of a data type object, for example, a `Simulink.NumericType` object
- An expression that evaluates to a data type, for example, `fixdt(1,16,0)`

Click the **Show data type assistant** button  to display the **Data Type Assistant**, which helps you set the **Output data type** parameter.

See “Specifying Block Output Data Types” in *Simulink User’s Guide* for more information.

## Lock output scaling against changes by the autoscaling tool

Select to lock scaling of outputs. This parameter is visible only if you enter an expression for the **Output data type** parameter.

## Integer rounding mode

Select the rounding mode for fixed-point operations. For more information, see “Rounding” in the *Simulink Fixed Point User’s Guide*.

## 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

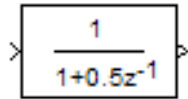
# Discrete Filter

---

**Purpose** Model IIR direct form II filters

**Library** Discrete

## Description



The Discrete Filter block independently filters each channel of the input signal with the specified digital IIR direct form II filter. The block implements static filters with fixed coefficients. You can tune the coefficients of a static filter during simulation.

This block filters each channel of the input signal independently over time, treating each element of the input as an individual channel. The output dimensions always equal those of the input signal that is filtered, except in single-input/multi-output mode.

The output of this block numerically matches the output of the Signal Processing Toolbox™ `dfilt.df2` function.

Use the **Numerator coefficient** parameter to specify the coefficients of the discrete filter's numerator polynomial. If you specify a single numerator polynomial as a vector for the **Numerator coefficient** parameter, the block outputs a scalar signal. Use the **Denominator coefficient** parameter to specify the coefficients of the function's denominator polynomial. The **Denominator coefficient** 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 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. Conversely, 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.

## Specifying Initial States

Use the **Initial states** parameter to specify initial conditions for the filter states. To determine the number of initial states you must specify and how to specify them, see the following table of valid initial states.

The **Initial states** parameter can take one of the forms described in this table.

## Valid Initial States

Initial Condition	Description
Scalar	The block initializes all delay elements in the filter to the scalar value.
Vector or matrix (for applying different delay elements to each channel)	Each vector or matrix element specifies a unique initial condition for a corresponding delay element in a corresponding channel: <ul style="list-style-type: none"><li>• The vector length must equal the number of delay elements in the filter, <math>\max(\#\_of\_zeros, \#\_of\_poles) - 1</math>.</li><li>• The matrix must have the same number of rows as the number of delay elements in the filter, <math>\max(\#\_of\_zeros, \#\_of\_poles) - 1</math>, and must have one column for each channel of the input signal.</li></ul>

# Discrete Filter

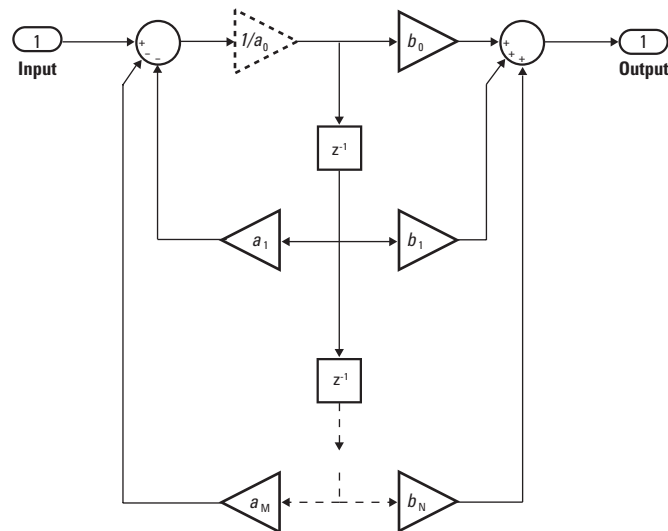
## Data Type Support

The Discrete Filter block accepts and outputs real and complex signals of any numeric data type supported by the Simulink software. The block supports the same types for the numerator and denominator coefficients.

Numerator and denominator coefficients must have the same complexity and word length. They can have different fraction lengths.

States are complex when either the input or the coefficients are complex.

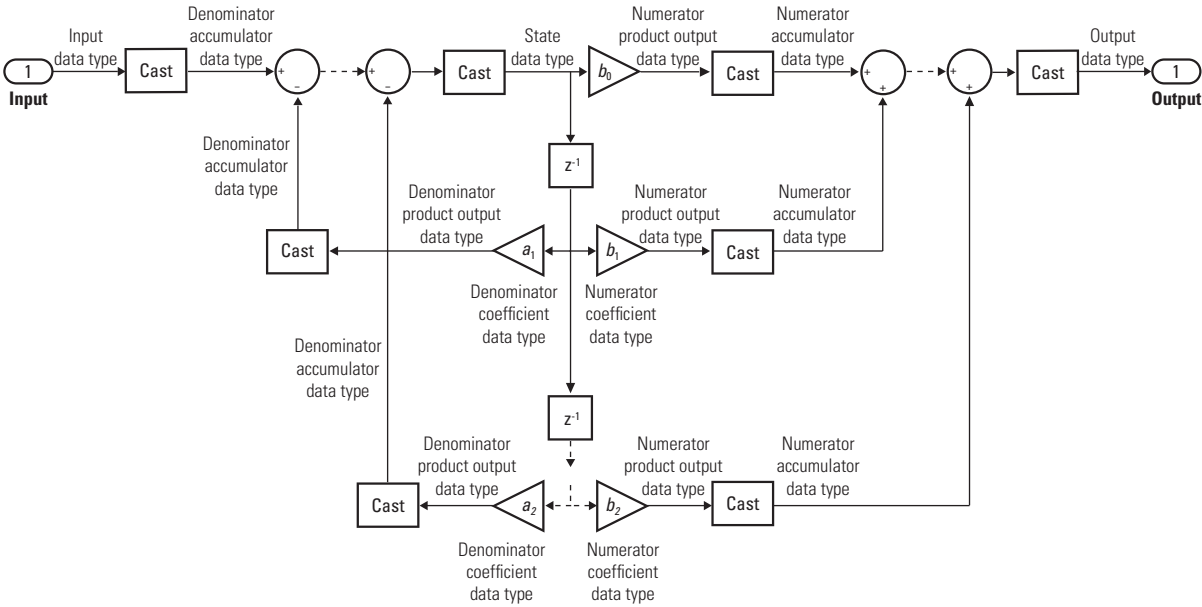
The following diagrams shows the filter structure and the data types used within the Discrete Filter block for fixed-point signals.



The dashed divide is omitted when the **Leading denominator coefficient equals 1** parameter is not selected.



# Discrete Filter



# Discrete Filter

## Parameters and Dialog Box

The **Main** pane of the Discrete Filter block dialog box appears as follows.

The screenshot shows a dialog box titled "Function Block Parameters: Discrete Filter". The main pane contains the following text and controls:

Discrete Filter

Independently filter each channel of the input over time using an IIR filter. You should specify coefficients in ascending order of powers of  $1/z$ .

Floating point inheritance takes precedence over the data types on the 'Data Type Attributes' pane. When the block input is floating point, all block data types match the input.

Navigation tabs: Main | Data Type Attributes | State Attributes

Numerator coefficient:  
[ 1 ]

Denominator coefficient:  
[ 1 0.5 ]

Initial states:  
[ 0 ]

Sample time (-1 for inherited):  
[ 1 ]

Leading denominator coefficient equals 1

Buttons: OK, Cancel, Help, Apply

## Numerator coefficient

Specify the coefficients of the discrete filter's numerator polynomial or polynomials in ascending powers of  $z^{-1}$ . Use a vector to specify the coefficients for a single numerator polynomial. If you specify a single numerator polynomial as a vector for this parameter, the block outputs a scalar signal.

## Denominator coefficient

Specify the coefficients of the discrete filter's denominator polynomial as a vector in ascending powers of  $z^{-1}$ .

## Initial states

Specify the initial conditions of the filter states. To learn how to specify initial states, see “Specifying Initial States” on page 2-274.

## Sample time (-1 for inherited)

Specify the time interval between samples. To inherit the sample time, set this parameter to -1. See “How to Specify the Sample Time” in “How Simulink Works” in the *Simulink User's Guide*.

## Leading denominator coefficient equals 1

This parameter only applies to floating-point inputs. Select when the leading denominator coefficient,  $a_0$ , equals one. When you select this check box, the block:

- Does not perform a divide-by- $a_0$  either in simulation or in the generated code
- Errors out at model edit time if the  $a_0$  value you provide in the dialog is not one
- Errors out if you tune  $a_0$  to any non-unity value

When you clear this check box, the block:

- Performs divide-by- $a_0$  during simulation
- Is fully tunable during simulation
- Performs a divide-by- $a_0$  in generated code, unless tunability is turned off in the **Configuration Parameters** dialog box.

## Discrete Filter

---

The **Data Type Attributes** pane of the Discrete Filter block dialog box appears as follows.

**Function Block Parameters: Discrete Filter**

Discrete Filter

Independently filter each channel of the input over time using an IIR filter. You should specify coefficients in ascending order of powers of  $1/z$ .

Floating point inheritance takes precedence over the data types on the 'Data Type Attributes' pane. When the block input is floating point, all block data types match the input.

Main | **Data Type Attributes** | State Attributes

Numerator coefficient minimum:  Numerator coefficient maximum:

Denominator coefficient minimum:  Denominator coefficient maximum:

Output minimum:  Output maximum:

State data type:  >>

Numerator coefficient data type:  >>

Denominator coefficient data type:  >>

Numerator product output data type:  >>

Denominator product output data type:  >>

Numerator accumulator data type:  >>

Denominator accumulator data type:  >>

Output data type:  >>

Lock scaling against changes by the autoscaling tool

Integer rounding mode:

Saturate on integer overflow

OK Cancel Help Apply

## **Numerator coefficient minimum**

Specify the minimum value that a numerator coefficient should have. The default value, [ ], is equivalent to  $-\text{Inf}$ . Simulink software uses this value to perform:

- Parameter range checking (see “Checking Parameter Values”)
- Automatic scaling of fixed-point data types

## **Numerator coefficient maximum**

Specify the maximum value that a numerator coefficient should have. The default value, [ ], is equivalent to  $\text{Inf}$ . Simulink software uses this value to perform:

- Parameter range checking (see “Checking Parameter Values”)
- Automatic scaling of fixed-point data types

## **Denominator coefficient minimum**

Specify the minimum value that a denominator coefficient should have. The default value, [ ], is equivalent to  $-\text{Inf}$ . Simulink software uses this value to perform:

- Parameter range checking (see “Checking Parameter Values”)
- Automatic scaling of fixed-point data types

## **Denominator coefficient maximum**

Specify the maximum value that a denominator coefficient should have. The default value, [ ], is equivalent to  $\text{Inf}$ . Simulink software uses this value to perform:

- Parameter range checking (see “Checking Parameter Values”)
- Automatic scaling of fixed-point data types

## **Output minimum**

Specify the minimum value that the block should output. The default value, [ ], is equivalent to  $-\text{Inf}$ . Simulink software uses this value to perform:

- Simulation range checking (see “Checking Signal Ranges”)
- Automatic scaling of fixed-point data types

## Output maximum


Specify the maximum value that the block should output. The default value, [], is equivalent to `Inf`. Simulink software uses this value to perform:

- Simulation range checking (see “Checking Signal Ranges”)
- Automatic scaling of fixed-point data types

## State data type

Specify the state data type. You can set it to:

- A rule that inherits a data type, for example, `Inherit: Same as input`
- A built-in integer, for example, `int8`
- A data type object, for example, a `Simulink.NumericType` object
- An expression that evaluates to a data type, for example, `fixdt(1,16,0)`

Click the **Show data type assistant** button  to display the **Data Type Assistant**, which helps you set the **State data type** parameter.

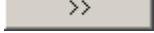
See “Using the Data Type Assistant” in *Simulink User’s Guide* for more information.

## Numerator coefficient data type

Specify the numerator coefficient data type. You can set it to:

- A rule that inherits a data type, for example, `Inherit: Inherit via internal rule`
- A built-in integer, for example, `int8`
- A data type object, for example, a `Simulink.NumericType` object

- An expression that evaluates to a data type, for example, `fixdt(1,16,0)`


Click the **Show data type assistant** button  to display the **Data Type Assistant**, which helps you set the **Numerator coefficient data type** parameter.

See “Using the Data Type Assistant” in *Simulink User’s Guide* for more information.

### **Denominator coefficient data type**

Specify the denominator coefficient data type. You can set it to:

- A rule that inherits a data type, for example, `Inherit: Inherit via internal rule`
- A built-in integer, for example, `int8`
- A data type object, for example, a `Simulink.NumericType` object
- An expression that evaluates to a data type, for example, `fixdt(1,16,0)`

Click the **Show data type assistant** button  to display the **Data Type Assistant**, which helps you set the **Denominator coefficient data type** parameter.

See “Using the Data Type Assistant” in *Simulink User’s Guide* for more information.


### **Numerator product output data type**

Specify the product output data type for the numerator coefficients. You can set it to:

- A rule that inherits a data type, for example, `Inherit: Inherit via internal rule`
- A built-in data type, for example, `int8`



- A data type object, for example, a `Simulink.NumericType` object
- An expression that evaluates to a data type, for example, `fixdt(1,16,0)`


Click the **Show data type assistant** button  to display the **Data Type Assistant**, which helps you set the **Numerator product output data type** parameter.

See “Using the Data Type Assistant” in *Simulink User’s Guide* for more information.

### Denominator product output data type

Specify the product output data type for the denominator coefficients. You can set it to:

- A rule that inherits a data type, for example, `Inherit: Inherit via internal rule`
- A built-in data type, for example, `int8`
- A data type object, for example, a `Simulink.NumericType` object
- An expression that evaluates to a data type, for example, `fixdt(1,16,0)`

Click the **Show data type assistant** button  to display the **Data Type Assistant**, which helps you set the **Denominator product output data type** parameter.

See “Using the Data Type Assistant” in *Simulink User’s Guide* for more information.


### Numerator accumulator data type

Specify the accumulator data type for the numerator coefficients. You can set it to:

# Discrete Filter

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- A rule that inherits a data type, for example, `Inherit: Inherit via internal rule`
- A built-in data type, for example, `int8`
- A data type object, for example, a `Simulink.NumericType` object
- An expression that evaluates to a data type, for example, `fixdt(1,16,0)`

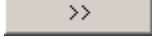
Click the **Show data type assistant** button  to display the **Data Type Assistant**, which helps you set the **Numerator accumulator data type** parameter.

See “Using the Data Type Assistant” in *Simulink User’s Guide* for more information.

## Denominator accumulator data type

Specify the accumulator data type for the denominator coefficients. You can set it to:

- A rule that inherits a data type, for example, `Inherit: Inherit via internal rule`
- A built-in data type, for example, `int8`
- A data type object, for example, a `Simulink.NumericType` object
- An expression that evaluates to a data type, for example, `fixdt(1,16,0)`

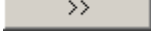
Click the **Show data type assistant** button  to display the **Data Type Assistant**, which helps you set the **Denominator accumulator data type** parameter.

See “Using the Data Type Assistant” in *Simulink User’s Guide* for more information.

## Output data type

Specify the output data type. You can set it to:

- A rule that inherits a data type, for example, `Inherit: Inherit via internal rule`
- A built-in data type, for example, `int8`
- A data type object, for example, a `Simulink.NumericType` object
- An expression that evaluates to a data type, for example, `fixdt(1,16,0)`

Click the **Show data type assistant** button  to display the **Data Type Assistant**, which helps you set the **Output data type** parameter.

See “Specifying Block Output Data Types” in *Simulink User’s Guide* for more information.

## Lock output scaling against changes by the autoscaling tool

Select this check box to lock scaling of outputs.

## Integer rounding mode

Select the rounding mode for fixed-point operations. For more information, see “Rounding” in the *Simulink Fixed Point User’s Guide*.

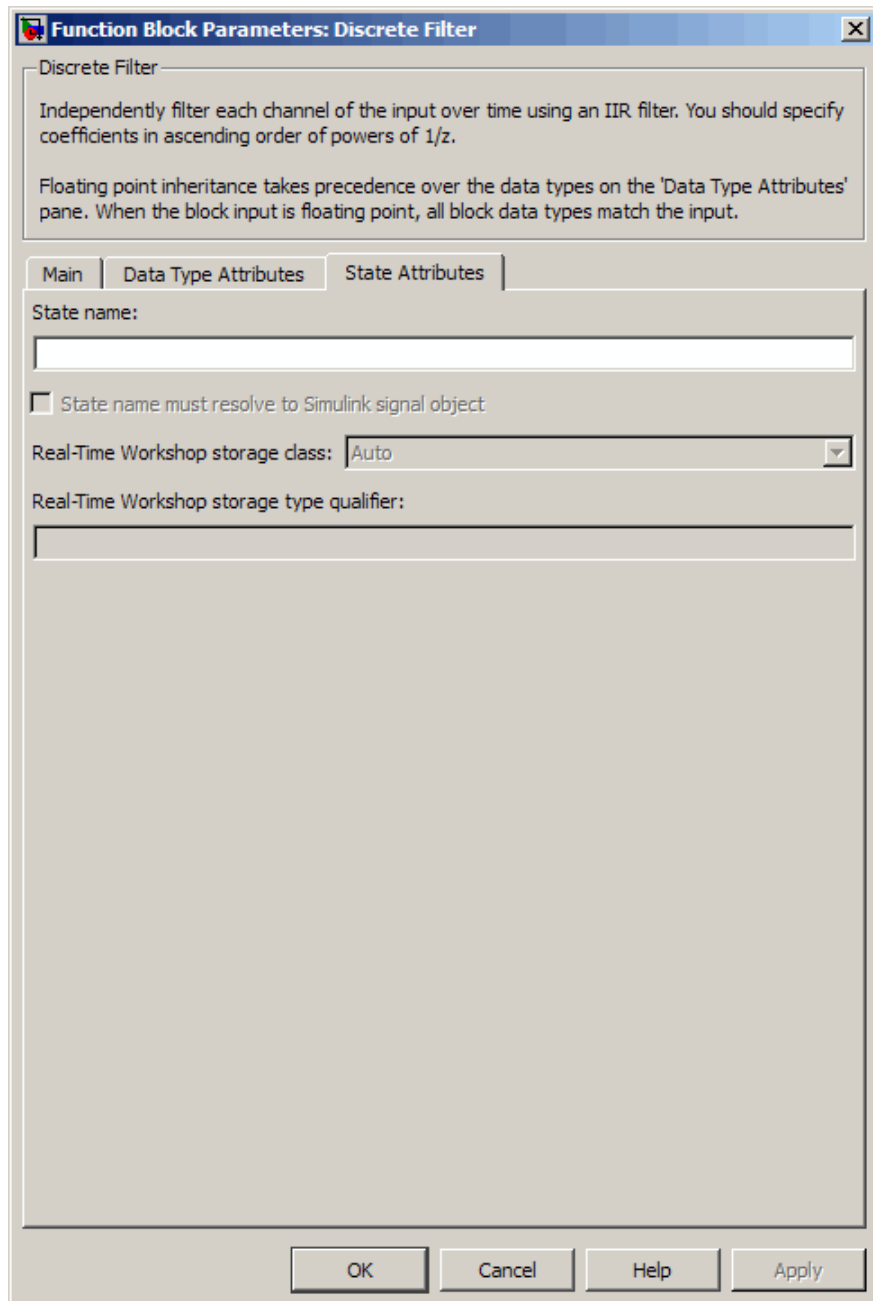
## Saturate on integer overflow

Select this check box to have overflows saturate. Otherwise, they wrap.

When you select this check box, saturation applies to every internal operation on the block, not just the output or result. In general, the code generation process can detect when overflow is not possible, in which case, no saturation code is generated.

The **State Attributes** pane of the Discrete Filter block dialog box appears as follows.

# Discrete Filter



## State name

Use this parameter to assign a unique name to each state. The default is ' '. When this field is blank, no name is assigned. Consider the following when using this parameter:

- To assign a name to a single state, enter the name between quotes, for example, 'velocity' .
- The state names apply only to the selected block.
- To assign names to multiple states, enter a comma-delimited list surrounded by braces. For example, {'a', 'b', 'c'} . Each name must be unique.
- The number of states must be evenly divided by the number of state names. There can be fewer names than states, but there cannot be more names than states.
- For example, you can specify two names in a system with four states. Simulink software assigns the first name to the first two states and the second name to the last two.
- To assign state names with a variable that has been defined in the MATLAB workspace, enter the variable without quotes. A variable can be a string, cell, or structure.

This parameter enables **State name must resolve to Simulink signal object** when you click **Apply**.

## State name must resolve to Simulink signal object

Select this check box to require that state name resolve to Simulink signal object. This check box is cleared by default.

This parameter is only enabled when you specify the **State name** parameter.

Selecting this check box enables **Real-Time Workshop storage class**.

## Real-Time Workshop storage class

From the list, select state storage class.

# Discrete Filter

---

## Auto

If you do not need states to interface to external code, select Auto as the storage class.

## ExportedGlobal

State is stored in a global variable.

## ImportedExtern

`model_private.h` declares the state as an extern variable.

## ImportedExternPointer

`model_private.h` declares the state as an extern pointer.

This parameter is only enabled when you specify the **State name** parameter.

Setting this parameter to `ExportedGlobal`, `ImportedExtern`, or `ImportedExternPointer` enables **Real-Time Workshop storage type qualifier**.

During simulation, the block uses the following values:

- The initial value of the signal object to which the state name is resolved
- Min and Max values of the signal object

See “Block State Storage and Interfacing” in the *Real-Time Workshop User’s Guide* for more information.

## Characteristics

Direct Feedthrough	Only when the leading numerator coefficient is not equal to zero
Sample Time	Specified in the <b>Sample time</b> parameter
Scalar Expansion	Yes, of initial states
States	See “Specifying Initial States” on page 2-274

Dimensionalized	Yes
Zero Crossing	No

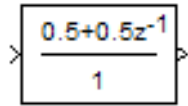
# Discrete FIR Filter

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**Purpose** Model FIR filters

**Library** Discrete

## Description



The Discrete FIR Filter block independently filters each channel of the input signal with the specified digital FIR filter. The block can implement static filters with fixed coefficients, as well as time-varying filters with coefficients that change over time. You can tune the coefficients of a static filter during simulation.

This block filters each channel of the input signal independently over time, treating each element of the input as an individual channel. The output dimensions equal those of the input, except in single-input/multi-output mode.

The outputs of this block numerically match the outputs of the Signal Processing Blockset Digital Filter Design block and of the Signal Processing Toolbox `dfilt` function.

This block supports the Simulink state logging feature. See “States” in the *Simulink User’s Guide* for more information.

## Filter Structure Support

You can change the filter structure implemented with the Discrete FIR Filter block by selecting one of the following from the **Filter structure** parameter:

- Direct form
- Direct form symmetric
- Direct form antisymmetric
- Direct form transposed
- Lattice MA

You must have an available Signal Processing Blockset software license to run a model with any of these filter structures other than direct form.



## Specifying Initial States

The Discrete FIR Filter block initializes the internal filter states to zero by default, which has the same effect as assuming that past inputs and outputs are zero. You can optionally use the **Initial states** parameter to specify nonzero initial conditions for the filter delays.

To determine the number of initial states you must specify and how to specify them, see the table on valid initial states. The **Initial states** parameter can take one of the forms described in the next table.

### Valid Initial States

Initial Condition	Description
Scalar	The block initializes all delay elements in the filter to the scalar value.
Vector or matrix (for applying different delay elements to each channel)	<p>Each vector or matrix element specifies a unique initial condition for a corresponding delay element in a corresponding channel:</p> <ul style="list-style-type: none"> <li>• The vector length equal the product of the number of input channels and the number of delay elements in the filter, <code>#_of_filter_coeffs-1</code> (or <code>#_of_reflection_coeffs</code> for Lattice MA).</li> <li>• The matrix must have the same number of rows as the number of delay elements in the filter, <code>#_of_filter_coeffs-1</code> (<code>#_of_reflection_coeffs</code> for Lattice MA), and must have one column for each channel of the input signal.</li> </ul>

### Data Type Support

The Discrete FIR Filter block accepts and outputs real and complex signals of any numeric data type supported by Simulink. The block supports the same types for the numerator coefficients.

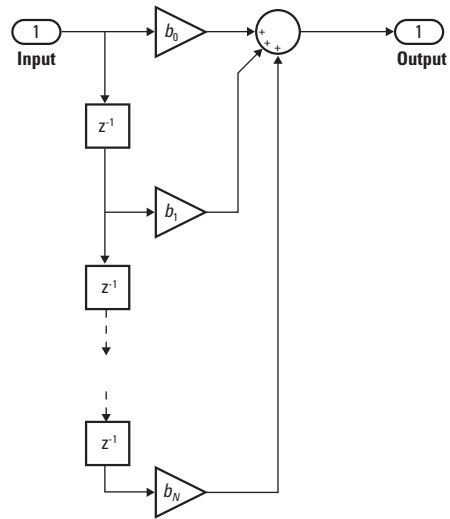
The following diagrams show the filter structure and the data types used within the Discrete FIR Filter block for fixed-point signals.

# Discrete FIR Filter

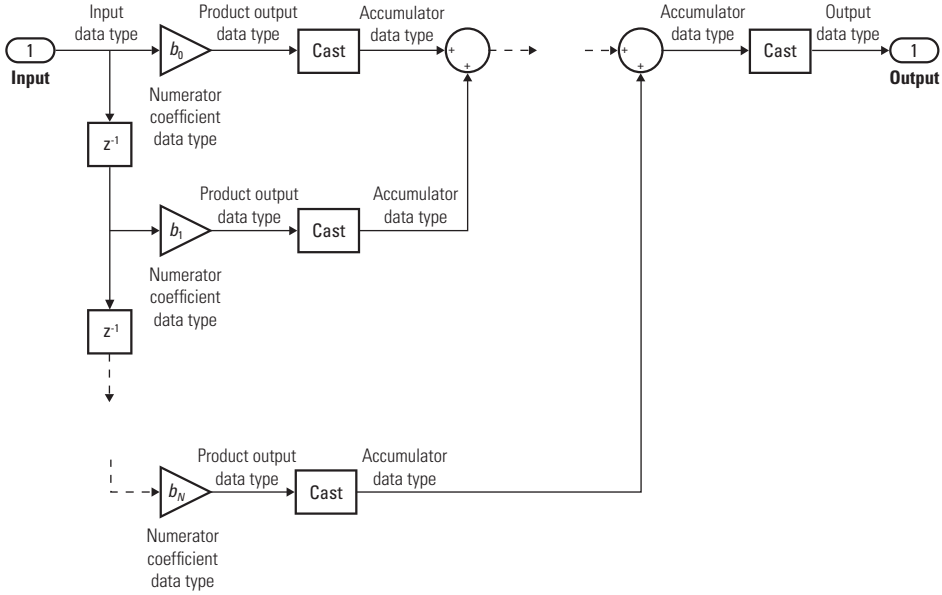
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## Direct Form

You cannot specify the state data type on the block mask for this structure because the input states have the same data types as the input.



# Discrete FIR Filter

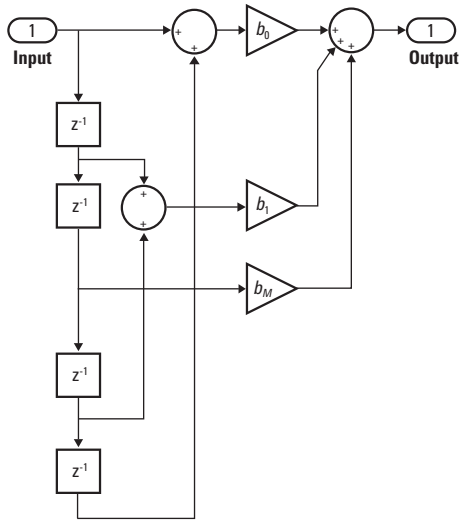


# Discrete FIR Filter

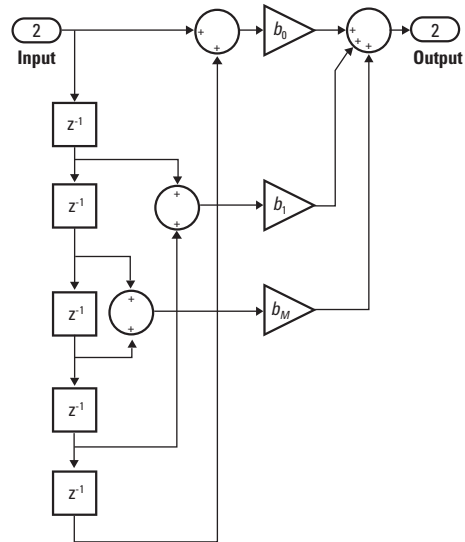
## Direct Form Symmetric

You cannot specify the state data type on the block mask for this structure because the input states have the same data types as the input.

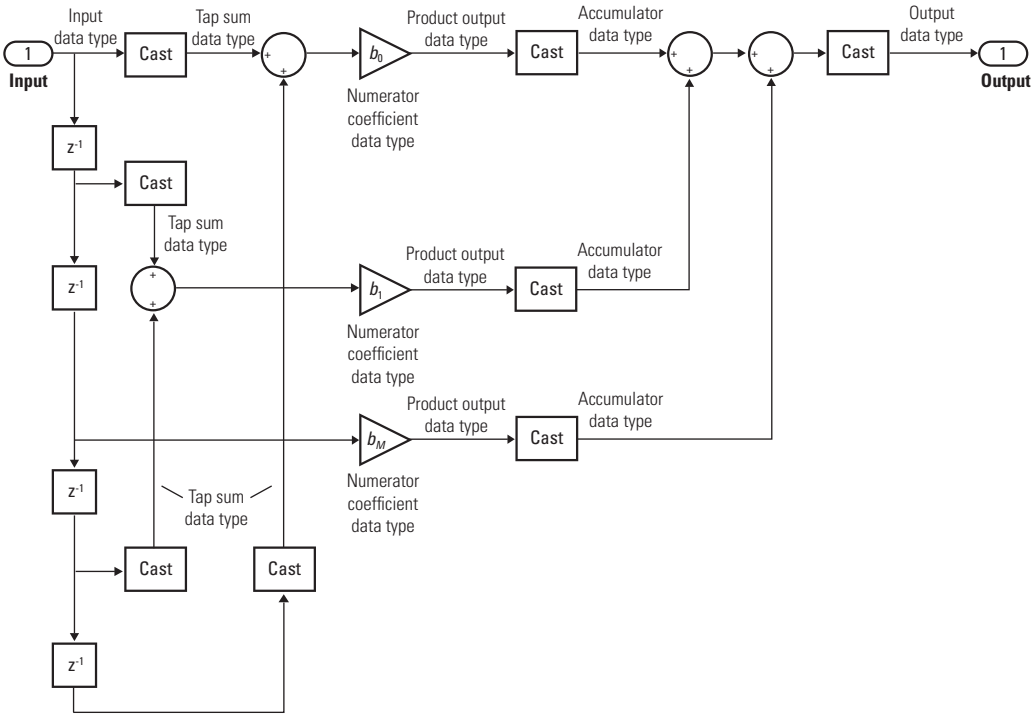
It is assumed that the filter coefficients are symmetric. The block only uses the first half of the coefficients for filtering.



Even Order - Type I

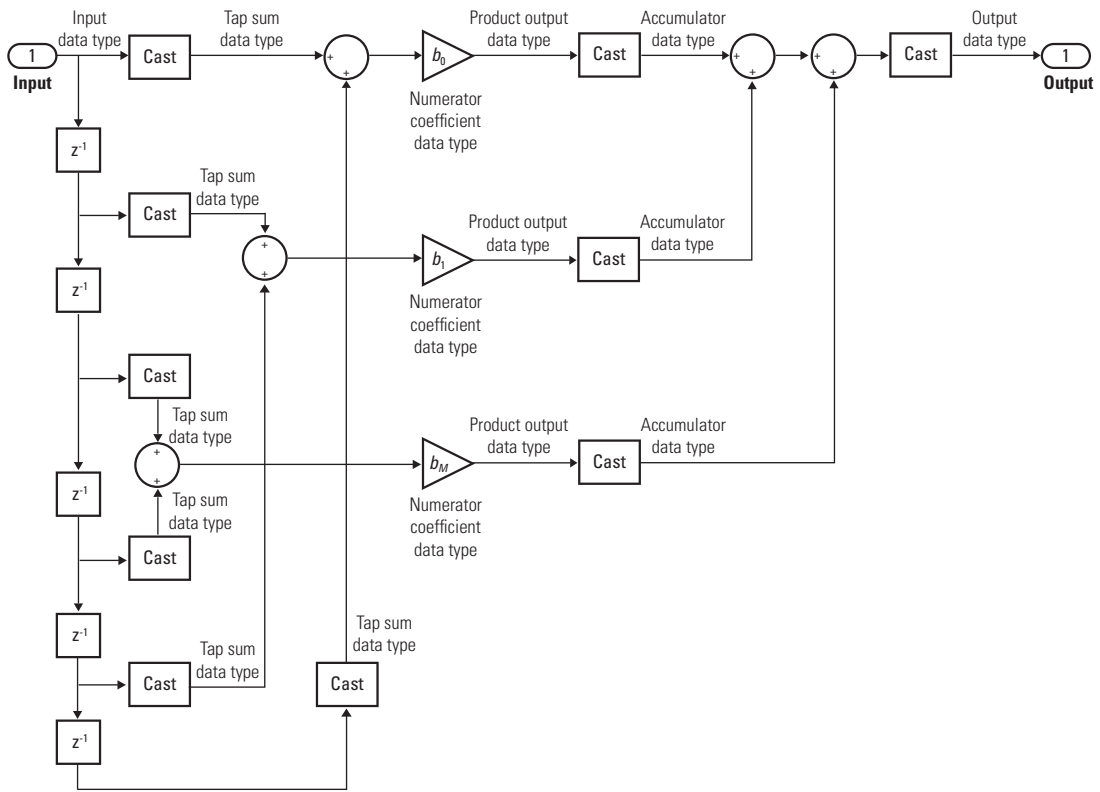


Odd Order - Type II



Even Order - Type I

# Discrete FIR Filter

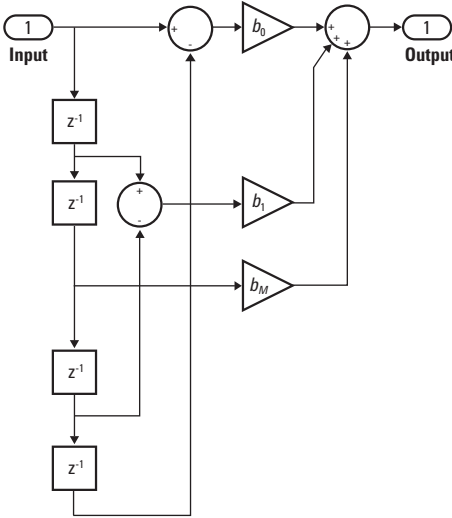


Odd Order - Type II

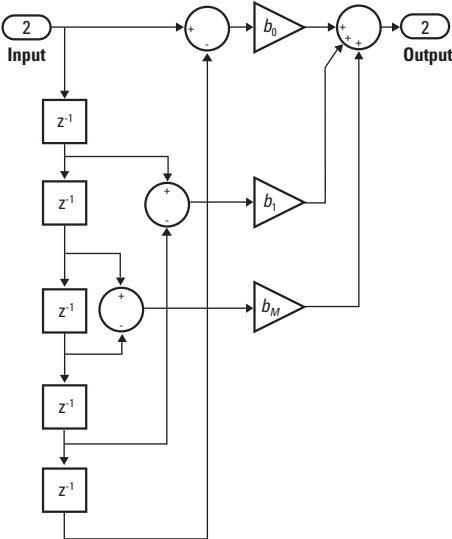
## Direct Form Antisymmetric

You cannot specify the state data type on the block mask for this structure because the input states have the same data types as the input.

It is assumed that the filter coefficients are antisymmetric. The block only uses the first half of the coefficients for filtering.

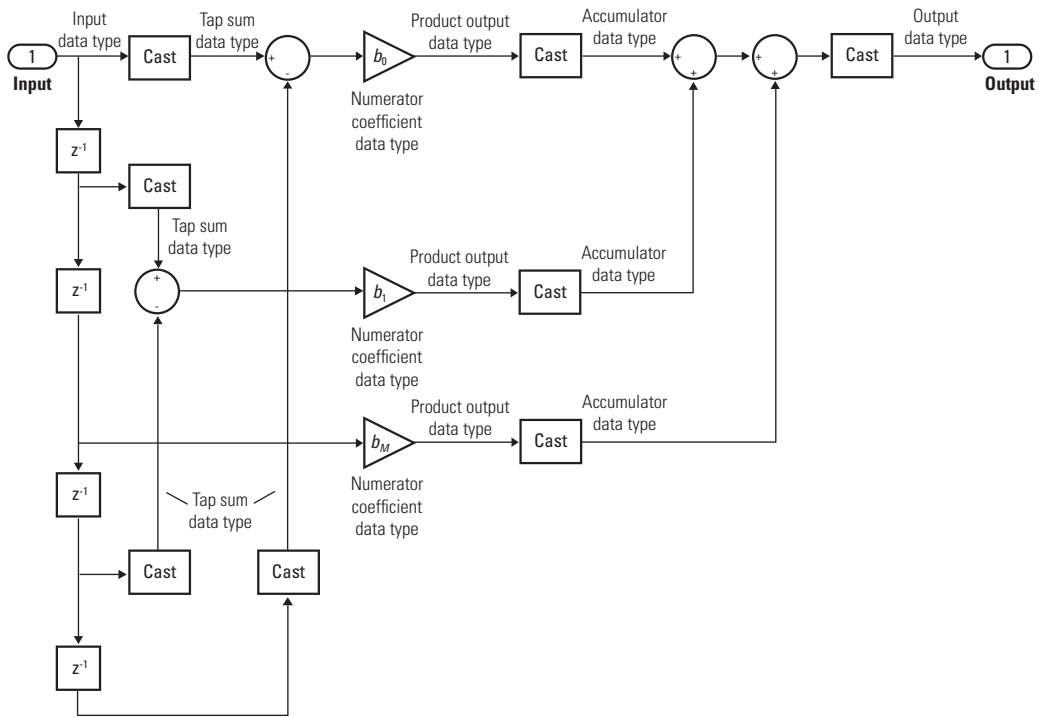


Even Order - Type III



Odd Order - Type IV

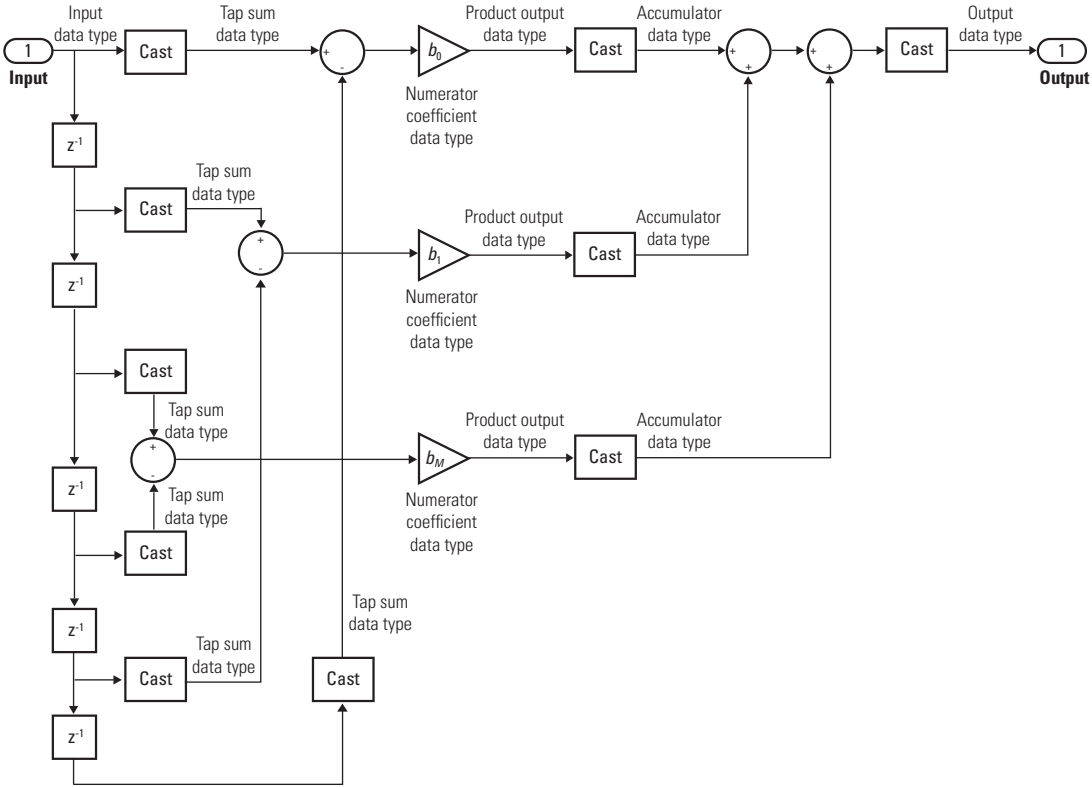
# Discrete FIR Filter



Even Order - Type III



# Discrete FIR Filter

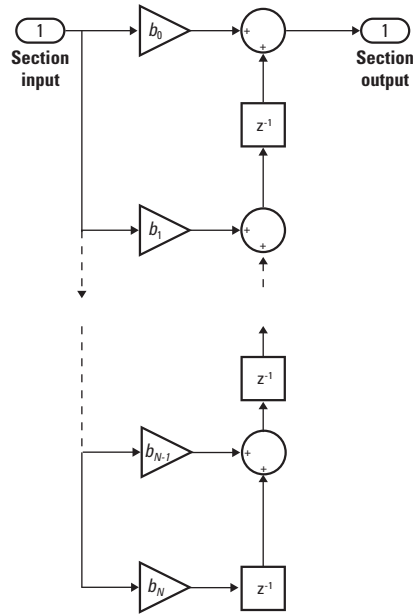


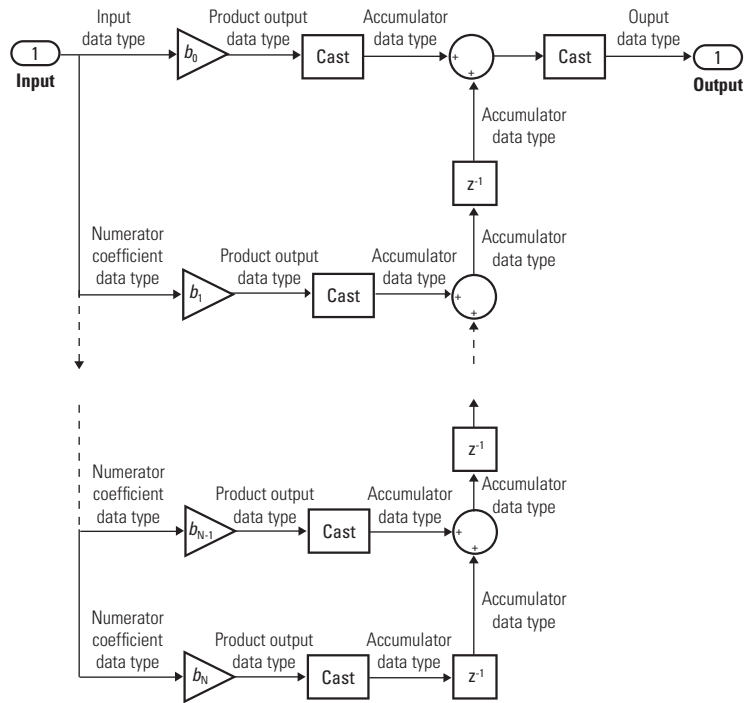
Odd Order - Type IV

# Discrete FIR Filter

## Direct Form Transposed

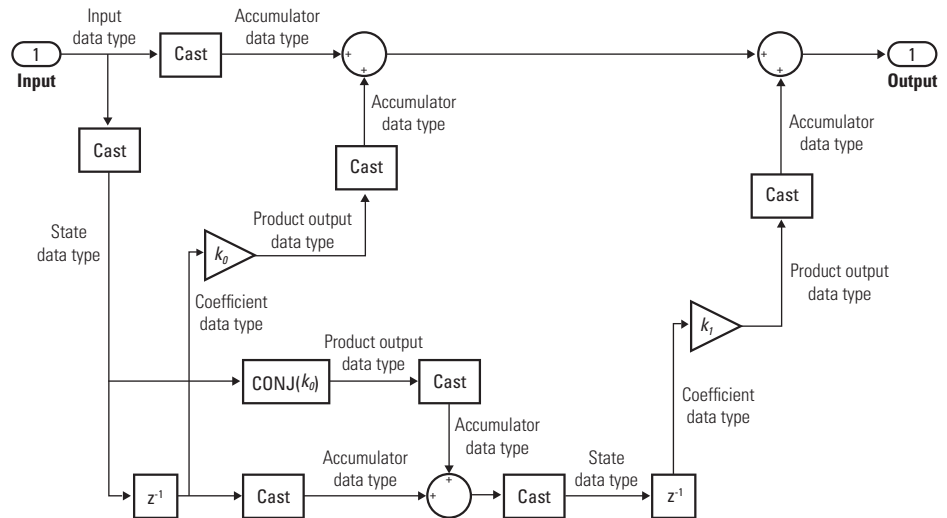
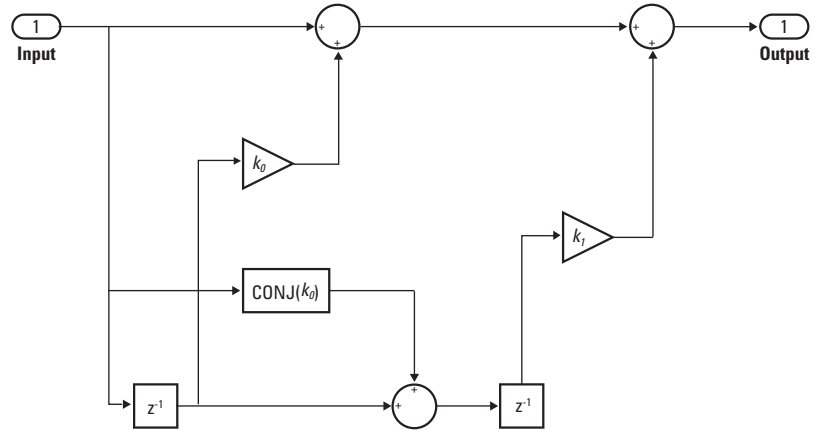
States are complex when either the inputs or the coefficients are complex.





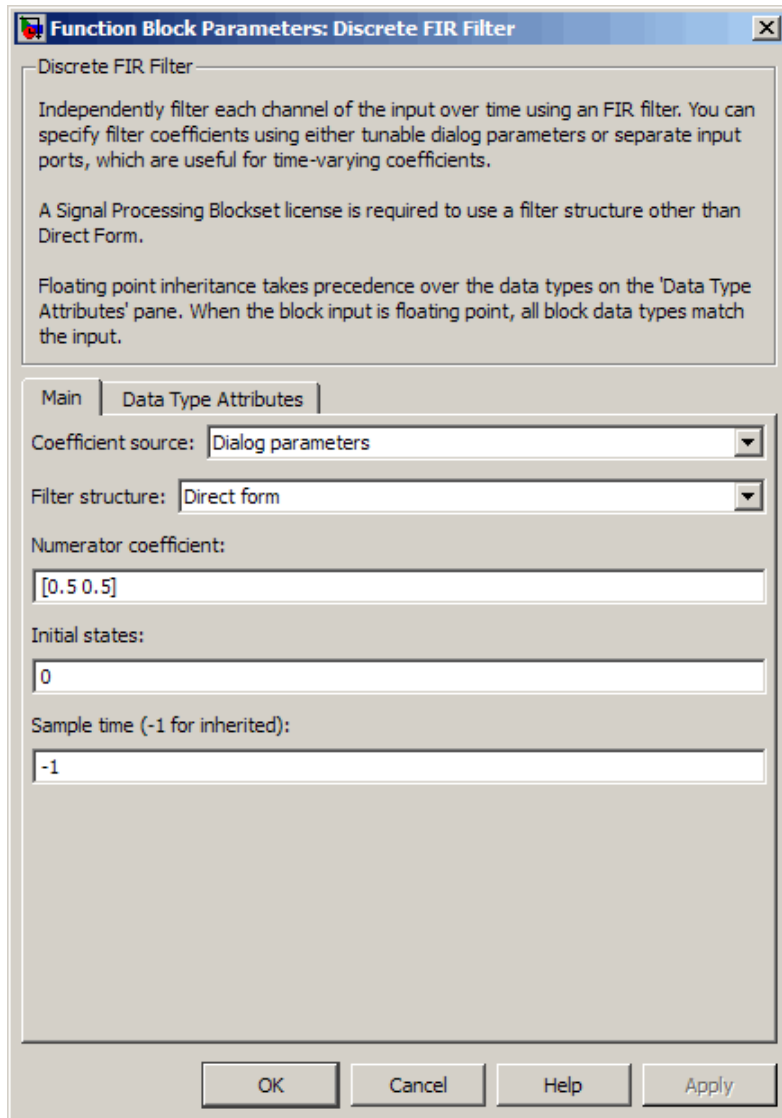
# Discrete FIR Filter

## Lattice MA



## Parameters and Dialog Box

The **Main** pane of the Discrete FIR Filter block dialog box appears as follows.



# Discrete FIR Filter

---

## **Coefficient source**

Specify whether you want to input the filter coefficients on the block mask or inherit them from an input port.

## **Filter structure**

Select the filter structure you want the block to implement. You must have an available Signal Processing Blockset software license to run a model with a Discrete FIR Filter block that implements any filter structure other than direct form.

## **Numerator coefficient**

Specify the vector of numerator coefficients of the filter's transfer function.

This parameter is only visible when `Dialog parameters` is selected for the **Coefficient source** parameter.

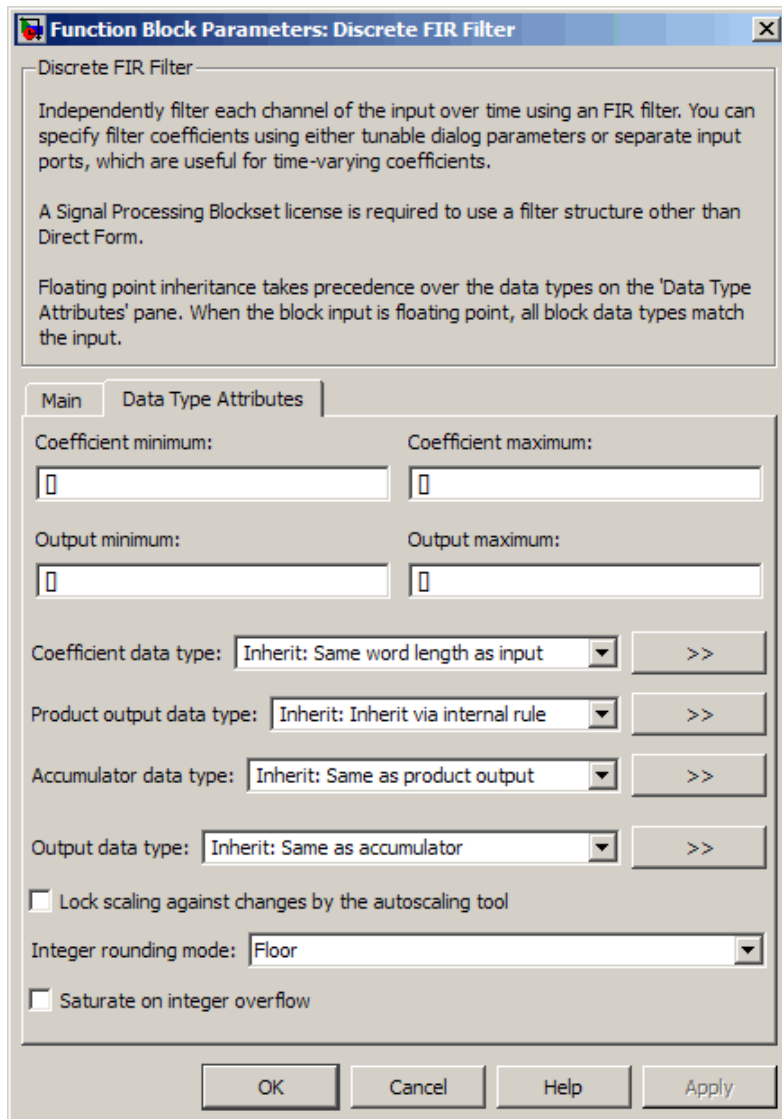
## **Initial states**

Specify the initial conditions of the filter states. To learn how to specify initial states, see "Specifying Initial States" on page 2-293.

## **Sample time (-1 for inherited)**

Specify the time interval between samples. To inherit the sample time, set this parameter to -1. See "How to Specify the Sample Time" in "How Simulink Works" in the *Simulink User's Guide*.

The **Data Type Attributes** pane of the Discrete FIR Filter block dialog box appears as follows.



## **Coefficient minimum**

Specify the minimum value that a filter coefficient should have. The default value, [ ], is equivalent to  $-\text{Inf}$ . Simulink software uses this value to perform:

- Parameter range checking (see “Checking Parameter Values”)
- Automatic scaling of fixed-point data types

## **Coefficient maximum**

Specify the maximum value that a filter coefficient should have. The default value, [ ], is equivalent to  $\text{Inf}$ . Simulink software uses this value to perform:

- Parameter range checking (see “Checking Parameter Values”)
- Automatic scaling of fixed-point data types

## **Output minimum**

Specify the minimum value that the block should output. The default value, [ ], is equivalent to  $-\text{Inf}$ . Simulink software uses this value to perform:

- Simulation range checking (see “Checking Signal Ranges”)
- Automatic scaling of fixed-point data types

## **Output maximum**

Specify the maximum value that the block should output. The default value, [ ], is equivalent to  $\text{Inf}$ . Simulink software uses this value to perform:

- Simulation range checking (see “Checking Signal Ranges”)
- Automatic scaling of fixed-point data types


## **Tap sum data type**

Specify the tap sum data type of a direct form symmetric or direct form antisymmetric filter, which is the data type the filter uses when it sums the inputs prior to multiplication by the coefficients. You can set it to:



- A rule that inherits a data type, for example, `Inherit: Same as input`
- A built-in integer, for example, `int8`
- A data type object, for example, a `Simulink.NumericType` object
- An expression that evaluates to a data type, for example, `fixdt(1,16,0)`

This parameter is only visible when the selected filter structure is either `Direct form symmetric` or `Direct form antisymmetric`.


Click the **Show data type assistant** button  to display the **Data Type Assistant**, which helps you set the **Tap sum data type** parameter.

See “Using the Data Type Assistant” in *Simulink User’s Guide* for more information.

## Coefficient data type

Specify the coefficient data type. You can set it to:

- A rule that inherits a data type, for example, `Inherit: Same word length as input`
- A built-in integer, for example, `int8`
- A data type object, for example, a `Simulink.NumericType` object
- An expression that evaluates to a data type, for example, `fixdt(1,16,0)`

Click the **Show data type assistant** button  to display the **Data Type Assistant**, which helps you set the **Coefficient data type** parameter.

# Discrete FIR Filter


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See “Using the Data Type Assistant” in *Simulink User’s Guide* for more information.

## Product output data type

Specify the product output data type. You can set it to:

- A rule that inherits a data type, for example, `Inherit: Inherit via internal rule`
- A built-in data type, for example, `int8`
- A data type object, for example, a `Simulink.NumericType` object
- An expression that evaluates to a data type, for example, `fixdt(1,16,0)`


Click the **Show data type assistant** button  to display the **Data Type Assistant**, which helps you set the **Product output data type** parameter.

See “Using the Data Type Assistant” in *Simulink User’s Guide* for more information.

## Accumulator data type

Specify the accumulator data type. You can set it to:

- A rule that inherits a data type, for example, `Inherit: Same as product output`
- A built-in data type, for example, `int8`
- A data type object, for example, a `Simulink.NumericType` object
- An expression that evaluates to a data type, for example, `fixdt(1,16,0)`

Click the **Show data type assistant** button  to display the **Data Type Assistant**, which helps you set the **Accumulator data type** parameter.

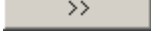
See “Using the Data Type Assistant” in *Simulink User’s Guide* for more information.

## State data type

Specify the state data type. You can set it to:

- A rule that inherits a data type, for example, `Inherit: Same as accumulator`
- A built-in integer, for example, `int8`
- A data type object, for example, a `Simulink.NumericType` object
- An expression that evaluates to a data type, for example, `fixdt(1,16,0)`

This parameter is only visible when the selected filter structure is Lattice MA.

Click the **Show data type assistant** button  to display the **Data Type Assistant**, which helps you set the **State data type** parameter.

See “Using the Data Type Assistant” in *Simulink User’s Guide* for more information.

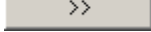
## Output data type

Specify the output data type. You can set it to:

- A rule that inherits a data type, for example, `Inherit: Same as accumulator`
- A built-in data type, for example, `int8`
- A data type object, for example, a `Simulink.NumericType` object
- An expression that evaluates to a data type, for example, `fixdt(1,16,0)`

# Discrete FIR Filter

---

Click the **Show data type assistant** button  to display the **Data Type Assistant**, which helps you set the **Output data type** parameter.

See “Specifying Block Output Data Types” in *Simulink User’s Guide* for more information.

## **Lock output scaling against changes by the autoscaling tool**

Select to lock scaling of outputs.

## **Integer rounding mode**

Select the rounding mode for fixed-point operations. For more information, see “Rounding” in the *Simulink Fixed Point User’s Guide*.

## **Saturate on integer overflow**

Select to have overflows saturate. Otherwise, they wrap.

When you select this check box, saturation applies to every internal operation on the block, not just the output or result. In general, the code generation process can detect when overflow is not possible, in which case, no saturation code is generated.

## **Characteristics**

Direct Feedthrough	Yes
Sample Time	Specified in the <b>Sample time</b> parameter
Scalar Expansion	Yes, of initial states
States	See “Specifying Initial States” on page 2-293
Dimensionalized	Yes
Zero Crossing	No

**Purpose** Implement discrete state-space system

**Library** Discrete

**Description** The Discrete State-Space block implements the system described by

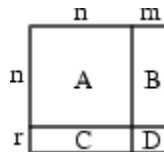
$$\begin{matrix} \rightarrow & \begin{matrix} y(n)=Cx(n)+Du(n) \\ x(n+1)=Ax(n)+Bu(n) \end{matrix} & \rightarrow \end{matrix}$$

$$x(n+1) = Ax(n) + Bu(n)$$

$$y(n) = Cx(n) + Du(n)$$

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.

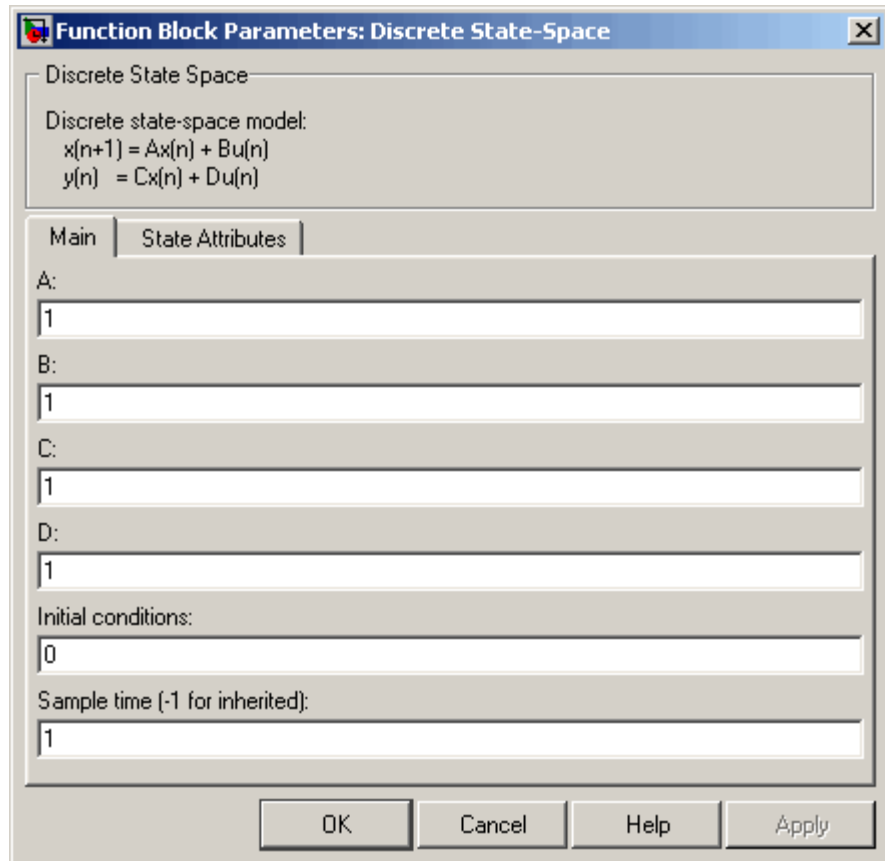
Simulink software converts a matrix containing zeros to a sparse matrix for efficient multiplication.

**Data Type Support** The Discrete State Space block accepts and outputs a real signal of type `single` or `double`.

# Discrete State-Space

## Parameters and Dialog Box

The **Main** tab of the Discrete State-Space block dialog box appears as follows:



### A, B, C, D

The matrix coefficients, as defined in the preceding equations.

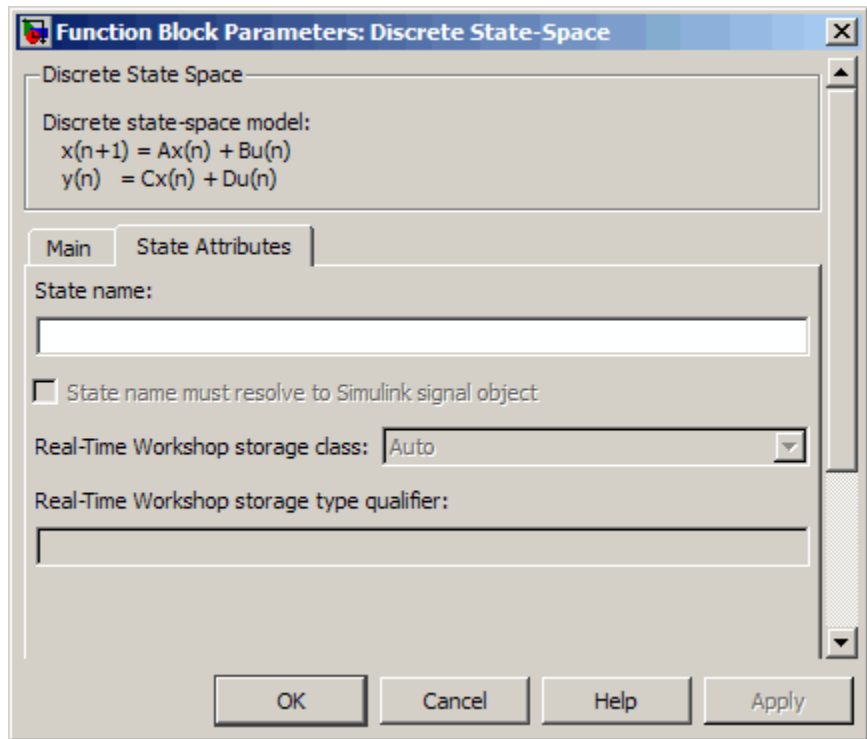
### Initial conditions

The initial state vector. The default is 0. Simulink software 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 Simulink documentation.

The **State Attributes** tab of the Discrete State-Space block dialog box appears as follows:



## State name

Use this parameter to assign a unique name to each state. The default is ' '. If left blank, no name is assigned. Consider the following when using this parameter:

# Discrete State-Space

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- To assign a name to a single state, enter the name between quotes, for example, 'velocity' .
- The state names apply only to the selected block.
- To assign names to multiple states, enter a comma-delimited list surrounded by braces. For example, {'a', 'b', 'c'} . Each name must be unique.
- The number of states must be evenly divided by the number of state names. You can have fewer names than states, but you cannot have more names than states.

For example, you can specify two names in a system with four states. Simulink assigns the first name to the first two states and the second name to the last two.

- To assign state names with a variable that has been defined in the MATLAB workspace, enter the variable without quotes. A variable can be a string, cell, or structure.

This parameter enables **State name must resolve to Simulink signal object** when you click the **Apply** button.

## **State name must resolve to Simulink signal object**

Select this check box to require that the state name resolve to the Simulink signal object. This check box is cleared by default.

This parameter is enabled by **State name**.

Selecting this check box enables **Real-Time Workshop storage class**.

## **Real-Time Workshop storage class**

From the list, select state storage class.

### **Auto**

Auto is the appropriate storage class for states that you do not need to interface to external code.



ExportedGlobal

State is stored in a global variable

ImportedExtern

*model\_private.h* declares the state as an extern variable.

ImportedExternPointer

*model\_private.h* declares the state as an extern pointer.

This parameter is enabled by **State name**.

Setting this parameter to ExportedGlobal, ImportedExtern, or ImportedExternPointer enables **Real-Time Workshop storage type qualifier**.

During simulation, the block uses the following values:

- The initial value of the signal object to which the state name is resolved
- Min and Max values of the signal object

See “Block State Storage and Interfacing” in the Real-Time Workshop User’s Guide for more information.

## Characteristics

Direct Feedthrough	Only if $D \neq 0$
Sample Time	Specified in the <b>Sample time</b> parameter
Scalar Expansion	Yes, of the initial conditions
States	Determined by the size of $A$
Dimensionalized	Yes
Zero Crossing	No

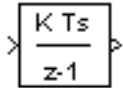
# Discrete-Time Integrator

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**Purpose** Perform discrete-time integration or accumulation of signal

**Library** Discrete

**Description** You can use the Discrete-Time Integrator block in place of the Integrator block to create a purely discrete system.



For the Discrete-Time Integrator block, you can:

- 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 software 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

$$y(n) = y(n-1) + K \cdot T \cdot u(n-1)$$

Let  $x(n+1) = x(n) + K \cdot T \cdot u(n)$ . The block uses the following steps to compute its output:

$$\begin{aligned} \text{Step 0: } \quad y(0) &= x(0) = \text{IC (clip if necessary)} \\ x(1) &= y(0) + K \cdot T \cdot u(0) \end{aligned}$$

$$\begin{aligned} \text{Step 1: } \quad y(1) &= x(1) \\ x(2) &= x(1) + K \cdot T \cdot u(1) \end{aligned}$$

$$\begin{aligned} \text{Step n: } \quad y(n) &= x(n) \\ x(n+1) &= x(n) + K \cdot T \cdot u(n) \text{ (clip if necessary)} \end{aligned}$$

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  $T \cdot z / (z-1)$ . The resulting expression for the output of the block at step  $n$  is

$$y(n) = y(n-1) + K \cdot T \cdot u(n)$$

Let  $x(n) = y(n-1)$ . The block uses the following steps to compute its output

$$\begin{aligned} \text{Step 0: } \quad y(0) &= x(0) = \text{IC (clipped if necessary)} \\ x(1) &= y(0) \end{aligned}$$

or, depending on **Use initial condition as initial and reset value for** parameter:

$$\begin{aligned} \text{Step 0: } \quad x(0) &= \text{IC (clipped if necessary)} \\ x(1) &= y(0) = x(0) + K \cdot T \cdot u(0) \end{aligned}$$

$$\begin{aligned} \text{Step 1: } \quad y(1) &= x(1) + K \cdot T \cdot u(1) \\ x(2) &= y(1) \end{aligned}$$

$$\begin{aligned} \text{Step n: } \quad y(n) &= x(n) + K \cdot T \cdot u(n) \\ x(n+1) &= y(n) \end{aligned}$$

# Discrete-Time Integrator

---

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

$$\begin{aligned} \text{Step 0: } & x(0) = \text{IC (clipped if necessary)} \\ & x(1) = y(0) + K*T/2 * u(0) \end{aligned}$$

or, depending on **Use initial condition as initial and reset value for** parameter:

$$\begin{aligned} \text{Step 0: } & y(0) = x(0) = \text{IC (clipped if necessary)} \\ & x(1) = y(0) = x(0) + K*T/2*u(0) \end{aligned}$$

$$\begin{aligned} \text{Step 1: } & y(1) = x(1) + K*T/2 * u(1) \\ & x(2) = y(1) + K*T/2 * u(1) \end{aligned}$$

$$\begin{aligned} \text{Step n: } & y(n) = x(n) + K*T/2 * u(n) \\ & x(n+1) = y(n) + K*T/2 * u(n) \end{aligned}$$

Here,  $x(n+1)$  is the best estimate of the next output. It isn't quite the state, in the sense that  $x(n) \neq y(n)$ .

If  $T$  is variable (i.e. obtained from the triggering times), the block uses the following algorithm to compute its outputs

$$\begin{aligned} \text{Step 0: } & y(0) = x(0) = \text{IC (clipped if necessary)} \\ & x(1) = y(0) \end{aligned}$$

or, depending on **Use initial condition as initial and reset value for** parameter:

$$\text{Step 0: } y(0) = x(0) = \text{IC (clipped if necessary)}$$

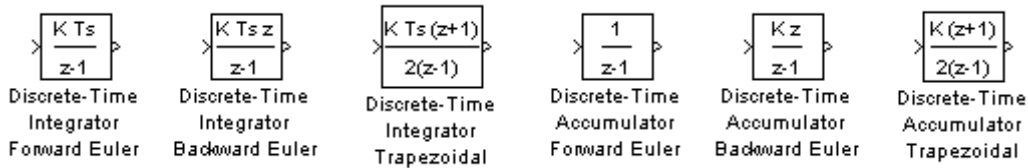
$$x(1) = y(0) = x(0) + K \cdot T / 2 \cdot u(0)$$

$$\begin{aligned} \text{Step 1: } y(1) &= x(1) + T / 2 \cdot (u(1) + u(0)) \\ x(2) &= y(1) \end{aligned}$$

$$\begin{aligned} \text{Step n: } y(n) &= x(n) + T / 2 \cdot (u(n) + u(n-1)) \\ x(n+1) &= y(n) \end{aligned}$$

With this method, input port 1 has direct feedthrough.

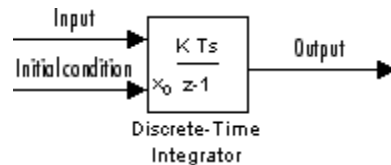
The block reflects the selected integration or accumulation method.



## 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.



# Discrete-Time Integrator

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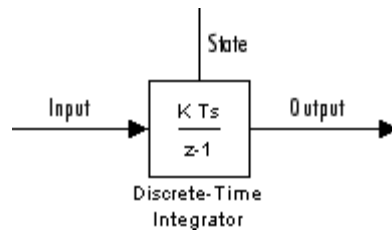
## Using the State Port

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 `sldemo_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 `sldemo_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 software 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.

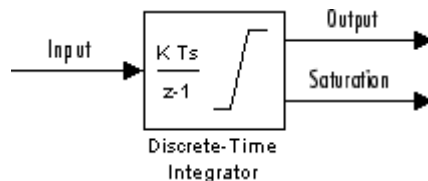


## Limiting the Integral

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** 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.



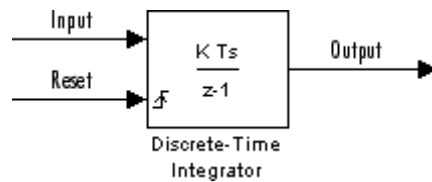
The signal has one of three values:

- 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.

# Discrete-Time Integrator



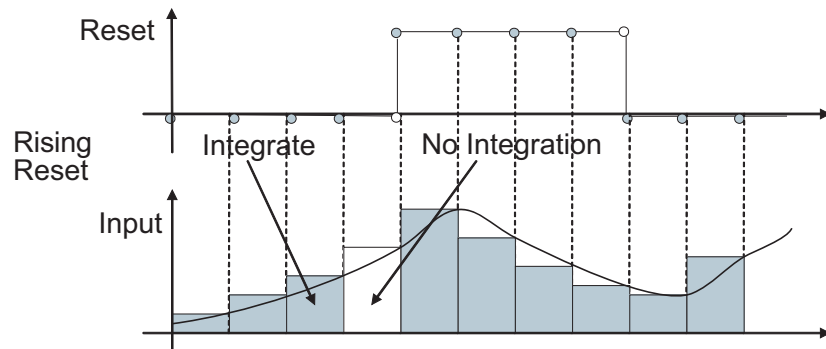
The reset port has direct feedthrough. If the block output is fed back into this port, either directly or through a series of blocks with direct feedthrough, an algebraic loop results. To resolve this loop, feed the output of the block's state port into the reset port instead. To access the block's state, 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.

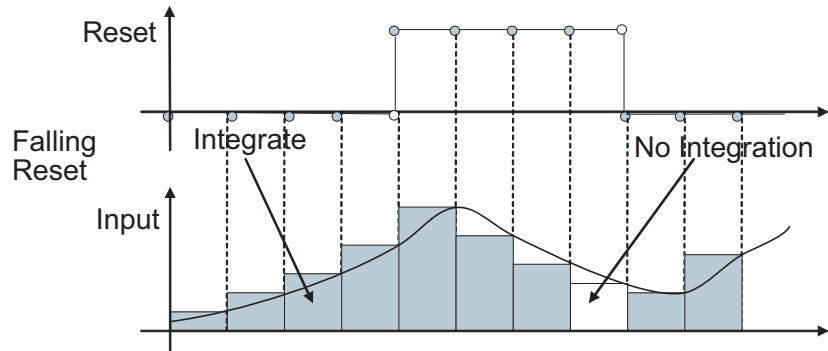


- falling



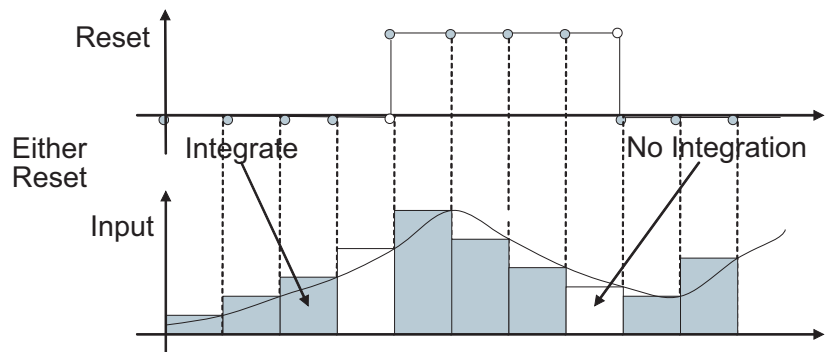
# Discrete-Time Integrator

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

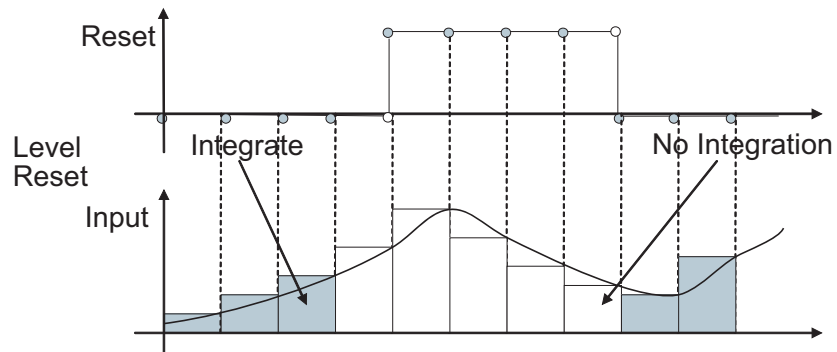
Resets the state when the reset signal rises or falls. For example, the following figure shows the effect that an either reset trigger has on backward Euler integration.



- level

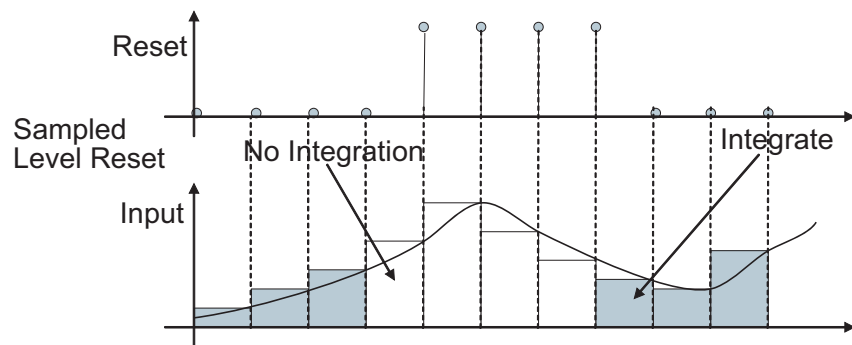
# Discrete-Time Integrator

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.



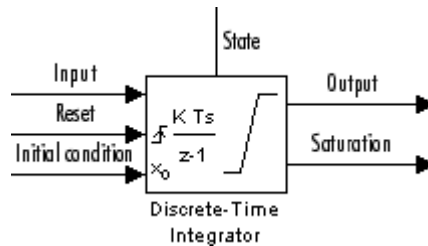
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**Note** The sampled level reset option requires fewer computations and hence is more efficient than the level reset option. However, the sampled level reset option might introduce a discontinuity when integration resumes.

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## Selecting All Options

When you select all options, the icon looks like this.



## Using Simplified Initialization Mode

If you use simplified initialization mode, the behavior of the Discrete-Time Integrator block differs from its behavior in classic initialization mode. The new initialization behavior is more robust, and provides more consistent behavior in these cases:

- In algebraic loops
- On enable and disable
- When comparing results using triggered sample time against results using explicit sample time, where the block is triggered at the same rate as the explicit sample time

In addition, the simplified initialization behavior makes it easier to convert Continuous-Time Integrator blocks to Discrete-Time Integrator blocks, since the initial conditions have the same meaning for both blocks.

# Discrete-Time Integrator

---

For more information on classic and simplified initialization modes, see “Underspecified initialization detection”.

## **Initial Conditions in Simplified Initialization Mode**

When you use simplified initialization mode, the **Initial conditions** parameter is applied only to the integrator output.

In addition, the **Use initial condition as initial and reset value for** parameter is disabled. The initial condition is always used as the initial and reset value for the output.

## **Input-Output Equations in Simplified Initialization Mode**

When you use simplified initialization mode, the block starts from first time step  $n = 0$  with initial output  $y(0) = IC$  (clipped if necessary).

For a given step  $n > 0$  with simulation time  $t(n)$ , Simulink updates output  $y(n)$  as follows:

- Forward Euler Method:

$$y(n) = y(n-1) + K*[t(n)-t(n-1)]*u(n-1)$$

- Backward Euler Method:

$$y(n) = y(n-1) + K*[t(n)-t(n-1)]*u(n)$$

- Trapezoidal Method:

$$y(n) = y(n-1) + K*[t(n)-t(n-1)]*[u(n)+u(n-1)]/2$$

Simulink automatically selects a state-space realization of these input-output equations depending on the block sample time, which can be explicit or triggered. When using explicit sample time,  $t(n) - t(n-1)$  reduces to the sample time  $T$  for all  $n > 0$ .

## **Enable and Disable Behavior in Simplified Initialization Mode**

When you use simplified initialization mode, the enable and disable behavior of the block is simplified as follows:

At disable time  $t_d$ :

$$y(t_d) = y(t_d-1)$$

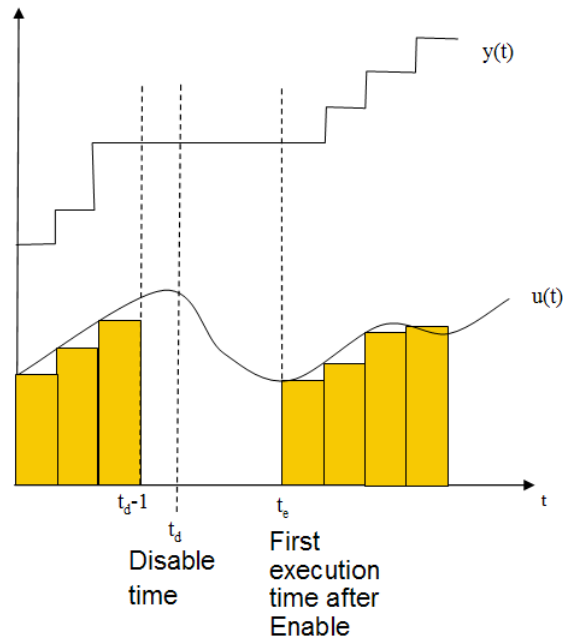
At enable time  $t_e$ :

- If parent subsystem resets on enable:

$$y(t_e) = IC$$

- In all other cases (see below):

$$y(t_e) = y(t_d)$$



## Iterator Subsystems

When using simplified initialization mode, you cannot place the Discrete-Time Integrator block within an Iterator Subsystem.

In simplified initialization mode, Iterator subsystems do not maintain elapsed time, so Simulink reports an error if any block needing elapsed

# Discrete-Time Integrator

---

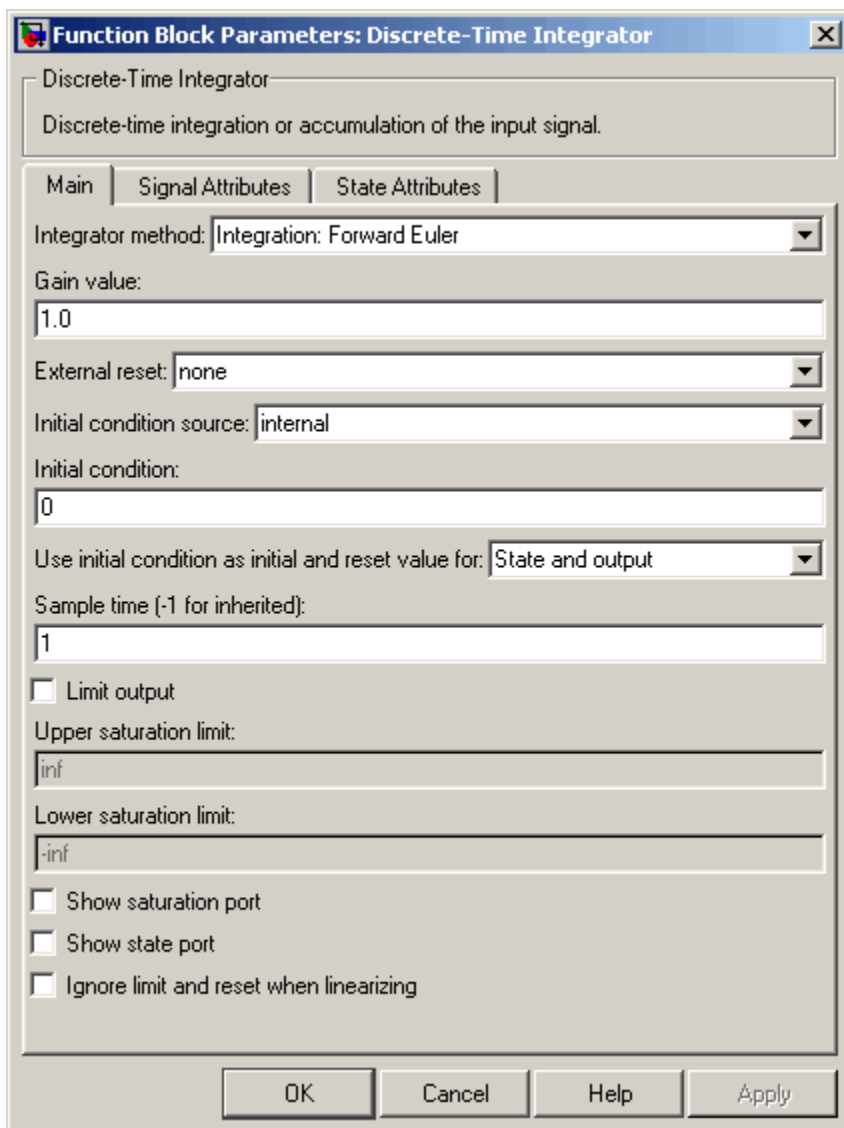
time, such as the Discrete-Time Integrator, is placed inside an Iterator Subsystem.

## **Data Type Support**

The Discrete-Time Integrator block accepts real signals of any numeric data type supported by Simulink software, including fixed-point data types.

## Parameters and Dialog Box

The **Main** pane of the Discrete-Time Integrator block dialog box appears as follows:



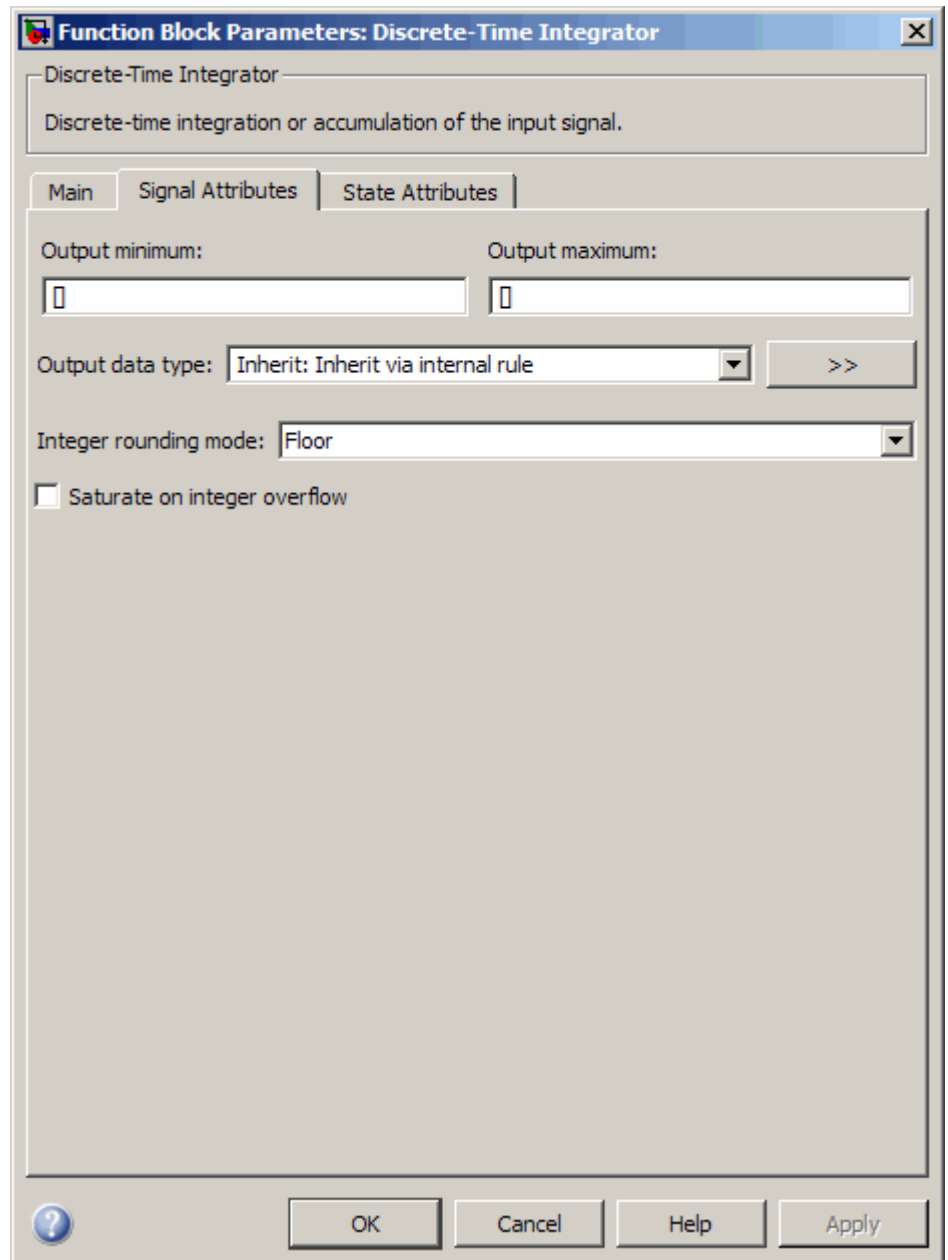
# Discrete-Time Integrator

---

The **Signal Attributes** pane of the Discrete-Time Integrator block dialog box appears as follows:



# Discrete-Time Integrator



# Discrete-Time Integrator

---

During simulation, the block uses the following values:

- The initial value of the signal object to which the state name is resolved
- Min and Max values of the signal object

See “Block State Storage and Interfacing” in the Real-Time Workshop User’s Guide for more information.

## **Show data type assistant**

Display the **Data Type Assistant**.

### **Settings**

The **Data Type Assistant** helps you set the **Output data type** parameter.

See “Specifying Block Output Data Types” in *Simulink User’s Guide* for more information.

### **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

# Discrete-Time Integrator

---

## **Integrator method**

Specify the integration or accumulation method.

### **Settings**

**Default:** Integration: Forward Euler

Integration: Forward Euler  
Integrator method is Forward Euler.

Integration: Backward Euler  
Integrator method is Backward Euler.

Integration: Trapezoidal  
Integrator method is Trapezoidal.

Accumulation: Forward Euler  
Accumulation method is Forward Euler.

Accumulation: Backward Euler  
Accumulation method is Backward Euler.

Accumulation: Trapezoidal  
Accumulation method is Trapezoidal.

### **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

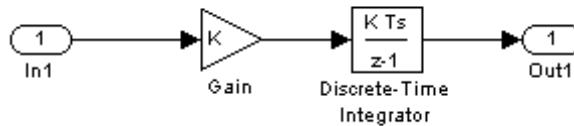
## Gain value

Specify a value by which to multiply the integrator input.

## Settings

**Default:** 1.0

- 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



- 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 software 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.

## Command-Line Information

See “Block-Specific Parameters” on page 8-96 for the command-line information.

# Discrete-Time Integrator

---

## External reset

Reset the states to their initial conditions when a trigger event occurs in the reset signal.

## Settings

**Default:** none

none

Do not reset the state to initial conditions.

rising

Reset the state when the reset signal has a rising edge.

falling

Reset the state when the reset signal has a falling edge.

either

Reset the state when the reset signal rises or falls.

level

Reset and holds the output to the initial condition while the reset signal is nonzero.

sampled level

Reset the output to the initial condition when the reset signal is nonzero.

## Command-Line Information

See “Block-Specific Parameters” on page 8-96 for the command-line information.

## Initial condition source

Get the initial conditions of the states.

### Settings

**Default:** internal

internal

Get the initial conditions of the states from the **Initial condition** parameter.

external

Get the initial conditions of the states from an external block.

### Tips

Simulink software does not allow the initial condition of this block to be inf or NaN.

### Dependencies

Selecting internal enables the **Initial condition** parameter.

Selecting external disables the **Initial condition** parameter.

### Command-Line Information

See “Block-Specific Parameters” on page 8-96 for the command-line information.

# Discrete-Time Integrator

---

## **Initial condition**

Specify the states' initial conditions.

## **Settings**

**Default:** 0

**Minimum:** value of **Output minimum** parameter

**Maximum:** value of **Output maximum** parameter

## **Tips**

Simulink software does not allow the initial condition of this block to be inf or NaN.

## **Dependencies**

This parameter is enabled by setting **Initial condition source** to internal.

This parameter is disabled by setting **Initial condition source** to external.

## **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.



## Use initial condition as initial and reset value for

Specify whether to apply the initial condition as the initial and reset value for the state and output, or the state only.

---

**Note** If you are using simplified initialization mode, this parameter is disabled. The initial condition is always used as the initial and reset value for the output. For more information, see “Underspecified initialization detection”.

---

### Settings

**Default:** State and output

State and output

Set the following for initial

$$y(0) = IC$$

$$x(0) = IC$$

or at reset

$$y(n) = IC$$

$$x(n) = IC$$

State only (most efficient)

Set the following for initial

$$x(0) = IC$$

or at reset

$$x(n) = IC$$

# Discrete-Time Integrator

---

## **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

## **Sample time (-1 for inherited)**

Enter the discrete interval between sample time hits or specify another appropriate sample time such as continuous or inherited.

### **Settings**

**Default:** -1

By default, the block inherits its sample time based upon the context of the block within the model. To set a different sample time, enter a valid sample time based upon the table in “Types of Sample Time”.

See also “How to Specify the Sample Time” in the online documentation for more information.

### **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

# Discrete-Time Integrator

---

## Limit output

Limit the block's output to a value between the **Lower saturation limit** and **Upper saturation limit** parameters.

### Settings

**Default:** Off

On

Limit the block's output to a value between the **Lower saturation limit** and **Upper saturation limit** parameters.

Off

Do not limit the block's output to a value between the **Lower saturation limit** and **Upper saturation limit** parameters.

### Dependencies

This parameter enables **Upper saturation limit**.

This parameter enables **Lower saturation limit**.

### Command-Line Information

See "Block-Specific Parameters" on page 8-96 for the command-line information.

## **Upper saturation limit**

Specify the upper limit for the integral.

### **Settings**

**Default:** inf

**Minimum:** value of **Output minimum** parameter

**Maximum:** value of **Output maximum** parameter

### **Dependencies**

This parameter is enabled by **Limit output**.

### **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

# Discrete-Time Integrator

---

## **Lower saturation limit**

Specify the lower limit for the integral.

### **Settings**

**Default:** -inf

**Minimum:** value of **Output minimum** parameter

**Maximum:** value of **Output maximum** parameter

### **Dependencies**

This parameter is enabled by **Limit output**.

### **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

## Show saturation port

Add a saturation output port to the block.

### Settings

**Default:** Off

On

Add a saturation output port to the block.

Off

Do not add a saturation output port to the block.

### Command-Line Information

See “Block-Specific Parameters” on page 8-96 for the command-line information.

# Discrete-Time Integrator

---

## Show state port

Add an output port to the block for the block's state.

### Settings

Default: Off

On

Add an output port to the block for the block's state.

Off

Do not add an output port to the block for the block's state.

### Command-Line Information

See “Block-Specific Parameters” on page 8-96 for the command-line information.



## Ignore limit and reset when linearizing

Cause Simulink linearization commands to treat this block as not resettable and as having no limits on its output, regardless of the settings of the block reset and output limitation options.

### Settings

**Default:** Off

On

Cause Simulink linearization commands to treat this block as not resettable and as having no limits on its output, regardless of the settings of the block reset and output limitation options.

Off

Do not cause Simulink linearization commands to treat this block as not resettable and as having no limits on its output, regardless of the settings of the block reset and output limitation options.

### Tips

Ignoring the limit and resetting allows you to linearize a model around an operating point. This point may cause the integrator to reset or saturate.

### Command-Line Information

See “Block-Specific Parameters” on page 8-96 for the command-line information.

# Discrete-Time Integrator

---

## Lock output scaling against changes by the autoscaling tool

Select to lock scaling of outputs.

### Settings

Default: Off



On

Lock scaling of outputs.



Off

Do not lock scaling of outputs.

### Dependencies

This parameter is enabled when you enter an expression for the **Output data type** or **Data type** parameter.

### Command-Line Information

See “Block-Specific Parameters” on page 8-96 for the command-line information.

## Integer rounding mode

Select the rounding mode for fixed-point operations.

### Settings

**Default:** Floor

#### Ceiling

Round both positive and negative numbers toward positive infinity.

#### Convergent

Round number to the nearest representable value. In the case of a tie, round to the nearest even stored value.

#### Floor

Round both positive and negative numbers toward negative infinity.

#### Nearest

Round number to the nearest representable value. In the case of a tie, round toward positive infinity.

#### Round

Round number to the nearest representable value. In the case of a tie, round positive numbers toward positive infinity and round negative numbers toward negative infinity.

#### Simplest

This option provides for an optimization of the rounding code for several blocks.

#### Zero

Round number toward zero.

## Command-Line Information

See “Block-Specific Parameters” on page 8-96 for the command-line information.

### See Also

For more information, see “Rounding” in the *Simulink Fixed Point User’s Guide*.

# Discrete-Time Integrator

---

## Saturate on integer overflow

Specify whether overflows saturate.

### Settings

**Default:** Off

On  
Overflows saturate.

Off  
Overflows do not saturate.

### Tips

- When you select this check box, saturation applies to every internal operation on the block, not just the output or result.
- In general, the code generation process can detect when overflow is not possible, in which case, no saturation code is generated.

### Command-Line Information

See “Block-Specific Parameters” on page 8-96 for the command-line information.

## State name

Use this parameter to assign a unique name to each state.

## Settings

Default: ' '

- If left blank, no name is assigned.

## Tips

- To assign a name to a single state, enter the name between quotes, for example, 'velocity' .
- The state names apply only to the selected block.
- To assign names to multiple states, enter a comma-delimited list surrounded by braces. For example, { 'a' , 'b' , 'c' } . Each name must be unique.
- The number of states must be evenly divided by the number of state names. There can be fewer names than states, but there cannot be more names than states.
- For example, you can specify two names in a system with four states. Simulink software will assign the first name to the first two states and the second name to the last two.
- To assign state names with a variable that has been defined in the MATLAB workspace, enter the variable without quotes. A variable can be a string, cell, or structure.

## Dependencies

This parameter enables **State name must resolve to Simulink signal object** when you click the **Apply** button.

## Command-Line Information

See “Block-Specific Parameters” on page 8-96 for the command-line information.

# Discrete-Time Integrator

---

## **State name must resolve to Simulink signal object**

Require that state name resolve to Simulink signal object.

### **Settings**

**Default:** Off

On

Require that state name resolve to Simulink signal object.

Off

Do not require that state name resolve to Simulink signal object.

### **Dependencies**

This parameter is enabled by **State name**.

Selecting this check box enables **Real-Time Workshop storage class**.

### **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

## Real-Time Workshop storage class

Select state storage class.

### Settings

**Default:** Auto

#### Auto

Auto is the appropriate storage class for states that you do not need to interface to external code.

#### ExportedGlobal

State is stored in a global variable

#### ImportedExtern

`model_private.h` declares the state as an extern variable.

#### ImportedExternPointer

`model_private.h` declares the state as an extern pointer.

### Dependencies

This parameter is enabled by **State name**.

Setting this parameter to `ExportedGlobal`, `ImportedExtern`, or `ImportedExternPointer` enables **Real-Time Workshop storage type qualifier**.

### Command-Line Information

See “Block-Specific Parameters” on page 8-96 for the command-line information.

### See Also

“Block State Storage Classes” in the *Real-Time Workshop User’s Guide*.

# Discrete-Time Integrator

---

## **Real-Time Workshop storage type qualifier**

Specify Real-Time storage type qualifier.

### **Settings**

**Default:** ' '

If left blank, no qualifier is assigned.

### **Dependencies**

This parameter is enabled by setting **Real-Time Workshop storage class** to ExportedGlobal, ImportedExtern, or ImportedExternPointer.

### **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.



## Output minimum

Specify the minimum value that the block should output.

### Settings

**Default:** []

The default value, [], is equivalent to  $-\text{Inf}$ .

Simulink software uses this value to perform:

- Parameter range checking (see “Checking Parameter Values”) for some blocks
- Simulation range checking (see “Checking Signal Ranges”)
- Automatic scaling of fixed-point data types

### Tip

This number must be a double scalar value.

### Command-Line Information

See “Block-Specific Parameters” on page 8-96 for the command-line information.

# Discrete-Time Integrator

---

## **Output maximum**

Specify the maximum value that the block should output.

### **Settings**

**Default:** []

The default value, [], is equivalent to Inf.

Simulink software uses this value to perform:

- Parameter range checking (see “Checking Parameter Values”) for some blocks
- Simulation range checking (see “Checking Signal Ranges”)
- Automatic scaling of fixed-point data types

### **Tip**

This number must be a double scalar value.

### **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

## Output data type

Specify the output data type.

### Settings

**Default:** Inherit: Inherit via internal rule (Discrete-Time Integrator, Gain, Product, Sum, Switch block), Inherit: Inherit from 'Constant value' (Constant block default), Inherit: Inherit via back propagation (Data Type Conversion block), Inherit: Same as input (Saturation block)

Inherit: Inherit via internal rule

This option appears for some blocks. Simulink software chooses a combination of output scaling and data type that requires the smallest amount of memory consistent with accommodating the calculated 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 software chooses the output data type without regard to hardware constraints. Otherwise, Simulink software 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 software displays an error message in the Simulation Diagnostics Viewer.

Inherit: Inherit from 'Constant value'

Use data type of **Constant value** parameter. This option appears for some blocks.

Inherit: Inherit via back propagation

A rule that inherits a data type

# Discrete-Time Integrator

---

**Inherit: Same as input**  
Use data type of sole input signal. This option appears for some blocks.

**Inherit: Same as first input**  
Use data type of first input signal. This option appears for some blocks.

**Inherit: Same as accumulator**  
Output data type same as accumulator data type. This option appears for some blocks.

**double**  
Output data type is double.

**single**  
Output data type is single.

**int8**  
Output data type is int8.

**uint8**  
Output data type is uint8.

**int16**  
Output data type is int16.

**uint16**  
Output data type is uint16.

**int32**  
Output data type is int32.

**uint32**  
Output data type is uint32.

**fixdt(1,16,0)**  
Output data type is fixed point fixdt(1,16,0).

**fixdt(1,16,2<sup>0</sup>,0)**  
Output data type is fixed point fixdt(1,16,2<sup>0</sup>,0).

<data type expression>

The name of a data type object, for example

`Simulink.NumericType`

### **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

### **See Also**

See “Specifying Block Output Data Types” in the *Simulink User’s Guide* for more information.

# Discrete-Time Integrator

---

## Mode

Select the category of data to specify

## Settings

**Default:** Inherit (Constant, Data Type Conversion, Discrete Time Integrator, Gain, Inport, Outport, Product, Saturation, Sum, Switch),  
**Built in** (Logical Operator, Relational Operator)

### Inherit

Inheritance rules for data types. Selecting **Inherit** enables a second menu/text box to the right. Below are the possible values, which can vary by block:

- Inherit from 'Constant value' (Constant block default)
- Inherit via internal rule (Discrete-Time Integrator, Gain, Product, Sum, Switch block default)
- Inherit via back propagation (Data Type Conversion block default)
- auto (Inport, Outport block default)
- Logical (see Configuration Parameters: Optimization)
- Same as first input
- Same as input (Saturation block default)
- Same as accumulator

### Built in

Built-in data types. Selecting **Built in** enables a second menu/text box to the right. Below are the possible values, which can vary by block:

- double (Constant, Data Type Conversion, Discrete-Time Integrator, Gain, Inport, Outport, Product, Saturation, Sum, Switch block default)
- single

- int8
- uint8
- int16
- uint16
- int32
- uint32
- boolean (Logical Operator, Relational Operator block default)

## Fixed point

Fixed-point data types.

## Enumerated

Enumerated data types. This option is available on some blocks. Selecting Enumerated enables a second menu/text box to the right. Below are the possible values, which can vary by block:

- <class name>

## Expression

Expressions that evaluate to data types. Selecting Expression enables a second menu/text box to the right. Below are the possible values, which can vary by block:

- <data type expression>

## Dependency

This parameter is enabled by the **Show data type assistant** button.

## Command-Line Information

See “Block-Specific Parameters” on page 8-96 for the command-line information.

## See Also

See “Using the Data Type Assistant” in the *Simulink User’s Guide*.

# Discrete-Time Integrator

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## **Signedness**

Specify whether you want the fixed-point data to be signed or unsigned.

## **Settings**

**Default:** Signed

Signed

Specify the fixed-point data to be signed.

Unsigned

Specify the fixed-point data to be unsigned.

## **Dependencies**

This parameter is enabled by selecting **Mode** > Fixed point.

## **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

## **See Also**

See “Specifying a Fixed-Point Data Type” in the *Simulink User’s Guide* for more information.



## Word length

Specify the bit size of the word that will hold the quantized integer.

### Settings

**Default:** 16

**Minimum:** 0

**Maximum:** 32

Large word sizes represent large values with greater precision than small word sizes.

### Dependencies

This parameter is enabled by selecting **Mode** > Fixed point.

### Command-Line Information

See “Block-Specific Parameters” on page 8-96 for the command-line information.

### See Also

See “Specifying a Fixed-Point Data Type” in the *Simulink User’s Guide* for more information.

# Discrete-Time Integrator

---

## Scaling

Specify the method for scaling your fixed-point data to avoid overflow conditions and minimize quantization errors.

## Settings

**Default:** Best precision (Constant), Binary point (Data Type Conversion, Discrete-Time Integrator, Gain, Inport, Outport, Product, Saturation, Sum, Switch), Integer (Logical Operator, Relational Operator)

Binary point

Specify binary point location.

Slope and bias

Enter slope and bias.

Best precision

Specify best-precision values. This option appears for some blocks.

Integer

Specify integer. This setting has the same result as specifying a binary point location and setting fraction length to 0. This option appears for some blocks.

## Dependencies

This parameter is enabled by selecting **Mode** > Fixed point.

Selecting Binary point enables:

- **Fraction length**
- **Calculate Best-Precision Scaling**

Selecting Slope and bias enables:

- **Slope**
- **Bias**
- **Calculate Best-Precision Scaling**

**Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

**See Also**

See “Specifying a Fixed-Point Data Type” in the *Simulink User’s Guide* for more information.

# Discrete-Time Integrator

---

## **Fraction length**

Specify fraction length for fixed-point data type.

## **Settings**

**Default:** 0

Binary points can be positive or negative integers.

## **Dependencies**

This parameter is enabled by selecting **Scaling** > Binary point.

## **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

## **See Also**

See “Specifying a Fixed-Point Data Type” in the *Simulink User’s Guide* for more information.

## **Slope**

Specify slope for the fixed-point data type.

## **Settings**

**Default:**  $2^0$

Specify any positive real number.

## **Dependencies**

This parameter is enabled by selecting **Scaling** > Slope and bias.

## **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

## **See Also**

See “Specifying a Fixed-Point Data Type” in the *Simulink User’s Guide* for more information.

# Discrete-Time Integrator

---

## Bias

Specify bias for the fixed-point data type.

## Settings

**Default:** 0

Specify any real number.

## Dependencies

This parameter is enabled by selecting **Scaling** > Slope and bias.

## Command-Line Information

See “Block-Specific Parameters” on page 8-96 for the command-line information.

## See Also

See “Specifying a Fixed-Point Data Type” in the *Simulink 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 <b>Sample time</b> parameter
Scalar Expansion	Yes, of parameters
States	Inherited from driving block and parameter
Dimensionalized	Yes
Zero Crossing	No

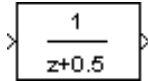
## Purpose

Implement discrete transfer function

## Library

Discrete

## Description



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.

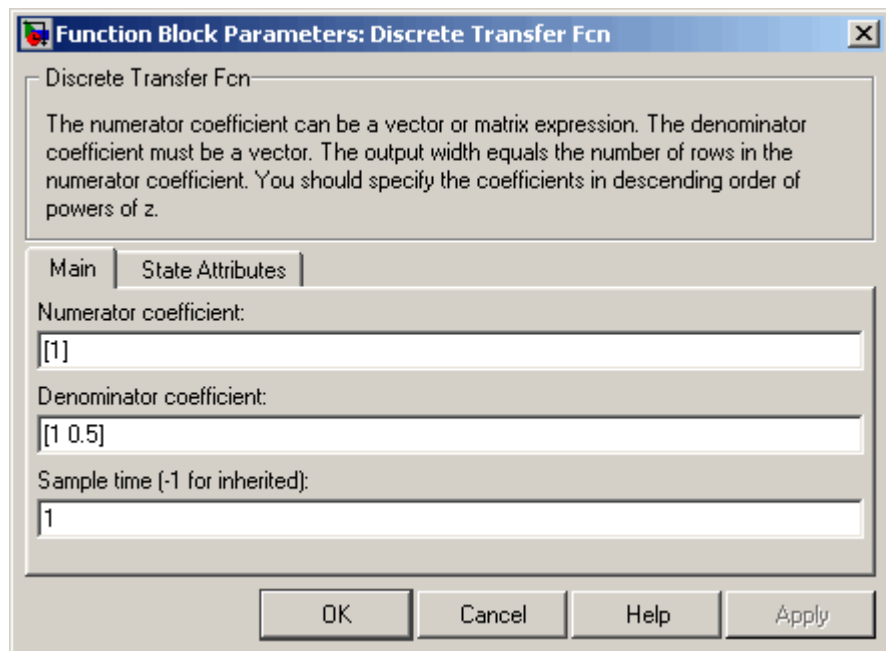
The Discrete Transfer Fcn block displays the numerator and denominator within its icon depending on how they are specified. See Transfer Fcn for more information.

## Data Type Support

The Discrete Transfer Function block accepts and outputs real signals of type `single` or `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

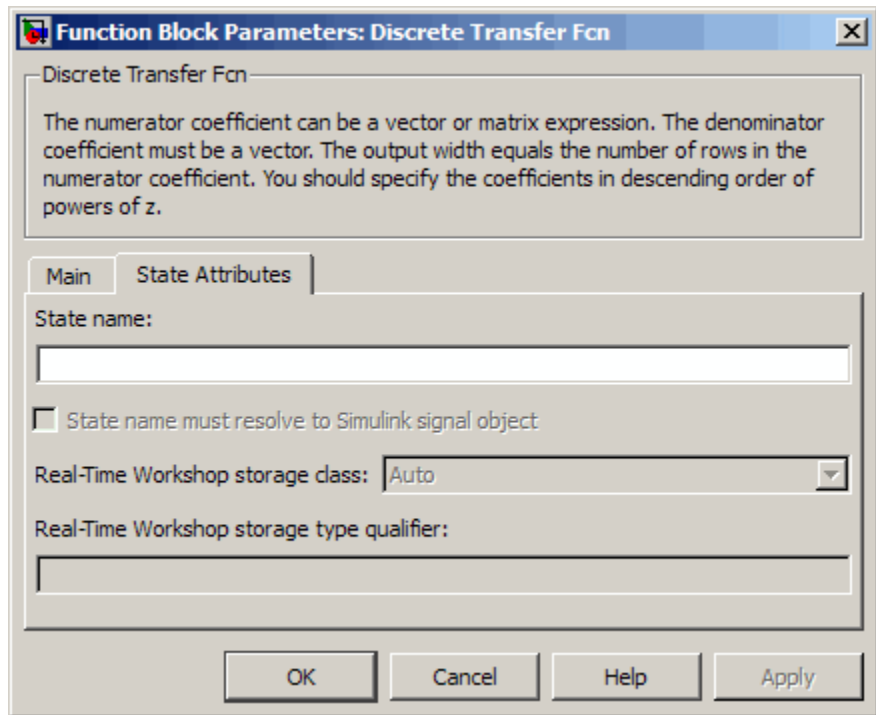
The row vector of denominator coefficients. The default is [1 0.5].

### Sample time

The time interval between samples. The default is 1. See Specifying Sample Time in the “How Simulink Works” chapter of the Simulink documentation.

The **State Attributes** pane of the Discrete Transfer Fcn block dialog box appears as follows:





## State name

Use this parameter to assign a unique name to each state. The default is ' '. If left blank, no name is assigned. Consider the following when using this parameter:

- To assign a name to a single state, enter the name between quotes, for example, 'velocity' .
- The state names apply only to the selected block.
- To assign names to multiple states, enter a comma-delimited list surrounded by braces. For example, {'a', 'b', 'c'} . Each name must be unique.

# Discrete Transfer Fcn

---

- The number of states must be evenly divided by the number of state names. There can be fewer names than states, but there cannot be more names than states.
- For example, you can specify two names in a system with four states. Simulink software will assign the first name to the first two states and the second name to the last two.
- To assign state names with a variable that has been defined in the MATLAB workspace, enter the variable without quotes. A variable can be a string, cell, or structure.

This parameter enables **State name must resolve to Simulink signal object** when you click the **Apply** button.

### **State name must resolve to Simulink signal object**

Select this checkbox to require that state name resolve to Simulink signal object. This check box is cleared by default.

This parameter is enabled by **State name**.

Selecting this check box enables **Real-Time Workshop storage class**.

### **Real-Time Workshop storage class**

From the list, select state storage class.

#### **Auto**

Auto is the appropriate storage class for states that you do not need to interface to external code.

#### **ExportedGlobal**

State is stored in a global variable

#### **ImportedExtern**

*model\_private.h* declares the state as an extern variable.

#### **ImportedExternPointer**

*model\_private.h* declares the state as an extern pointer.

This parameter is enabled by **State name**.

Setting this parameter to `ExportedGlobal`, `ImportedExtern`, or `ImportedExternPointer` enables **Real-Time Workshop storage type qualifier**.

During simulation, the block uses the following values:

- The initial value of the signal object to which the state name is resolved
- Min and Max values of the signal object

See “Block State Storage and Interfacing” in the Real-Time Workshop User’s Guide for more information.

## Characteristics

Direct Feedthrough	Only if the lengths of the <b>Numerator</b> and <b>Denominator</b> parameters are equal
Sample Time	Specified in the <b>Sample time</b> parameter
Scalar Expansion	No
States	Length of <b>Denominator</b> parameter -1
Dimensionalized	No
Zero Crossing	No

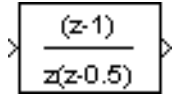
# Discrete Zero-Pole

---

**Purpose** Model system defined by zeros and poles of 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



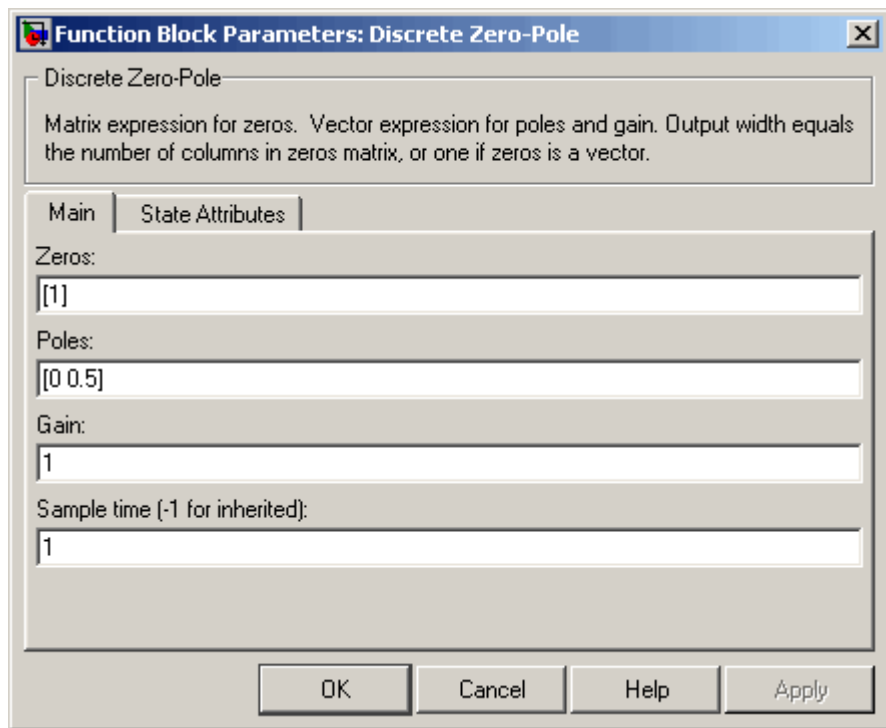
$$H(z) = K \frac{Z(z)}{P(z)} = K \frac{(z - Z_1)(z - Z_2) \dots (z - Z_m)}{(z - P_1)(z - P_2) \dots (z - P_n)}$$

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

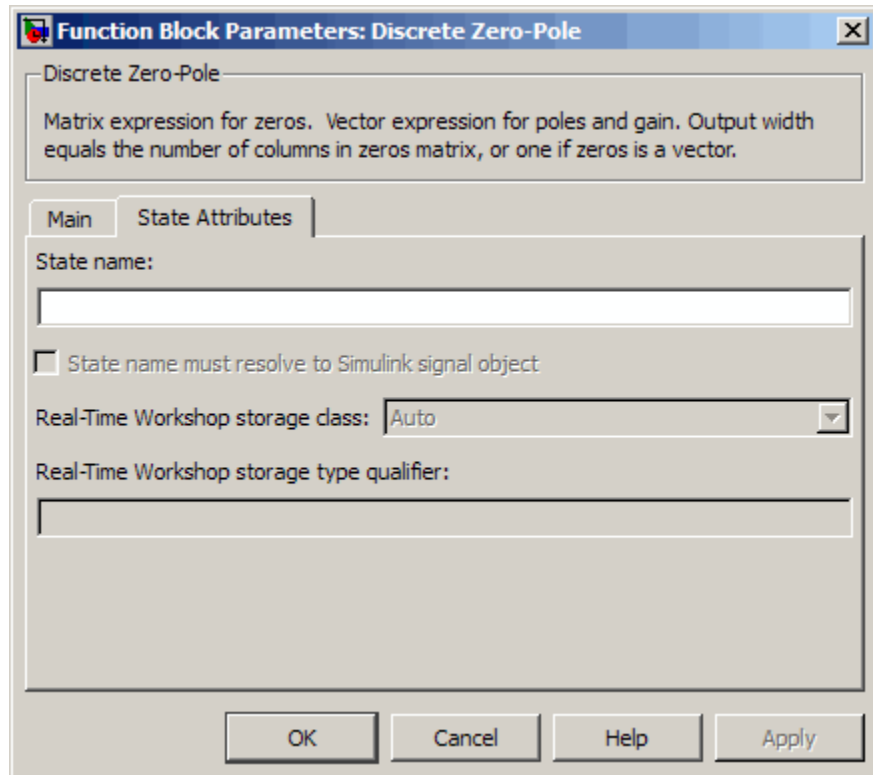
The gain. The default is 1.

### Sample time

The time interval between samples. See Specifying Sample Time in the “How Simulink Works” chapter of the Simulink documentation.

# Discrete Zero-Pole

The **State Attributes** pane of the Discrete Zero-Pole block dialog box appears as follows:



## State name

Use this parameter to assign a unique name to each state. The default is ' '. If left blank, no name is assigned. Consider the following when using this parameter:

- To assign a name to a single state, enter the name between quotes, for example, 'velocity' .
- The state names apply only to the selected block.

- To assign names to multiple states, enter a comma-delimited list surrounded by braces. For example, {'a', 'b', 'c'}. Each name must be unique.
- The number of states must be evenly divided by the number of state names. There can be fewer names than states, but there cannot be more names than states.
- For example, you can specify two names in a system with four states. Simulink software will assign the first name to the first two states and the second name to the last two.
- To assign state names with a variable that has been defined in the MATLAB workspace, enter the variable without quotes. A variable can be a string, cell, or structure.

This parameter enables **State name must resolve to Simulink signal object** when you click the **Apply** button.

### **State name must resolve to Simulink signal object**

Select this checkbox to require that state name resolve to Simulink signal object. This check box is cleared by default.

This parameter is enabled by **State name**.

Selecting this check box enables **Real-Time Workshop storage class**.

### **Real-Time Workshop storage class**

From the list, select state storage class.

#### **Auto**

Auto is the appropriate storage class for states that you do not need to interface to external code.

#### **ExportedGlobal**

State is stored in a global variable

#### **ImportedExtern**

`model_private.h` declares the state as an extern variable.

# Discrete Zero-Pole

---

ImportedExternPointer

*model\_private.h* declares the state as an extern pointer.

This parameter is enabled by **State name**.

Setting this parameter to ExportedGlobal, ImportedExtern, or ImportedExternPointer enables **Real-Time Workshop storage type qualifier**.

During simulation, the block uses the following values:

- The initial value of the signal object to which the state name is resolved
- Min and Max values of the signal object

See “Block State Storage and Interfacing” in the Real-Time Workshop User’s Guide for more information.

## Characteristics

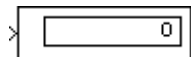
Direct Feedthrough	Yes, if the number of zeros and poles are equal
Sample Time	Specified in the <b>Sample time</b> parameter
Scalar Expansion	No
States	Length of <b>Poles</b> vector
Dimensionalized	No
Zero Crossing	No



**Purpose** Show value of 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

If the signal input to a Display block has an enumerated data type (see “Using Enumerated Data”):

- The block displays enumerated values, not the values’ underlying integers.
- Setting the **Format** to any of the `Stored Integer` settings causes an error.

# Display

The amount of data displayed and the time steps at which the data is displayed are determined by the **Decimation** block parameter and the `SampleTime` property:

- The **Decimation** parameter enables you to display data at every  $n$ th sample, where  $n$  is the decimation factor. The default decimation, 1, displays data at every time step.

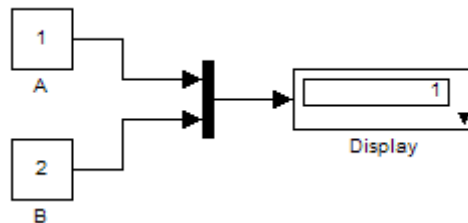
---

**Note** The Display block updates its display at the initial time, even when the **Decimation** value is greater than one.

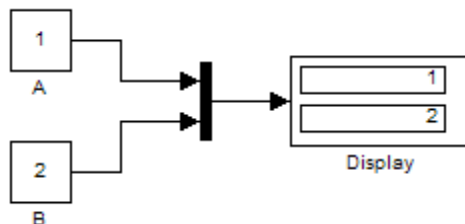
---

- The `SampleTime` property, settable with `set_param`, enables you to specify a sampling interval at which to display points. This property 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** The Display block shows only the first 200 elements of a one-dimensional (vector) signal and only the first 20 rows and 10 columns of a two-dimensional (matrix) signal.

---

## Display Abbreviations

The following abbreviations appear on the Display block to help you identify the format of the number being displayed.

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

# Display

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 your Simulink software. See “Signal storage reuse” in the “Running Simulations” chapter of the Simulink documentation.

---

**Note** The floating display does not support multidimensional signals. If you connect a multidimensional signal to a floating display, the display generates an error.

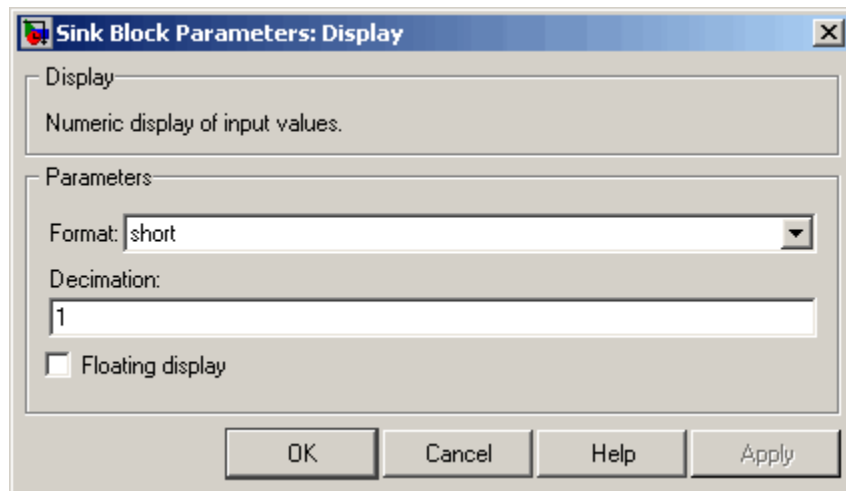
---

## Data Type Support

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

For a discussion on the data types supported by Simulink software, see “Data Types Supported by Simulink” in the “Working with Data” chapter of the 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**

SampleTime	Use <code>set_param</code> to specify the <code>SampleTime</code> property
Dimensionalized	Yes

# Divide

---

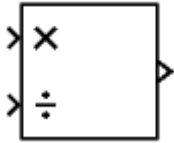
## Purpose

Divide one input by another

## Library

Math Operations

## Description



The Divide block outputs the result of dividing its first input by its second. The inputs can be scalars, a scalar and a nonscalar, or two nonscalars that have the same dimensions. The Divide block is functionally a Product block that has two block parameter values preset:

- **Multiplication:** `Element-wise(.*)`
- **Number of Inputs:** `*/`

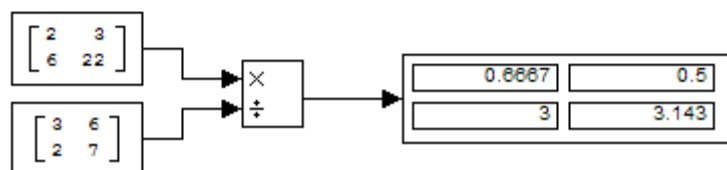
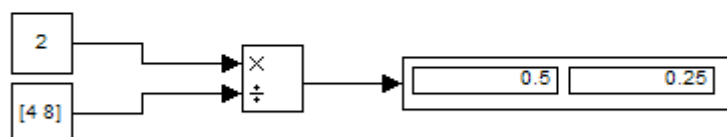
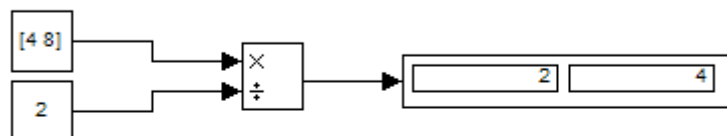
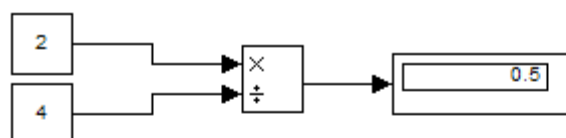
Setting non-default values for either of those parameters can change a Divide block to be functionally equivalent to a Product block or a Product of Elements block. See the documentation of those two blocks for more information.

## Parameters and Dialog Box

The Divide block has the same parameters and dialog box as the Product block. If all you need is to divide two inputs to create an output, you can use the Divide block with default parameter values. If you need additional capabilities, see the Product block documentation, which also describes the capabilities of the Divide block's "Signal Attributes Pane" on page 2-770.

## Examples

These examples show the output of the Divide block for some typical inputs using default block parameter values.



# DocBlock

---

**Purpose** Create text that documents model and save text with 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 the block creates a temporary file containing the text associated with this block and opens the file in an editor. Use the editor to modify the text and save the file. Simulink software stores the contents of the saved file in the model file.

The DocBlock supports HTML, Rich Text Format (RTF), and ASCII text document types. The default editors for these different document types are

- HTML — Microsoft® Word (if available). Otherwise, the DocBlock opens HTML documents using the editor specified on the **Editor/Debugger Preferences** pane of the Preferences dialog box.
- RTF — Microsoft Word (if available). Otherwise, the DocBlock opens RTF documents using the editor specified on the **Editor/Debugger Preferences** pane of the Preferences dialog box.
- Text — The DocBlock opens text documents using the editor specified on the **Editor/Debugger Preferences** pane of the Preferences dialog box.

Use the `docblock` command to change the default editors.

---

**Note** Simulink software embeds DocBlock documents in the model file (see Chapter 9, “Model File Format”). This can greatly increase the size of a model file, for example, if the RTF document contains bitmapped images, and can require more time to open and save the model.

---

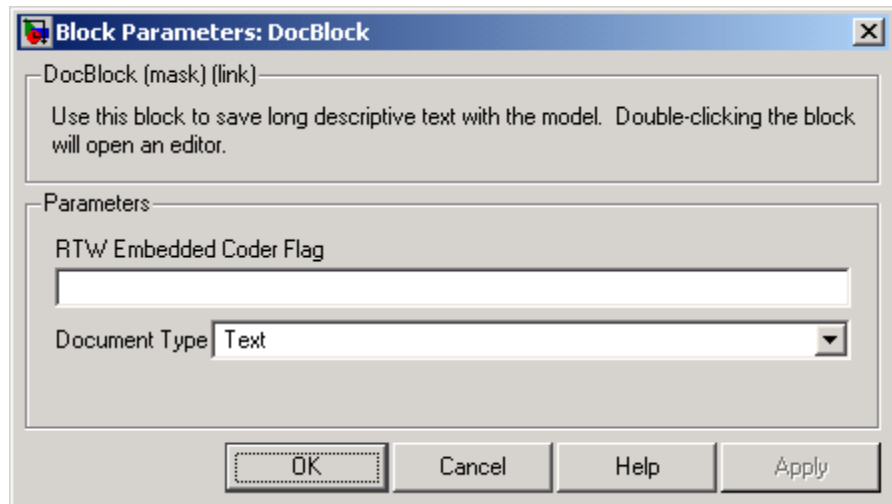
## Data Type Support

Not applicable.



## Parameters and Dialog Box

Double-clicking an instance of the DocBlock opens an 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** (Real-Time Workshop® Embedded Coder™ license required)

Enter a template symbol name in this field. Real-Time Workshop Embedded Coder software uses this symbol to add comments to the code generated from the model. See “Adding Global Comments” in the *Real-Time Workshop Embedded Coder Module Packaging Features* documentation for more information.

### Document Type

Specifies the type of document associated with the DocBlock. The options are

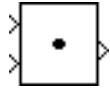
- Text (the default)
- RTF
- HTML

**Characteristics** Not applicable

**Purpose** Generate 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



$$y = \text{sum}(\text{conj}(u1) .* u2)$$

where  $u1$  and  $u2$  represent the vectors at the block's top and bottom inputs, respectively. (See "How to Rotate a Block" in the Simulink User's Guide for a description of the port order for various block orientations.) 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.

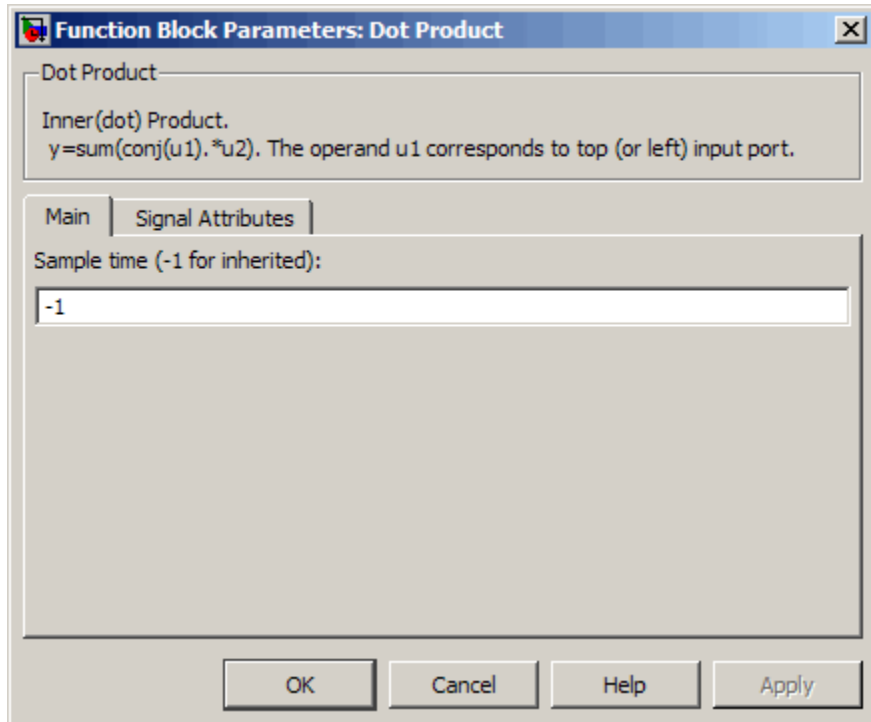
**Data Type Support** The Dot Product block accepts and outputs signals of any numeric data type supported by Simulink software, including fixed-point data types.

For a discussion on the data types supported by Simulink software, see "Data Types Supported by Simulink".

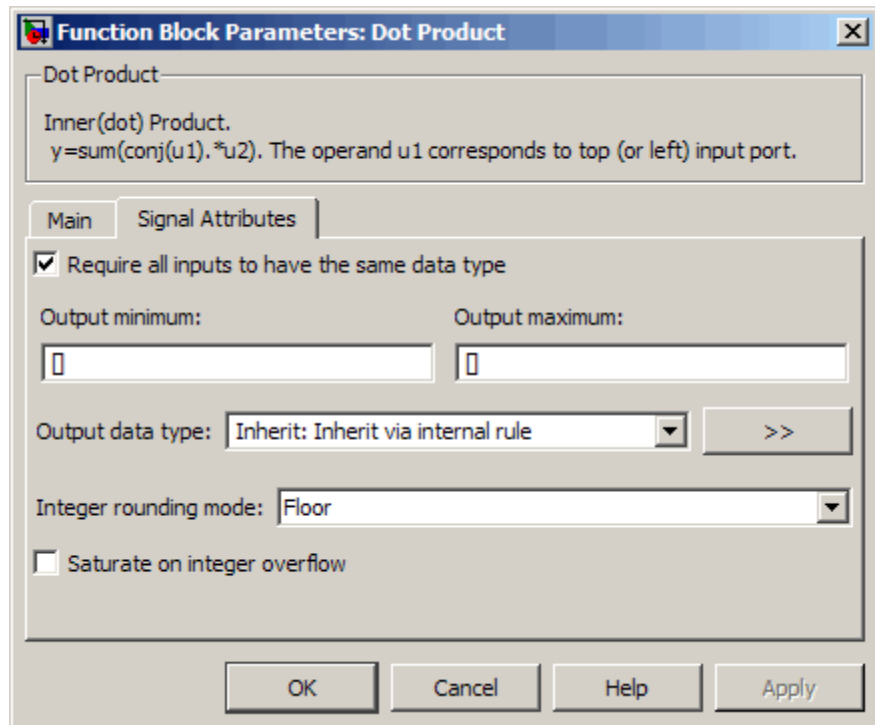
# Dot Product

## Parameters and Dialog Box

The **Main** pane of the Dot Product block dialog box appears as follows:



The **Signal Attributes** pane of the Dot Product block dialog box appears as follows:



### **Sample time (-1 for inherited)**

Specify the time interval between samples. To inherit the sample time, set this parameter to -1. See “How to Specify the Sample Time” in the Simulink User’s Guide for more information.

### **Require all inputs to have same data type**

Select to require all inputs to have the same data type.

### **Output minimum**

Specify the minimum value that the block should output. The default value, [], is equivalent to -Inf. Simulink software uses this value to perform:

- Simulation range checking (see “Checking Signal Ranges”)

- Automatic scaling of fixed-point data types

## Output maximum

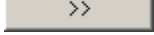
Specify the maximum value that the block should output. The default value, [], is equivalent to `Inf`. Simulink software uses this value to perform:

- Simulation range checking (see “Checking Signal Ranges”)
- Automatic scaling of fixed-point data types

## Output data type

Specify the output data type. You can set it to:

- A rule that inherits a data type, for example, `Inherit: Inherit via back propagation`
- The name of a built-in data type, for example, `single`
- The name of a data type object, for example, a `Simulink.NumericType` object
- An expression that evaluates to a data type, for example, `fixdt(1,16,0)`

Click the **Show data type assistant** button  to display the **Data Type Assistant**, which helps you set the **Output data type** parameter.

See “Specifying Block Output Data Types” in *Simulink User’s Guide* for more information.

## Lock output scaling against changes by the autoscaling tool

Select to lock scaling of outputs. This parameter is visible only if you enter an expression for the **Output data type** parameter.

## Integer rounding mode

Select the rounding mode for fixed-point operations. For more information, see “Rounding” in the *Simulink Fixed Point User’s Guide*.

## Saturate on integer overflow

Select to have overflows saturate.

When you select this check box, saturation applies to every internal operation on the block, not just the output or result. In general, the code generation process can detect when overflow is not possible, in which case, no saturation code is generated

## Characteristics

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

# Embedded MATLAB Function

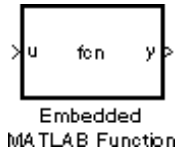
## Purpose

Include MATLAB code in models that generate embeddable C code

## Library

User-Defined Functions

## Description



An Embedded MATLAB™ Function block lets you compose a MATLAB function within a Simulink model like the following example:

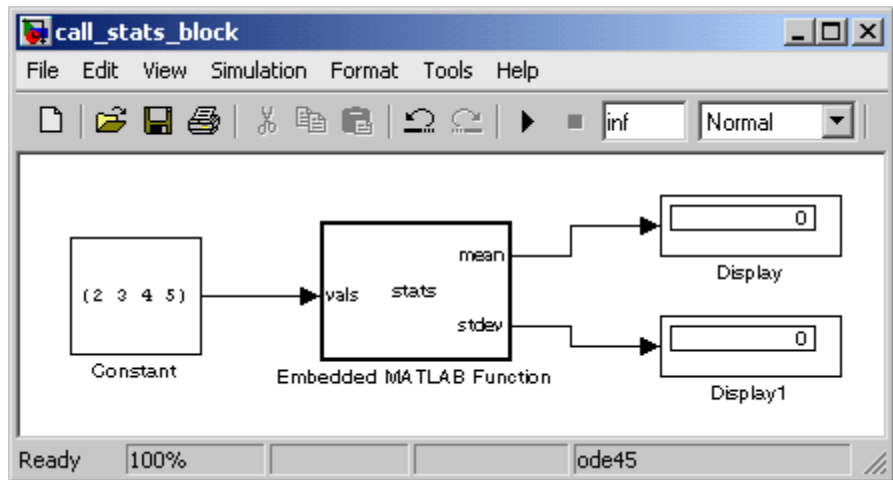
```
1 function [mean, stdev] = stats(vals)
2
3 % calculates a statistical mean and a standard
4 % deviation for the values in vals.
5
6 - eml.extrinsic('plot');
7
8 - len = length(vals);
9 - mean = avg(vals, len);
10 - stdev = sqrt(sum((vals-avg(vals, len)).^2)/len);
11 - plot(vals, '-+');
12
13 function mean = avg(array, size)
14 - mean = sum(array)/size;
```

The MATLAB function you create executes for simulation and generates code for a Real-Time Workshop target. If you are new to the Simulink and MATLAB products, see “Using the Embedded MATLAB Function Block” in the 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 “Embedded MATLAB Function 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 the Simulink model.





The Embedded MATLAB Function block supports a subset of the language for which it can generate efficient embeddable code. For details about the Embedded MATLAB subset, see “Working with the Embedded MATLAB Subset” in the Embedded MATLAB documentation.

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 “Using Matrix Indexing Operations” and “Working with Complex Numbers” in the Embedded MATLAB documentation.

# Embedded MATLAB Function

---

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 Function Library Reference” in the Embedded MATLAB documentation. 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 Function Library — Categorical List” in the Embedded MATLAB documentation for a complete list of function categories.

---

**Note** Although Embedded MATLAB software attempts to produce exactly the same results as MATLAB software, 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 the Embedded MATLAB 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 Arguments”, “Sizing Function Arguments”, 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 functions.

## Data Type Support

The Embedded MATLAB Function block accepts inputs of any type supported by Simulink software, except enumerated types. For a discussion on the variable types supported by Embedded MATLAB functions in Simulink software, refer to “Data Types Supported by Simulink” in the Simulink documentation.

For more information on fixed-point support in Embedded MATLAB, refer to “Working with the Fixed-Point Embedded MATLAB Subset” in the Fixed-Point Toolbox™ documentation.

The Embedded MATLAB Function block supports Simulink frames. See “Frame-Based Signals” in the Signal Processing Blockset documentation for more information.

## 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, Nonvirtual Subsystem, CodeReuse Subsystem blocks for an identification of each field.

## Characteristics

Direct Feedthrough	Yes
Sample Time	Specified in the <b>Sample time</b> parameter
Scalar Expansion	Yes
Dimensionalized	Yes

## Embedded MATLAB Function

---

Multidimensionalized	Yes
Zero Crossing	No

**Purpose** Add enabling port to 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 software 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.

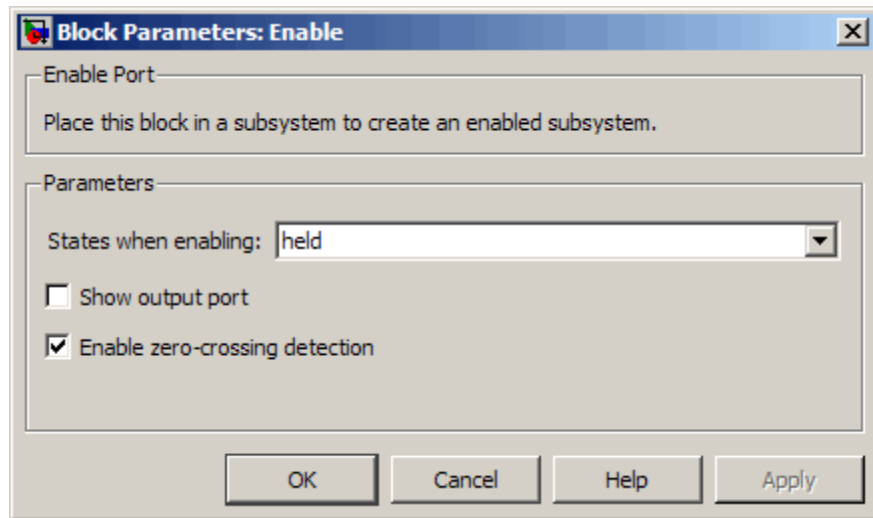
## Data Type Support

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 numeric data type supported by Simulink software, including fixed-point data types.

For a discussion on the data types supported by Simulink software, see “Data Types Supported by Simulink” in the “Working with Data” chapter of the 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 software 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 “How Blocks Work with Zero-Crossing Detection” in the “How Simulink Works” chapter of the Simulink documentation.

## Characteristics

Sample Time	Determined by the signal at the enable port
Dimensionalized	Yes
Zero-Crossing Detection	Yes, if enabled.

# Enabled and Triggered Subsystem

---

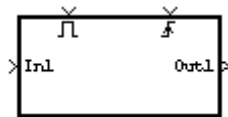
## Purpose

Represent 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

---

<b>Purpose</b>	Represent subsystem whose execution is enabled by external input
<b>Library</b>	Ports & Subsystems
<b>Description</b>	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 Simulink documentation.



**Purpose** Create branches of 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. The table below describes various scenarios where either the Sim or RTW port applies.

Scenario	Output
Normal mode simulation	Sim
Accelerator mode simulation	Sim
Rapid Accelerator mode simulation	RTW
Simulation of a referenced model (Normal or Accelerator modes)	Sim
Simulation of a referenced model (Processor-in-the-loop (PIL) mode)	RTW (uses the same code generated for a referenced model)
External mode simulation	RTW
Standard code generation	RTW
Code generation of a referenced model	RTW

Real-Time Workshop software does not generate code for blocks connected to the Sim port if these conditions hold:

- You select the **Inline parameters** check box on the **Optimization** pane of the Configuration Parameters dialog box.

# Environment Controller

---

- The blocks connected to the Sim port do not have external signals.

If you enable block reduction optimization, Simulink software eliminates blocks in the branch connected to the block's RTW port when compiling the model for simulation. For information about block reduction, see "Block reduction" in the online Simulink documentation.

---

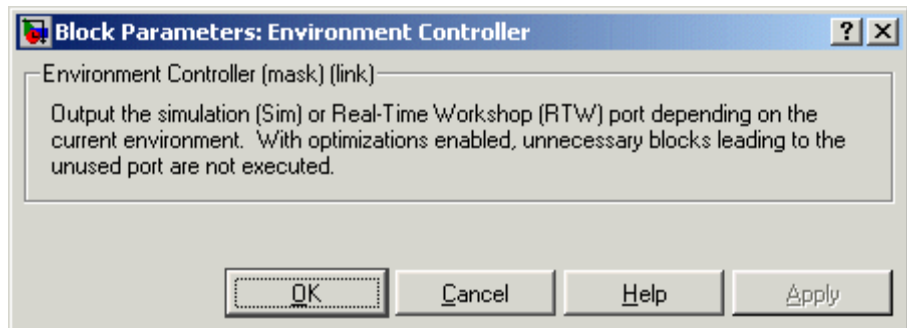
**Note** Real-Time Workshop code generation eliminates the blocks connected to the Sim branch only if the Sim branch has the same signal dimensions as the RTW branch. Regardless of whether it eliminates the Sim branch, Real-Time Workshop uses the sample times on the Sim branch as well as the RTW branch 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 Support

The Environment Controller block accepts signals of any data type supported by Simulink software. It outputs the type at its input.

## Parameters and Dialog Box



## Characteristics

Multidimensionalized	Yes
----------------------	-----

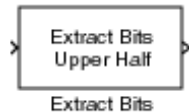
## Purpose

Output selection of contiguous bits from 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. Use the **Bits to extract** parameter to define the method for selecting the output 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.

# Extract Bits

## Data Type Support

The Extract Bits block accepts inputs of any numeric data type supported by Simulink software, including fixed-point data types. Floating-point inputs are passed through the block unchanged. Boolean inputs are treated as uint8 signals.

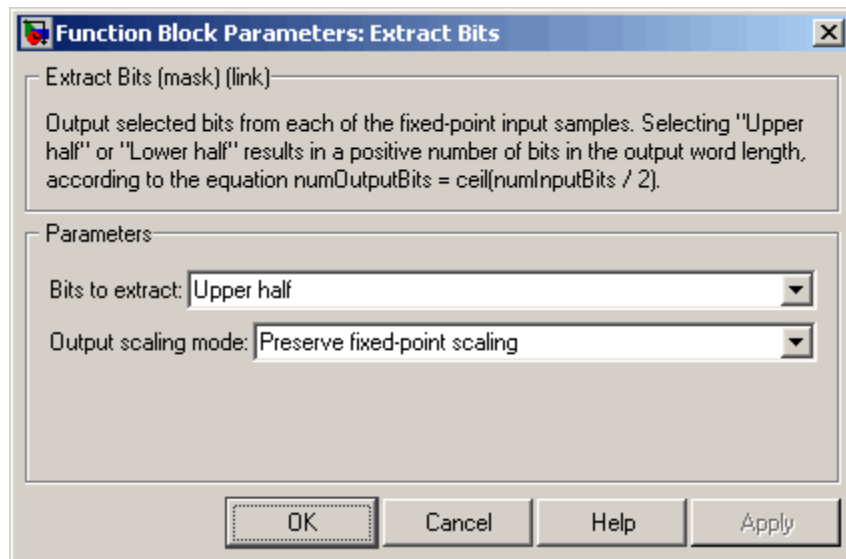
---

**Note** Performing bit operations on a signed integer is difficult. You can avoid difficulty by converting the data type of your input signals to unsigned integer types.

---

For a discussion on the data types supported by Simulink software, see “Data Types Supported by Simulink” in the Simulink documentation.

## Parameters and Dialog Box



### Bits to extract

Select the method for extracting bits from the input signal.

## Number of bits

(Not shown on dialog above.) Select the number of bits to output from the input signal. Signed integer data types can have no less than two bits in them. Unsigned data integer types can be as short as a single bit.

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.

## 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.

## Extract Bits

---

- 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

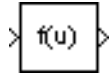
Direct Feedthrough	Yes
Sample Time	Inherited
Scalar Expansion	N/A
States	None
Dimensionalized	Inherited
Multidimensionalized	Yes
Zero Crossing	No

**Purpose**

Apply specified expression to input

**Library**

User-Defined Functions

**Description**

The Fcn block applies the specified mathematical 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  $i$ th 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.

---

**Note** The Fcn block does not support round and fix. Use the Rounding Function block to apply these rounding modes.

---

- 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).

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 (:).

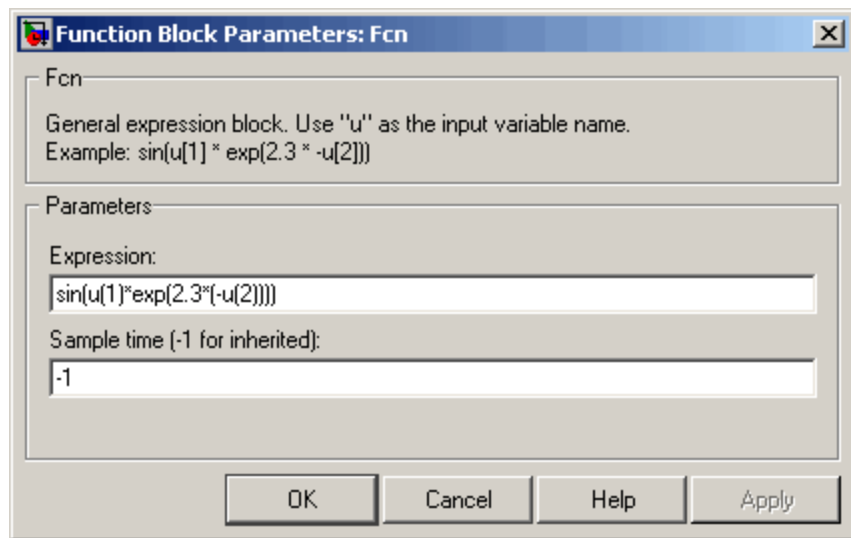
Block input can be a scalar or vector. The output is always a scalar. For vector output, consider using the Math Function block. If a block input is a vector and the function operates on input elements individually (for example, the sin function), the block operates on only the first vector element.

## Data Type Support

The Fcn block accepts and outputs signals of type `single` or `double`.



## Parameters and Dialog Box



### Expression

The mathematical 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.).

---

**Note** You cannot tune the expression during accelerated-mode simulation (see “Accelerating Models”), in referenced models executing in Accelerator mode (see “Referencing a Model”, or in generated code.

The Fcn block does not support custom storage classes. See “Using Custom Storage Classes”.

---

## Sample time (-1 for inherited)

Specify the time interval between samples. To inherit the sample time, set this parameter to -1. See “How to Specify the Sample Time” in the online documentation for more information.

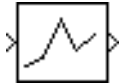
## Characteristics

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

**Purpose** Implement first-order sample-and-hold

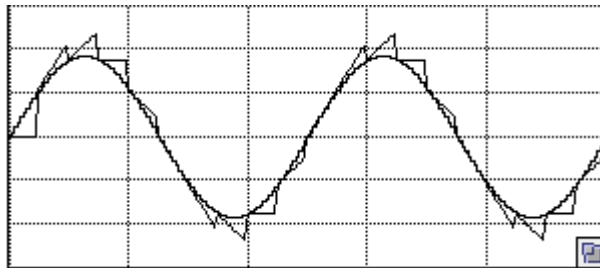
**Library** Discrete

**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.

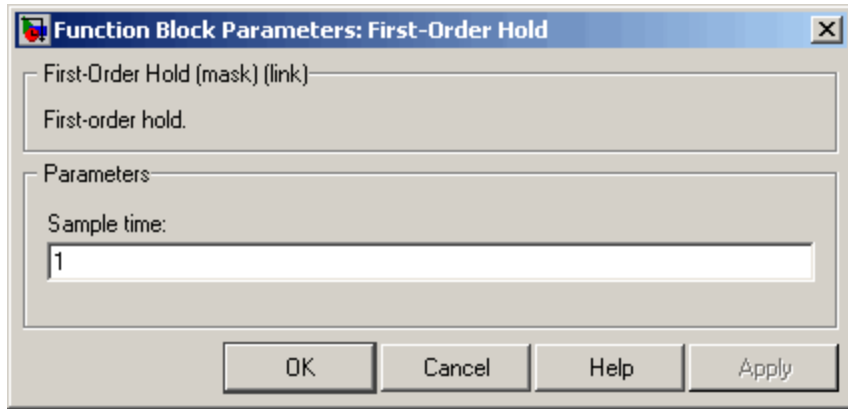


**Data Type Support**

The First-Order Hold block accepts and outputs signals of type double.

# First-Order Hold

## Parameters and Dialog Box



### Sample time

The time interval between samples. See “How to Specify the Sample Time” in the online documentation for more information.

## Characteristics

Direct Feedthrough	No
Sample Time	Specified in the <b>Sample time</b> parameter
Scalar Expansion	No
States	1 continuous and 1 discrete per input element
Dimensionalized	Yes
Zero Crossing	No

## Purpose

Implement discrete-time state space

## Library

Additional Math & Discrete / Additional Discrete

## Description

The Fixed-Point State-Space block implements the system described by

$$\begin{array}{l} y(n)=Cx(n)+Du(n) \\ x(n+1)=Ax(n)+Bu(n) \end{array}$$

$$y(n) = Cx(n) + Du(n)$$

$$x(n+1) = Ax(n) + Bu(n)$$

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 an n-by-1 vector.
- The input  $u$  must be an m-by-1 vector.
- The output  $y$  must be an r-by-1 vector.

The block accepts one input and generates one output. The block determines the input vector width by the number of columns in the B and D matrices. Similarly, the block determines the output vector width by the number of rows in the C and D matrices.

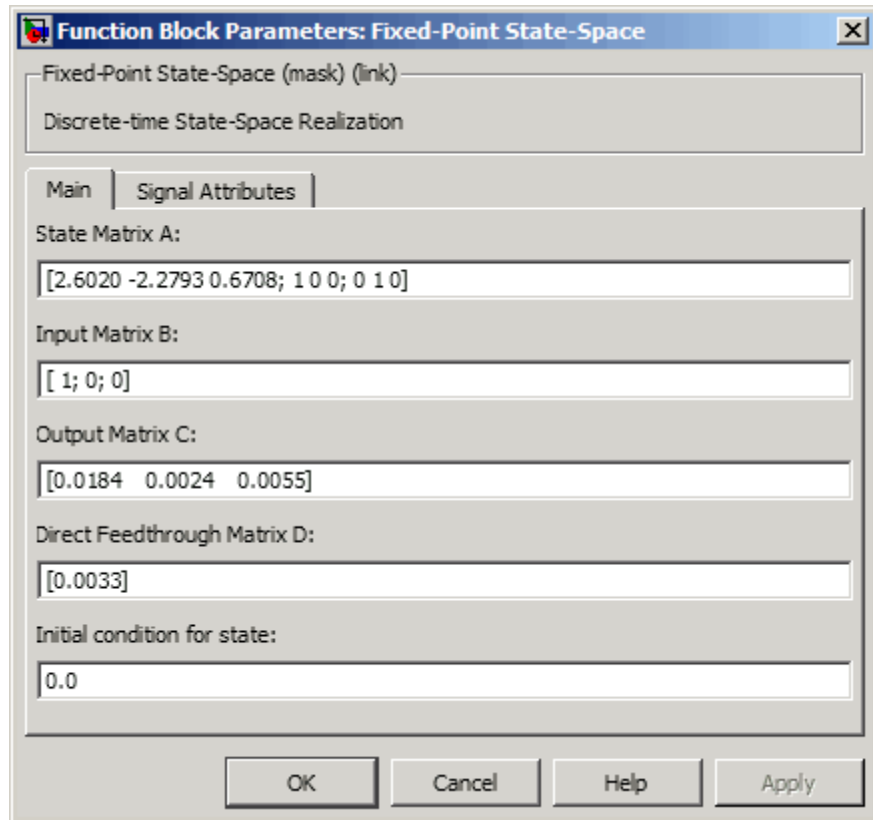
## Data Type Support

The Fixed-Point State-Space block accepts signals of any numeric data type supported by Simulink software, including fixed-point data types.

# Fixed-Point State-Space

## Parameters and Dialog Box

The **Main** pane of the Fixed-Point State-Space block dialog box 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.

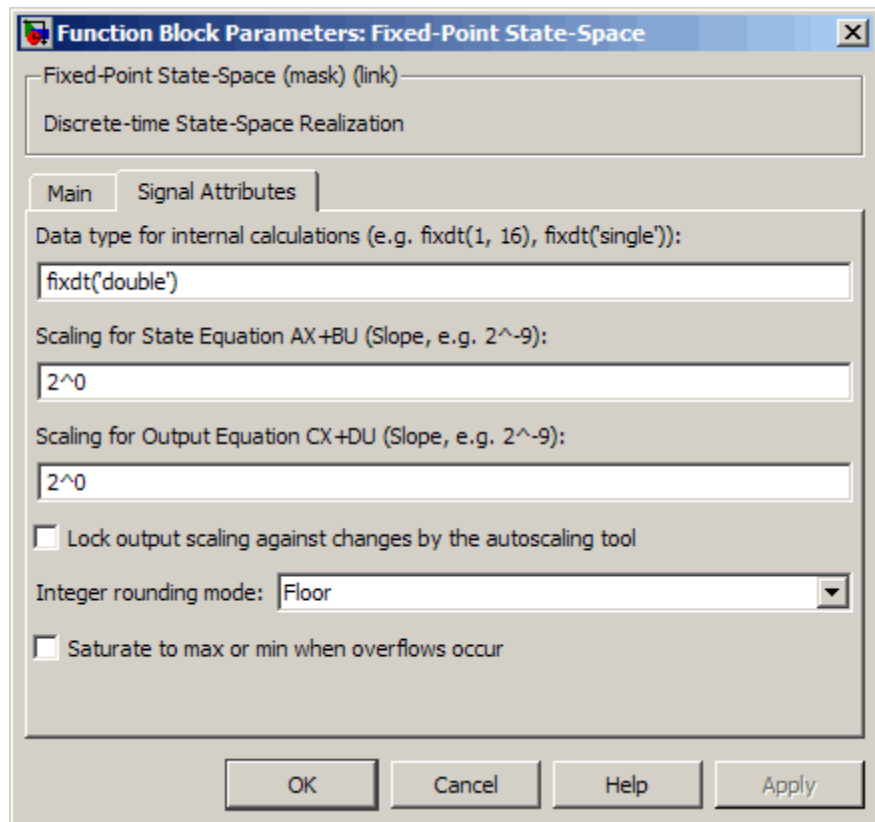
## Direct Feedthrough Matrix D

Specify the matrix for direct feedthrough.

## Initial condition for state

Specify the initial condition for the state.

The **Signal Attributes** pane of the Fixed-Point State-Space block dialog box appears as follows:



## Data type for internal calculations

Specify the data type for internal calculations.

# Fixed-Point State-Space

---

## 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 against changes by the autoscaling tool

If you select this check box, the output scaling is locked.

## Integer rounding mode

Select the rounding mode for fixed-point operations. For more information, see “Rounding” in the *Simulink Fixed Point User’s Guide*.

## Saturate to max or min when overflows occur

If selected, fixed-point overflows saturate.

## Characteristics

Direct Feedthrough	Yes
Scalar Expansion	Yes, of initial conditions



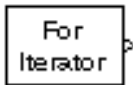
## Purpose

Repeatedly execute contents of subsystem at current time step until iteration variable exceeds 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.

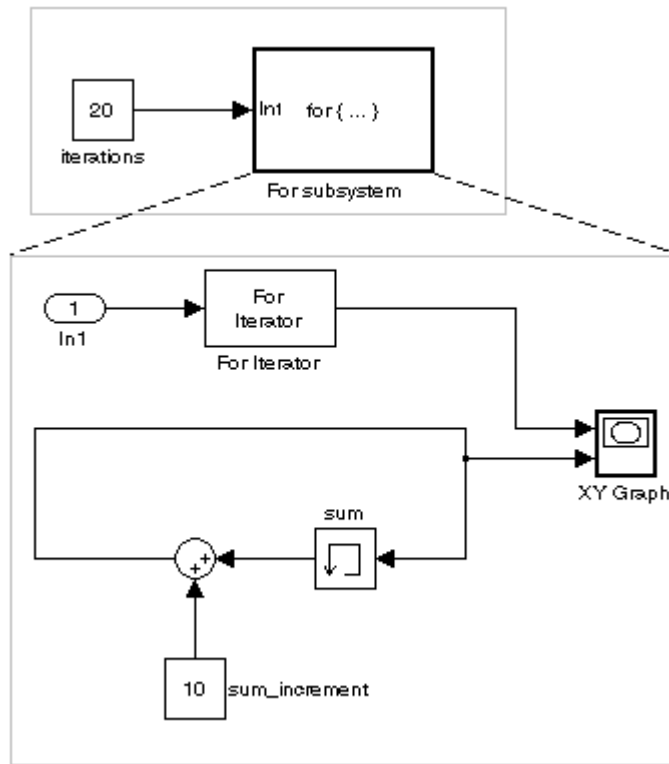
The output of a For Iterator subsystem can not be a function-call signal. Simulink software will display an error message if the simulation is run or the diagram updated.

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:

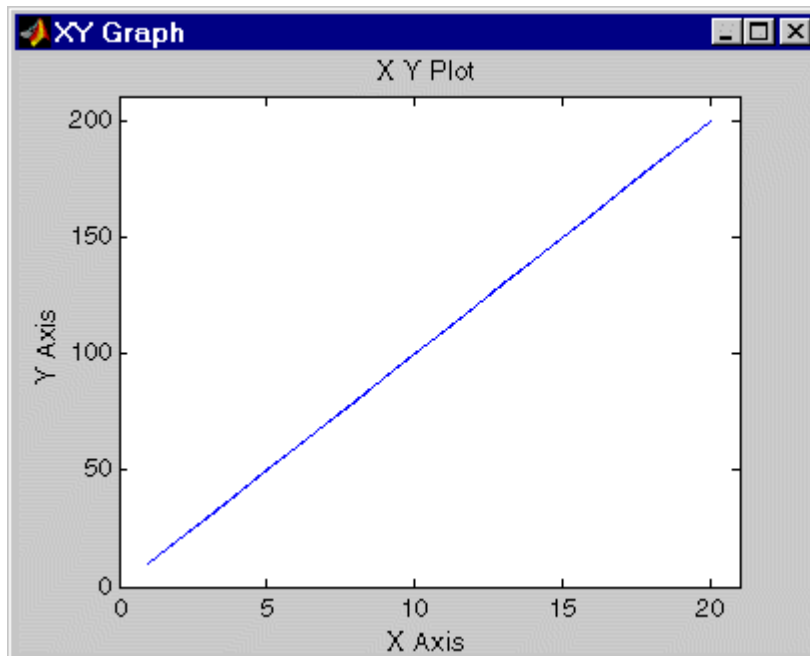
$$i_{n+1} = i_n + 1$$

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.

# For Iterator



The following figure shows the result.



Points:  
(1,10)  
(2,20)  
etc.

The For Iterator subsystem in this example is equivalent to the following C code.

```
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:

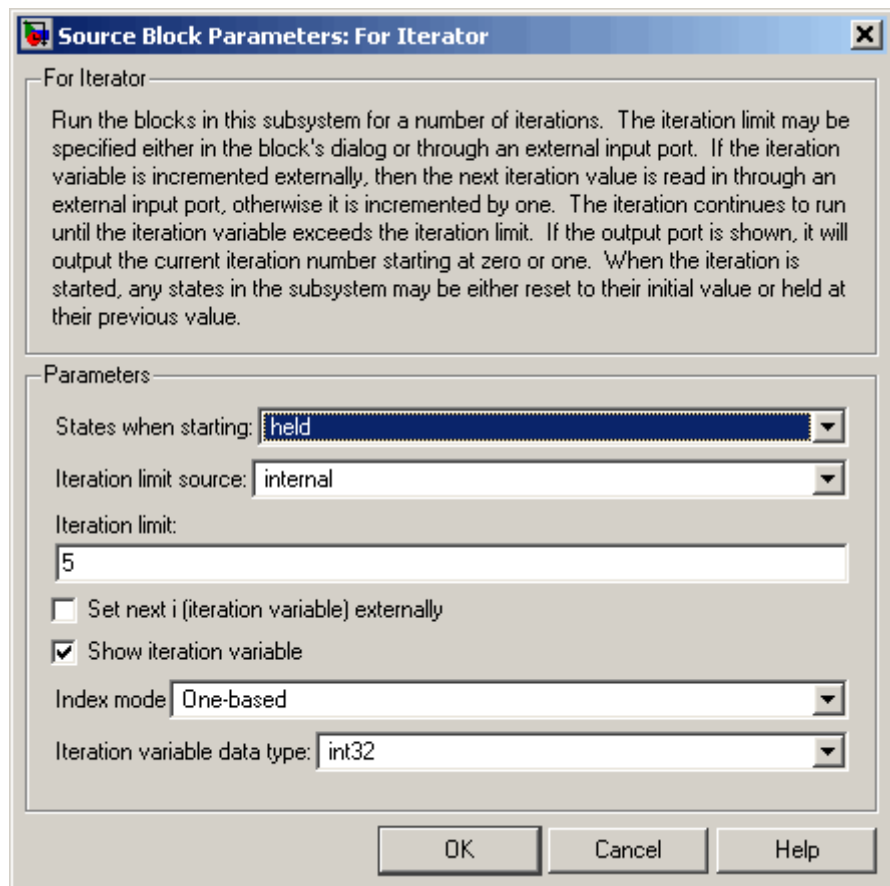
- The input port accepts data of mixed numeric types.
- If the input port value is noninteger, it is first truncated to an integer.
- Internally, the input value is cast to an integer of the type specified for the iteration variable output port.
- If no output port is specified, the input port value 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.

# For Iterator

---

## 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.

## 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

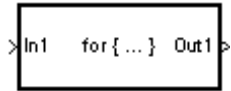
# For Iterator Subsystem

---

**Purpose** Represent subsystem that executes repeatedly during 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 Simulink documentation.

When using simplified initialization mode, you cannot place any block needing elapsed time within an Iterator Subsystem. In simplified initialization mode, Iterator subsystems do not maintain elapsed time, so Simulink will report an error if any such block (such as the Discrete-Time Integrator block) is placed within the subsystem. For more information on simplified initialization modes, see “Underspecified initialization detection”.



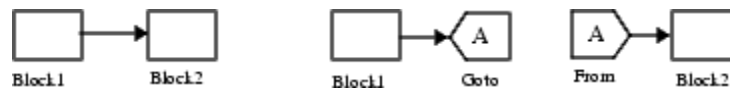
**Purpose** Accept input from Goto block

**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:

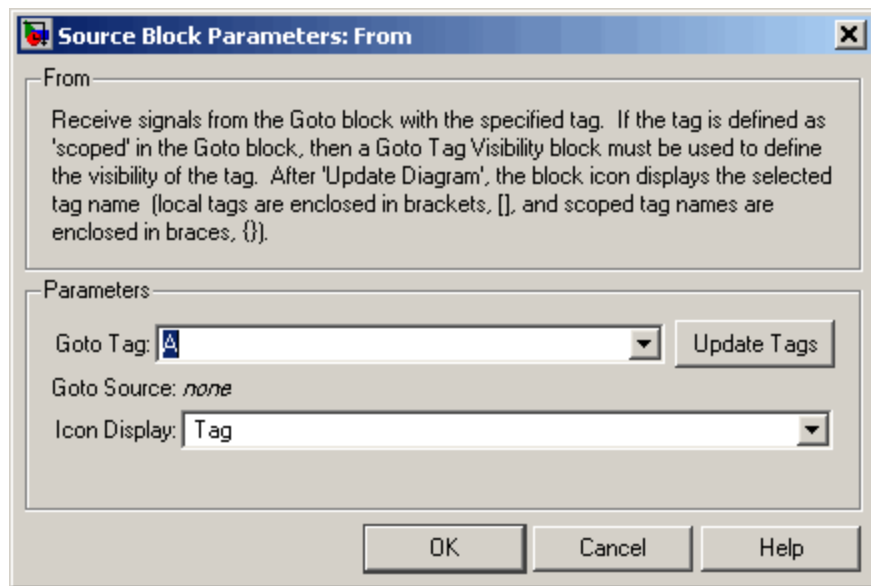
- A local tag name is enclosed in brackets ([]).
- A scoped tag name is enclosed in braces ({}).
- A global tag name appears without additional characters.

## Data Type Support

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

For a discussion on the data types supported by Simulink software, see “Data Types Supported by Simulink” in the Simulink documentation.

## Parameters and Dialog Box



### 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 software displays a progress bar while building the list of library tags. Simulink software 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.

**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
Multidimensionalized	Yes

# From File

---

**Purpose** Read data from MAT-file

**Library** Sources

**Description**



The From File block reads scalar or vector data of type double from a MAT-file outputs the data as a signal. The block's icon shows the pathname of the file supplying the data. Simulink software reads the MAT-file into memory at the start of the simulation, automatically uncompressing it if it had previously been saved by MATLAB in a compressed format. Therefore:

- Enough memory must be available at the start of simulation to contain the complete uncompressed MAT-file.
- A From File block cannot read data from a MAT-file that is being written by a To File block during the current simulation.

The MAT-file contains the stored data as a matrix of two or more rows. The first element of each column contains a simulation time. The remainder of each column contains scalar or vector data for the time shown at the top of the column, one element for each data point in the input. The time values in the first row must increase monotonically. The matrix in the file has this form:

$$\begin{bmatrix} t_1 & t_2 & \dots & t_{final} \\ u_{1_1} & u_{1_2} & \dots & u_{1_{final}} \\ \dots & & & \\ u_{n_1} & u_{n_2} & \dots & u_{n_{final}} \end{bmatrix}$$

The width of the output depends on the number of rows in the MAT-file. The block uses the time data at the top of each column to determine when to output the data values in the column, but does not output the time value itself. This means that given a MAT-file containing  $m$  rows, the block outputs a vector of length  $m-1$ , consisting of data from all but the first row of each column.

See “Importing Data from a Workspace” for guidelines on choosing time vectors for discrete systems.

### Missing and Duplicate Time Stamps

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 software extrapolates, using the first two or last two data points to compute a value.

If the matrix includes two or more columns at the same time value, the output is the data point for the first such 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.

### Using Data Saved by a To File Block

The From File block can read data written by a To File block without any modifications to the data or other special provisions.

### Using Data Saved by a To Workspace Block

The From File block can read data written by a To Workspace block subject to the following requirements:

- 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 “Data Import/Export Pane” for more information.
- The data must be the transposition of the data saved to the workspace by the To Workspace block. Before saving the data to a MAT-file, transpose it to the form expected by the From File block.

# From File

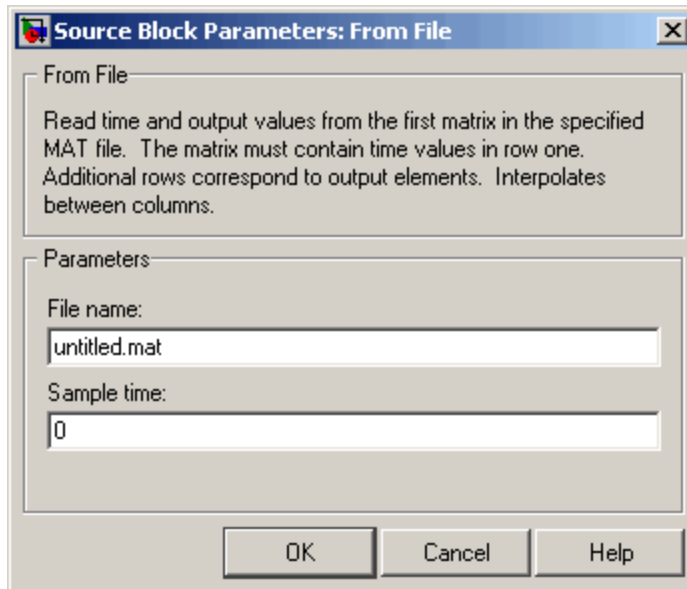
---

- The data in the file must be scalar or vector data of type double.

## Data Type Support

The From File block can read data only in MAT-file format. The block can output only vector and scalar data of type double. The block cannot output matrix signals or complex data.

## Parameters and Dialog Box



### File name

The fully qualified pathname or file name of the MAT-file that contains the data used as input. On UNIX<sup>®</sup> systems, 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 software 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 software 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. The default is 0, which specifies continuous sample time: the MAT-file is read at the base (fastest) rate of the model. See “How to Specify the Sample Time” for more information.

If the specified **Sample time** requires data at a time for which the MAT-file contains no matching time stamp, Simulink software extrapolates or interpolates to obtain the needed data, as described in “Missing and Duplicate Time Stamps” on page 2-433. If the MAT-file contains columns with time stamps that the specified **Sample time** never requires, the data points in columns with those time stamps are ignored.

**Characteristics**

Sample Time	Specified in the <b>Sample time</b> parameter
Scalar Expansion	No
Dimensionalized	1-D array only
Zero Crossing	No

**See Also**

“Importing and Exporting Data”, From Workspace, To File, To Workspace

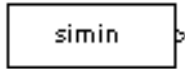
# From Workspace

---

**Purpose** Read data from workspace

**Library** Sources

## Description



The From Workspace block reads data from a workspace and outputs the data as a signal. The block's **Data** parameter specifies the workspace data using a MATLAB expression that evaluates to one of the following:

- A two-dimensional matrix:
  - The first element of each matrix row is a time stamp.
  - The rest of each row is a scalar or vector of signal values.

The leftmost element of each row is the time stamp of the value(s) in the rest of the row.

- A structure in Structure with Time format, which contains:
  - A vector named `time`, which contains time stamps
  - An array or matrix named `signals.values`, which contains scalars or vectors of signal values.

The *n*'th `time` element is the time stamp of the *n*'th `signals.values` element. See “Importing Data from a Workspace” for a description of Structure with Time format.

- A `Simulink.Timeseries` object.

The From Workspace icon displays the expression specified in the **Data** parameter. The Simulink software evaluates this expression as described in “Resolving Symbols”.

The format of a matrix or structure read by a From Workspace block is the same as that used to load root-level input port data from the workspace. You must use the Structure with Time format or a time series object to load matrix (2-D) data from the workspace. See “Importing Data from a Workspace” for guidelines on choosing time vectors for discrete systems. See the documentation of the `sim`



command for some data import capabilities that are available only for programmatic simulation.

**Limitation:** You cannot use a From Workspace block to import fixed-point data that is contained in a structure. Consider using a `Simulink.Timeseries` object instead of a structure.

## Using Data Saved by a To File Block

The From Workspace block requires data written by the To File block to be transposed before the From Workspace block can read it. The source file contains consecutive time stamps at the beginnings of columns, followed by the corresponding data. The transposed data contains consecutive time stamps at the beginning of rows, followed by the corresponding data. To provide the required format, use MATLAB commands to load and transpose (') the MAT-file (see “Reshaping a Matrix”). You can then use a From Workspace block to access the data loaded into the workspace. Resave the transposed data if needed to avoid retransposing it again later.

## Using Data Saved by a To Workspace Block

The From Workspace block requires data written by a To Workspace block to be written in `Structure with Time` format. Use this format to save sample-based data if you intend to use a From Workspace block to read the data back into another simulation. See “Importing Data from a Workspace” for a description of `Structure with Time` format.

**Limitation:** You cannot use a From Workspace block to import fixed-point data that is contained in a structure. Consider using a `Simulink.Timeseries` object instead of a structure.

## Interpolating Missing Data Values

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:

# From Workspace

---

```
time:      1  2  3  4
signal:    253 254 ? 256
```

The block would output:

```
time:      1  2  3  4
signal:    253 254 255 256
```

If you clear the **Interpolate data** option, the block uses the most recent data value supplied from the workspace to provide any missing data values. For example, the result of the incomplete set of signal values shown above would be:

```
time:      1  2  3  4
signal:    253 254 254 256
```

## Interpolating 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
```

## Interpolating 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.

## Specifying Output After Final Data

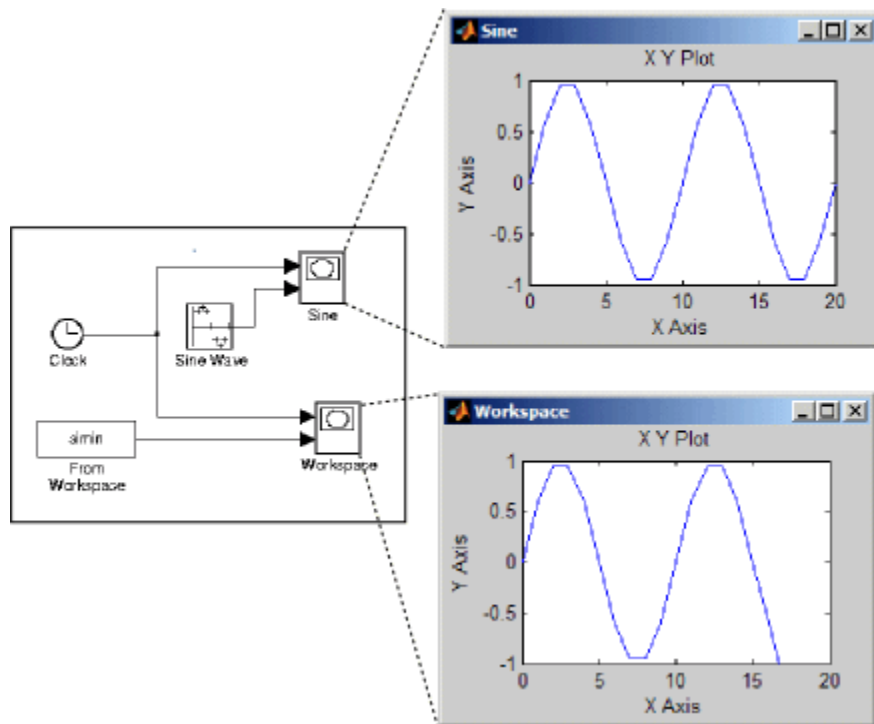
The block's **Form output after final data value** by and **Interpolate data** parameters work together to determine the block's output after the last time step for which workspace data is available. The following table describes the block output based on the values of the two options:

Form Output Option	Interpolate Option	Block Output After Final Data
Extrapolate	On	Extrapolated from final data value
	Off	Error
Setting to zero	On	Zero
	Off	Zero
Holding final value	On	Final value from workspace
	Off	Final value from workspace

# From Workspace

Form Output Option	Interpolate Option	Block Output After Final Data
Cyclic repetition	On	Error
	Off	Repeated from workspace if the workspace data is in structure-without-time format. Error otherwise.

For example, if **Form output after final data value by** is Extrapolate and **Interpolate data** is selected, the block uses the last two known data points to extrapolate data points that occur after the last known point. Consider the following model.



In this model, 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.

## Detecting Zero-Crossings

If the input array contains more than one entry for the same time step, Simulink software detects a zero crossing at that 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. The effect of this zero crossing depends on the value of the **Enable zero crossing detection** parameter. See “Zero-Crossing Detection” for more information.

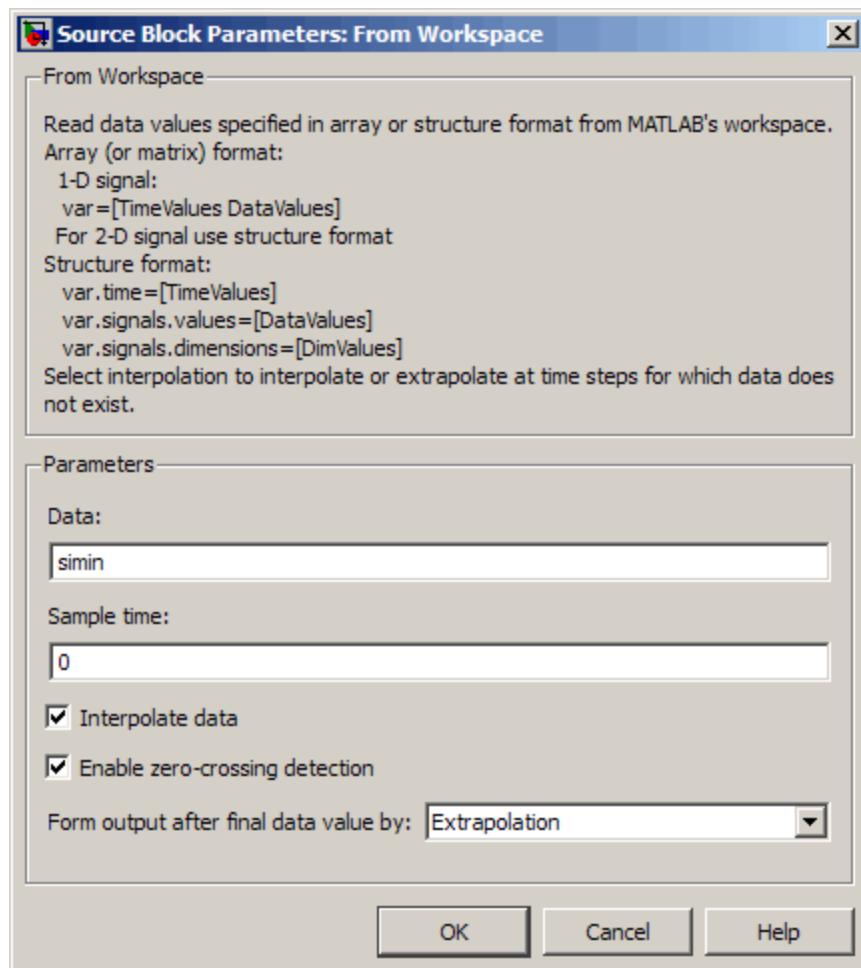
## Data Type Support

The From Workspace block accepts from the workspace and outputs real or complex signals of any type supported by Simulink software, including fixed-point and enumerated data types. 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.

**Limitation:** You cannot use a From Workspace block to import fixed-point data that is contained in a structure. Consider using a `Simulink.Timeseries` object instead of a structure.

# From Workspace

## Parameters and Dialog Box



### 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 column 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 “How to Specify the 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 “How Blocks Work with Zero-Crossing Detection” in the “How Simulink Works” chapter of the 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 <b>Sample time</b> parameter
Scalar Expansion	No
Dimensionalized	Yes
Multidimensionalized	Yes
Zero-Crossing Detection	Yes, if enabled.

## See Also

“Importing and Exporting Data”, From File, To File, To Workspace

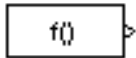
# Function-Call Generator

---

**Purpose** Execute function-call subsystem specified number of times at specified rate

**Library** Ports & Subsystems

## Description



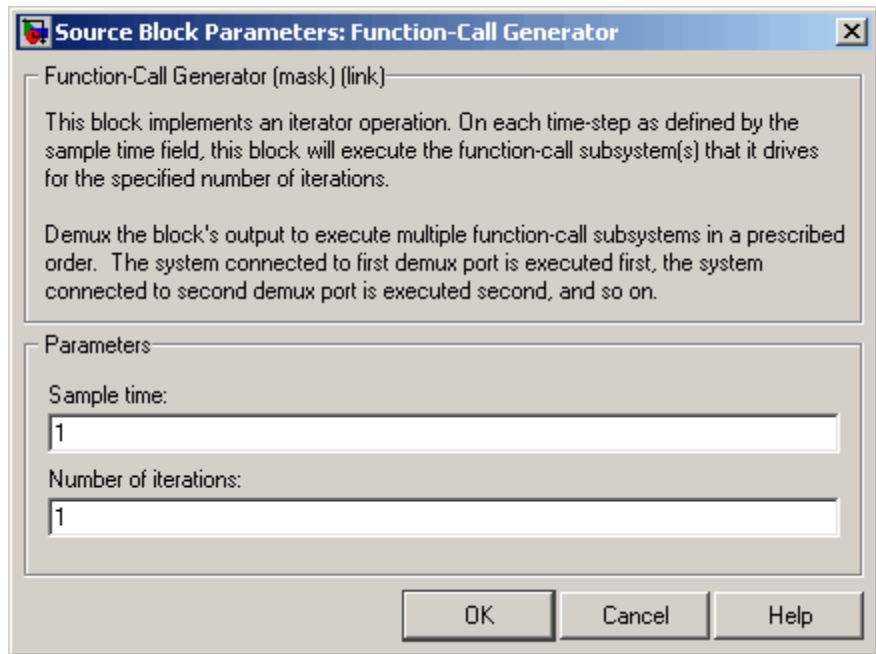
The Function-Call Generator block executes a function-call subsystem (for example, a Stateflow<sup>®</sup> state chart configured as a function-call system) at the rate specified by the block's **Sample time** parameter. To execute multiple function-call subsystems in a prescribed order, first connect 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 “How to Specify the 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.

# Function-Call Generator

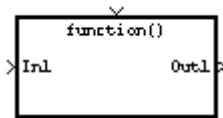
---

<b>Characteristics</b>	Direct Feedthrough	No
	Sample Time	Specified in the <b>Sample time</b> parameter
	Scalar Expansion	No
	Dimensionalized	Yes
	Zero Crossing	No

**Purpose** Represent subsystem that can be invoked as 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 Simulink documentation.



# Gain

---

## Purpose

Multiply input by 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.

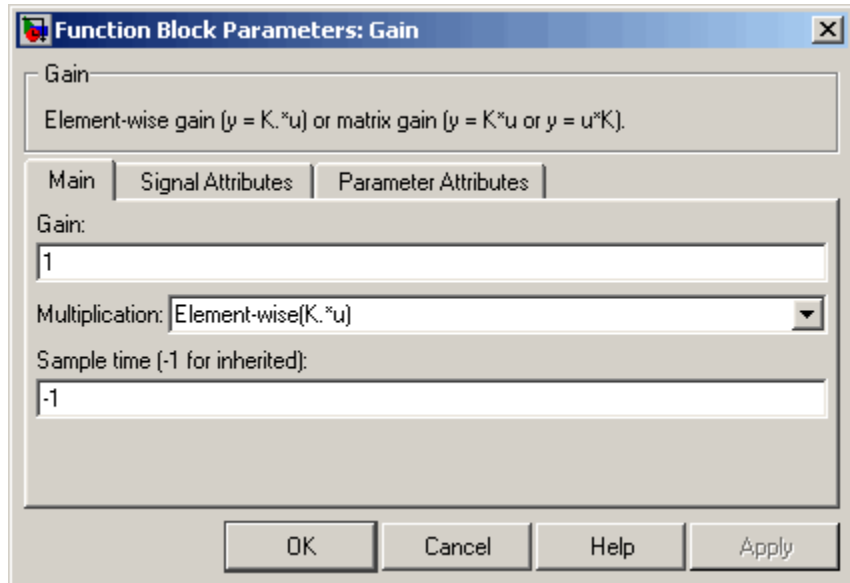
## Data Type Support

The Gain block accepts a real or complex scalar, vector, or matrix of any numeric data type supported by Simulink software. 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 software, see “Data Types Supported by Simulink” in the Simulink documentation.

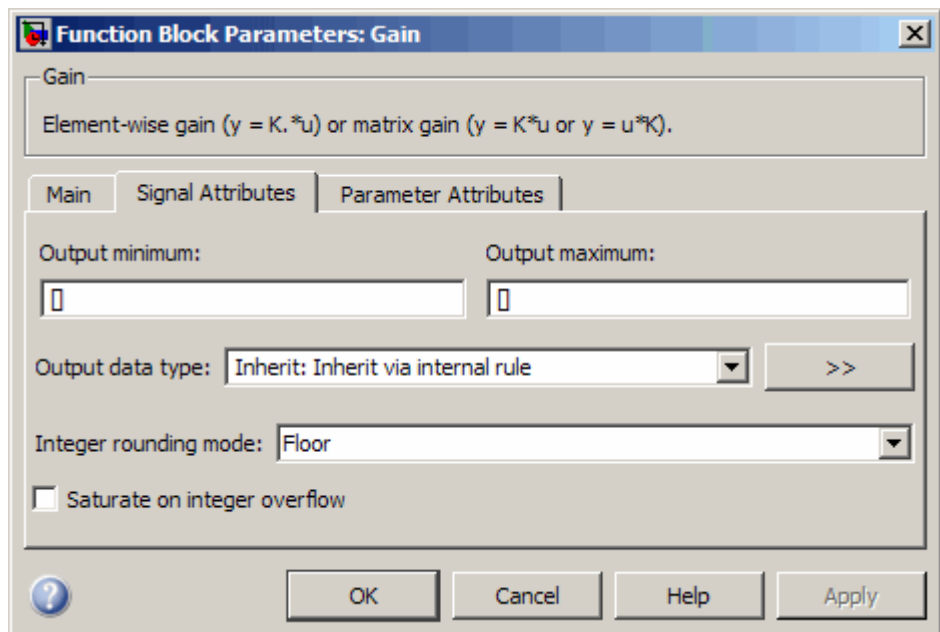
## Parameters and Dialog Box

The **Main** pane of the Gain block dialog box appears as follows:

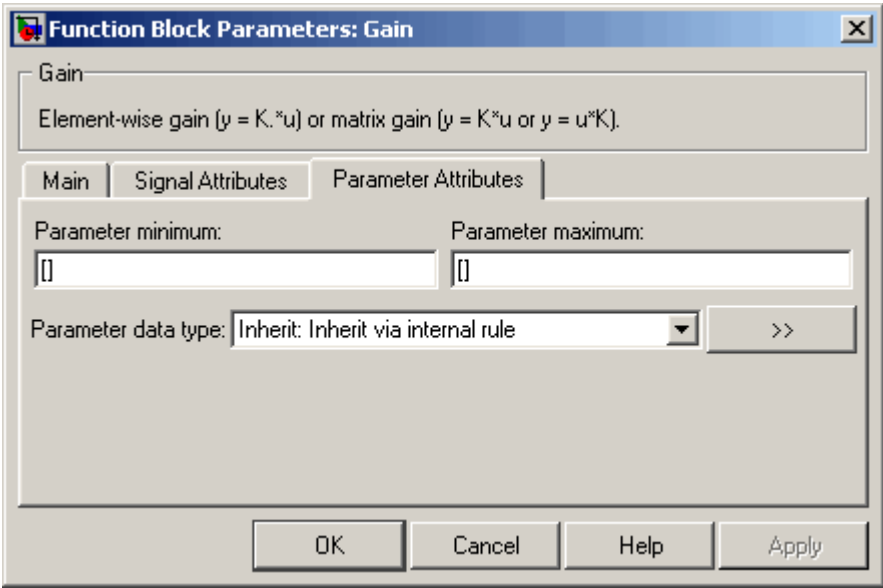


The **Signal Attributes** pane of the Gain block dialog box appears as follows:

# Gain



The **Parameter Attributes** pane of the Gain block dialog box appears as follows:



# Gain

---

## Gain

Specify the value by which to multiply the input.

### Settings

**Default:** 1

**Minimum:** value of **Parameter minimum** parameter

**Maximum:** value of **Parameter maximum** parameter

The gain may be a scalar, vector, or matrix.

### Command-Line Information

See “Block-Specific Parameters” on page 8-96 for the command-line information.



## Multiplication

Specify the multiplication mode.

### Settings

**Default:** Element-wise( $K.*u$ )

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. This mode is identical to Matrix( $K*u$ ), except for how dimensions are determined.

Suppose that  $K$  is an  $m$ -by- $n$  matrix. Matrix( $K*u$ ) ( $u$  vector) sets the input to a vector of length  $n$  and the output to a vector of length  $m$ . In contrast, Matrix( $K*u$ ) uses propagation to determine dimensions for the input and output. For an  $m$ -by- $n$  gain matrix, the input can propagate to an  $n$ -by- $q$  matrix, and the output becomes an  $m$ -by- $q$  matrix.

### Command-Line Information

See “Block-Specific Parameters” on page 8-96 for the command-line information.

## **Sample time (-1 for inherited)**

Specify the time interval between samples.

### **Settings**

**Default:** -1

To inherit the sample time, set this parameter to -1.

See “How to Specify the Sample Time” in the online documentation for more information.

### **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

**Output minimum**

Specify the minimum value that the block should output.

**Settings**

**Default:** []

The default value, [], is equivalent to  $-\text{Inf}$ .

Simulink software uses this value to perform:

- Parameter range checking (see “Checking Parameter Values”) for some blocks
- Simulation range checking (see “Checking Signal Ranges”)
- Automatic scaling of fixed-point data types

**Tip**

This number must be a double scalar value.

**Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

## **Output maximum**

Specify the maximum value that the block should output.

### **Settings**

**Default:** []

The default value, [], is equivalent to Inf.

Simulink software uses this value to perform:

- Parameter range checking (see “Checking Parameter Values”) for some blocks
- Simulation range checking (see “Checking Signal Ranges”)
- Automatic scaling of fixed-point data types

### **Tip**

This number must be a double scalar value.

### **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

## Output data type

Specify the output data type.

### Settings

**Default:** Inherit: Inherit via internal rule (Discrete-Time Integrator, Gain, Product, Sum, Switch block), Inherit: Inherit from 'Constant value' (Constant block default), Inherit: Inherit via back propagation (Data Type Conversion block), Inherit: Same as input (Saturation block)

Inherit: Inherit via internal rule

This option appears for some blocks. Simulink software chooses a combination of output scaling and data type that requires the smallest amount of memory consistent with accommodating the calculated 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 software chooses the output data type without regard to hardware constraints. Otherwise, Simulink software 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 `sfixed24`. 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 software displays an error message in the Simulation Diagnostics Viewer.

Inherit: Inherit from 'Constant value'

Use data type of **Constant value** parameter. This option appears for some blocks.

Inherit: Inherit via back propagation

A rule that inherits a data type

**Inherit: Same as input**  
Use data type of sole input signal. This option appears for some blocks.

**Inherit: Same as first input**  
Use data type of first input signal. This option appears for some blocks.

**Inherit: Same as accumulator**  
Output data type same as accumulator data type. This option appears for some blocks.

**double**  
Output data type is double.

**single**  
Output data type is single.

**int8**  
Output data type is int8.

**uint8**  
Output data type is uint8.

**int16**  
Output data type is int16.

**uint16**  
Output data type is uint16.

**int32**  
Output data type is int32.

**uint32**  
Output data type is uint32.

**fixdt(1,16,0)**  
Output data type is fixed point fixdt(1,16,0).

**fixdt(1,16,2<sup>0</sup>,0)**  
Output data type is fixed point fixdt(1,16,2<sup>0</sup>,0).

<data type expression>

The name of a data type object, for example  
Simulink.NumericType

**Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

**See Also**

See “Specifying Block Output Data Types” in the *Simulink User’s Guide* for more information.

## **Show data type assistant**

Display the **Data Type Assistant**.

### **Settings**

The **Data Type Assistant** helps you set the **Output data type** parameter.

See “Specifying Block Output Data Types” in *Simulink User’s Guide* for more information.

### **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.



## **Lock output scaling against changes by the autoscaling tool**

Select to lock scaling of outputs.

### **Settings**

**Default:** Off

On

Lock scaling of outputs.

Off

Do not lock scaling of outputs.

### **Dependencies**

This parameter is enabled when you enter an expression for the **Output data type** or **Data type** parameter.

### **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

## Integer rounding mode

Select the rounding mode for fixed-point operations.

### Settings

**Default:** Floor

#### Ceiling

Round both positive and negative numbers toward positive infinity.

#### Convergent

Round number to the nearest representable value. In the case of a tie, round to the nearest even stored value.

#### Floor

Round both positive and negative numbers toward negative infinity.

#### Nearest

Round number to the nearest representable value. In the case of a tie, round toward positive infinity.

#### Round

Round number to the nearest representable value. In the case of a tie, round positive numbers toward positive infinity and round negative numbers toward negative infinity.

#### Simplest

This option provides for an optimization of the rounding code for several blocks.

#### Zero

Round number toward zero.

### Command-Line Information

See “Block-Specific Parameters” on page 8-96 for the command-line information.

### See Also

For more information, see “Rounding” in the *Simulink Fixed Point User’s Guide*.

### Saturate on integer overflow

Specify whether overflows saturate.

#### Settings

**Default:** Off

On  
Overflows saturate.

Off  
Overflows do not saturate.

#### Tips

- When you select this check box, saturation applies to every internal operation on the block, not just the output or result.
- In general, the code generation process can detect when overflow is not possible, in which case, no saturation code is generated.

#### Command-Line Information

See “Block-Specific Parameters” on page 8-96 for the command-line information.

## **Parameter minimum**

Specify the minimum value of the gain.

### **Settings**

**Default:** [ ]

The default value, [ ], is equivalent to  $-\text{Inf}$ . Simulink software uses this value to perform:

- Parameter range checking (see “Checking Parameter Values”)
- Automatic scaling of fixed-point data types

### **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

## **Parameter maximum**

Specify the maximum value of the gain.

### **Settings**

**Default:** []

The default value, [], is equivalent to Inf. Simulink software uses this value to perform:

- Parameter range checking (see “Checking Parameter Values”)
- Automatic scaling of fixed-point data types

### **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

## Parameter data type

Specify the data type of the **Gain** parameter.

### Settings

#### Default:

Inherit: Inherit via internal rule  
A rule that inherits a data type

Inherit: Same as input  
Use data type of sole input signal

double  
Data type is double

single  
Data type is single

int8  
Data type is int8

uint8  
Data type is uint8

int16  
Data type is int16

uint16  
Data type is uint16

int32  
Data type is int32

uint32  
Data type is uint32

fixdt(1,16)  
Data type is fixdt(1,16)

fixdt(1,16,0)  
Data type is fixdt(1,16,0)

```
fixdt(1,16,2^0,0)
```

```
    Data type is fixdt(1,16,2^0,0)
```

```
<data type expression>
```

```
    The name of a data type object, for example
```

```
    Simulink.NumericType
```

## **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.



## Mode

Select the category of data to specify

### Settings

**Default:** Inherit (Constant, Data Type Conversion, Discrete Time Integrator, Gain, Inport, Outport, Product, Saturation, Sum, Switch),  
**Built in** (Logical Operator, Relational Operator)

#### Inherit

Inheritance rules for data types. Selecting **Inherit** enables a second menu/text box to the right. Below are the possible values, which can vary by block:

- Inherit from 'Constant value' (Constant block default)
- Inherit via internal rule (Discrete-Time Integrator, Gain, Product, Sum, Switch block default)
- Inherit via back propagation (Data Type Conversion block default)
- auto (Inport, Outport block default)
- Logical (see Configuration Parameters: Optimization)
- Same as first input
- Same as input (Saturation block default)
- Same as accumulator

#### Built in

Built-in data types. Selecting **Built in** enables a second menu/text box to the right. Below are the possible values, which can vary by block:

- double (Constant, Data Type Conversion, Discrete-Time Integrator, Gain, Inport, Outport, Product, Saturation, Sum, Switch block default)
- single

- int8
- uint8
- int16
- uint16
- int32
- uint32
- boolean (Logical Operator, Relational Operator block default)

## Fixed point

Fixed-point data types.

## Enumerated

Enumerated data types. This option is available on some blocks. Selecting Enumerated enables a second menu/text box to the right. Below are the possible values, which can vary by block:

- <class name>

## Expression

Expressions that evaluate to data types. Selecting Expression enables a second menu/text box to the right. Below are the possible values, which can vary by block:

- <data type expression>

## Dependency

This parameter is enabled by the **Show data type assistant** button.

## Command-Line Information

See “Block-Specific Parameters” on page 8-96 for the command-line information.

## See Also

See “Using the Data Type Assistant” in the *Simulink User’s Guide*.

## **Signedness**

Specify whether you want the fixed-point data to be signed or unsigned.

### **Settings**

**Default:** Signed

Signed

Specify the fixed-point data to be signed.

Unsigned

Specify the fixed-point data to be unsigned.

### **Dependencies**

This parameter is enabled by selecting **Mode** > Fixed point.

### **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

### **See Also**

See “Specifying a Fixed-Point Data Type” in the *Simulink User’s Guide* for more information.

## **Word length**

Specify the bit size of the word that will hold the quantized integer.

### **Settings**

**Default:** 16

**Minimum:** 0

**Maximum:** 32

Large word sizes represent large values with greater precision than small word sizes.

### **Dependencies**

This parameter is enabled by selecting **Mode** > Fixed point.

### **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

### **See Also**

See “Specifying a Fixed-Point Data Type” in the *Simulink User’s Guide* for more information.

## Scaling

Specify the method for scaling your fixed-point data to avoid overflow conditions and minimize quantization errors.

### Settings

**Default:** Best precision (Constant), Binary point (Data Type Conversion, Discrete-Time Integrator, Gain, Inport, Outport, Product, Saturation, Sum, Switch), Integer (Logical Operator, Relational Operator)

#### Binary point

Specify binary point location.

#### Slope and bias

Enter slope and bias.

#### Best precision

Specify best-precision values. This option appears for some blocks.

#### Integer

Specify integer. This setting has the same result as specifying a binary point location and setting fraction length to 0. This option appears for some blocks.

### Dependencies

This parameter is enabled by selecting **Mode** > Fixed point.

Selecting Binary point enables:

- **Fraction length**
- **Calculate Best-Precision Scaling**

Selecting Slope and bias enables:

- **Slope**
- **Bias**
- **Calculate Best-Precision Scaling**

**Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

**See Also**

See “Specifying a Fixed-Point Data Type” in the *Simulink User’s Guide* for more information.

**Fraction length**

Specify fraction length for fixed-point data type.

**Settings**

**Default:** 0

Binary points can be positive or negative integers.

**Dependencies**

This parameter is enabled by selecting **Scaling** > Binary point.

**Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

**See Also**

See “Specifying a Fixed-Point Data Type” in the *Simulink User’s Guide* for more information.

## **Slope**

Specify slope for the fixed-point data type.

### **Settings**

**Default:** 2<sup>0</sup>

Specify any positive real number.

### **Dependencies**

This parameter is enabled by selecting **Scaling** > Slope and bias.

### **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

### **See Also**

See “Specifying a Fixed-Point Data Type” in the *Simulink User’s Guide* for more information.



**Bias**

Specify bias for the fixed-point data type.

**Settings**

**Default:** 0

Specify any real number.

**Dependencies**

This parameter is enabled by selecting **Scaling** > Slope and bias.

**Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

**See Also**

See “Specifying a Fixed-Point Data Type” in the *Simulink User’s Guide* for more information.

**Characteristics**

Direct Feedthrough	Yes
Sample Time	Specified in the <b>Sample time</b> parameter
Scalar Expansion	Yes, of input and <b>Gain</b> parameter for <b>Element-wise (K.*u)</b> multiplication
Dimensionalized	Yes
Multidimensionalized	Yes, only if the <b>Multiplication</b> parameter specifies <b>Element-wise (K.*u)</b>
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

“Creating Conditional Subsystems” in the “Creating a Model” chapter of the Simulink documentation.

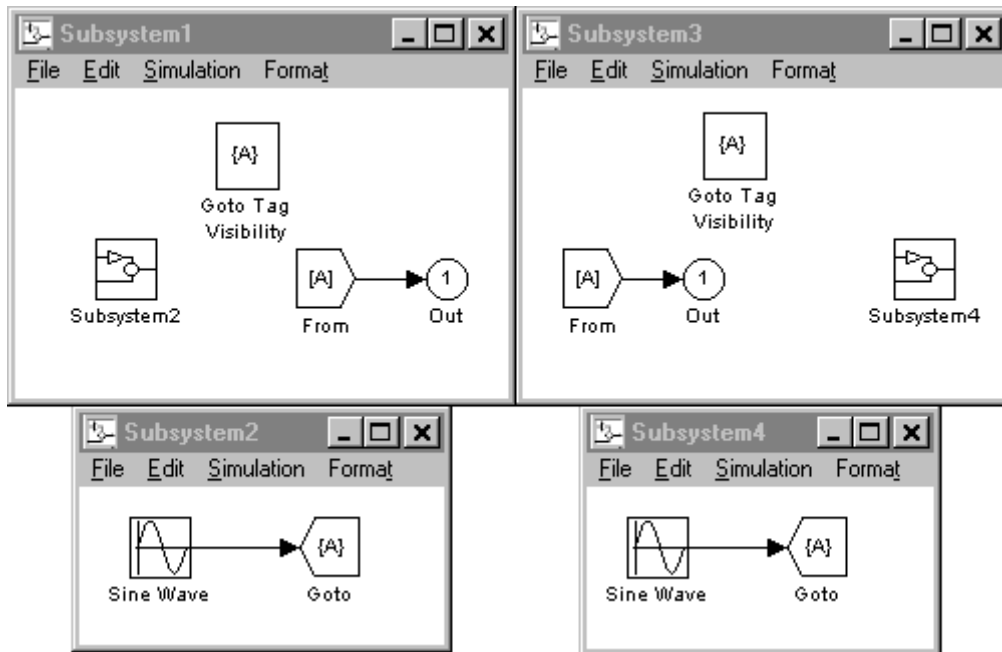
---

**Note** A scoped Goto block in a masked system is visible only in that subsystem and in the nonvirtual subsystems it contains. Simulink software 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).

# Goto

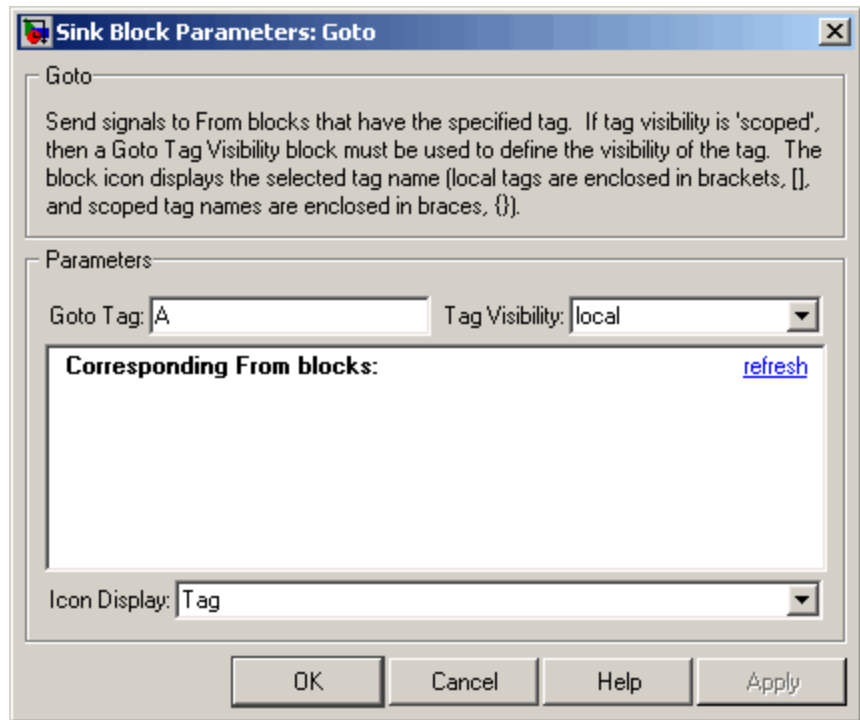


## Data Type Support

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

For a discussion on the data types supported by Simulink software, 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.

## Characteristics

Sample Time	Inherited from driving block
Dimensionalized	Yes
Multidimensionalized	Yes

**Purpose** Define scope of Goto block tag

**Library** Signal Routing

## Description

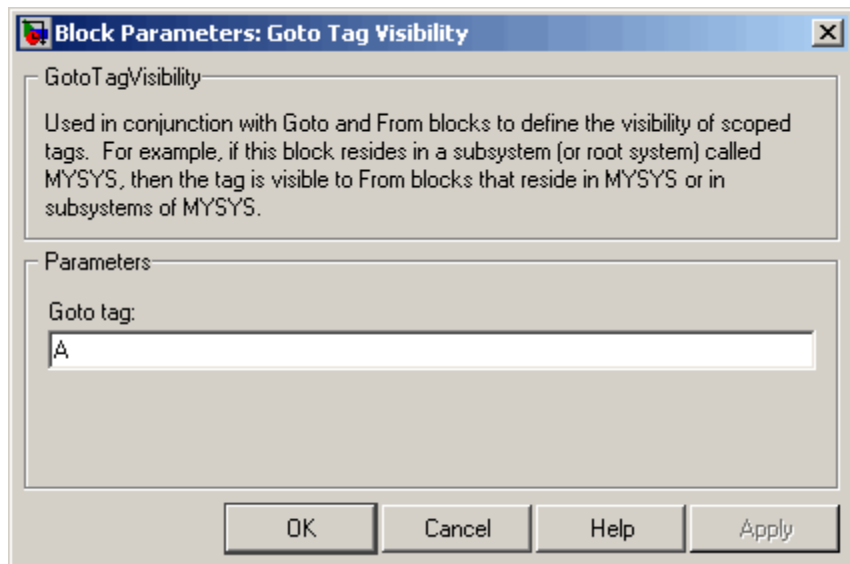


The Goto Tag Visibility block defines the accessibility of Goto block tags that have **scoped** visibility. The tag specified as the **Goto tag** parameter is accessible by From blocks in the same subsystem that contains the Goto Tag Visibility block and in subsystems below it in the model hierarchy.

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



# Goto Tag Visibility

---

## Goto tag

The Goto block tag whose visibility is defined by the location of this block.

## Characteristics

Sample Time	N/A
Dimensionalized	N/A



**Purpose** Ground unconnected input port

**Library** Sources

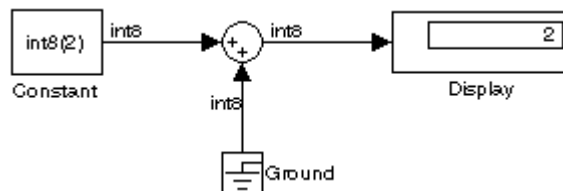
## Description



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 software 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 data type as the port to which it is connected. For example, consider the following model:

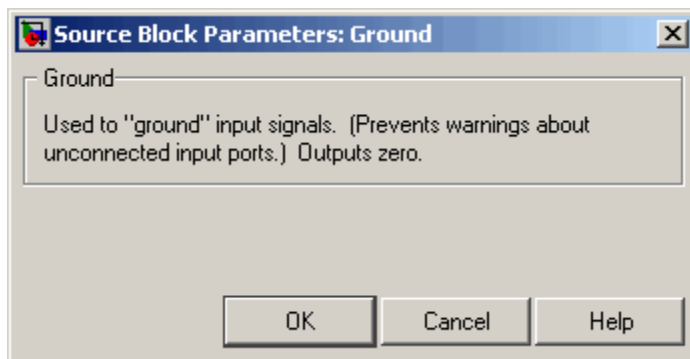


In this example, the output of the Constant block determines the data type (`int8`) of the port to which the Ground block is connected. That port in turn determines the type of the signal output by the Ground block.

The Ground block supports all data types supported by Simulink software, including fixed-point data types.

# Ground

## Parameters and Dialog Box



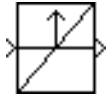
## Characteristics

Sample Time	Inherited from driven block
Dimensionalized	Yes
Multidimensionalized	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.

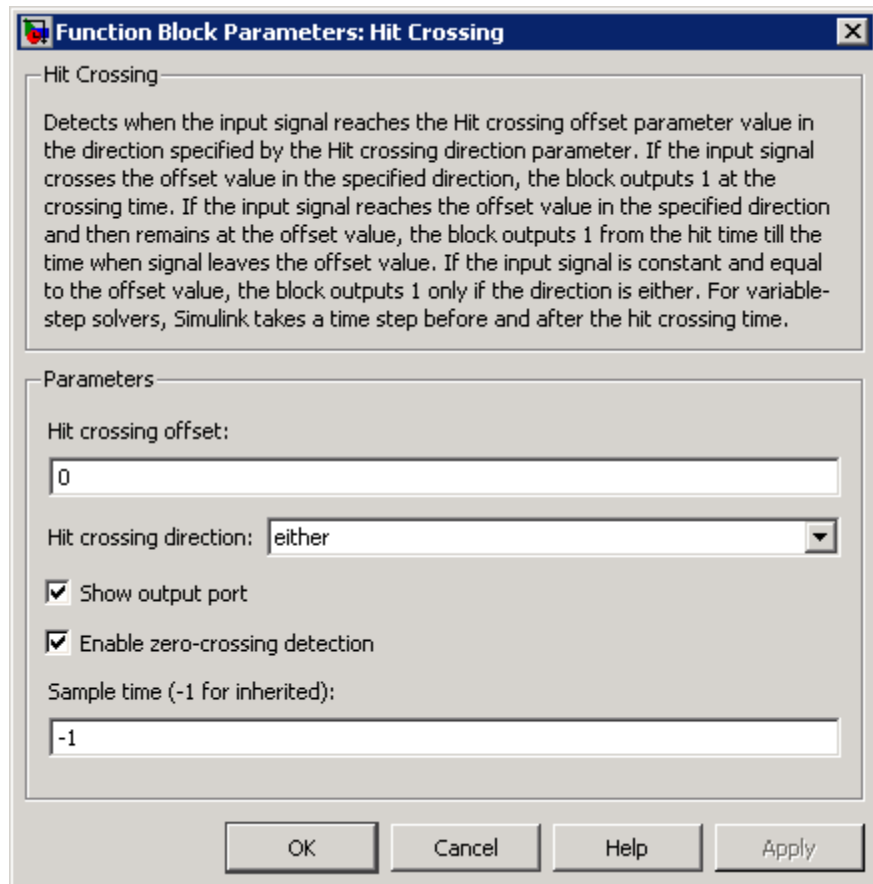
The **hardstop** and **sldemo\_clutch** demos illustrate the use of the Hit Crossing block. In the **hardstop** demo, the Hit Crossing block is in the Friction Model subsystem. In the **sldemo\_clutch** demo, the Hit Crossing block is in the Friction Mode Logic/Lockup Detection subsystem.

## Data Type Support

The Hit Crossing block outputs a signal of type **Boolean** if Boolean logic signals are enabled (see "Implement logic signals as boolean data (vs. double)"). 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 “How Blocks Work with Zero-Crossing Detection” in the “How Simulink Works” chapter of the Simulink documentation.

## **Sample time (-1 for inherited)**

Specify the time interval between samples. To inherit the sample time, set this parameter to -1. See “How to Specify the Sample Time” in the online documentation for more information.

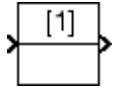
## **Characteristics**

Direct Feedthrough	Yes
Sample Time	Inherited from driving block
Scalar Expansion	Yes
Dimensionalized	Yes
Zero-Crossing Detection	Yes, if enabled.

**Purpose** Set initial value of signal

**Library** Signal Attributes

**Description**



The IC block sets the initial condition of the signal at its input port, e.g., the value of the signal at the simulation start time ( $t_{start}$ ). 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.

---

**Note** If an IC block inherits or specifies a nonzero sample time offset ( $t_{offset}$ ), the IC block outputs its initial value at time  $t$ ,

$$t = n * t_{period} + t_{offset}$$

where  $n$  is the smallest integer such that  $t \geq t_{start}$ .

That is, the IC block outputs its initial value the first time blocks with sample time  $[t_{period}, t_{offset}]$  execute, which can be after  $t_{start}$ .

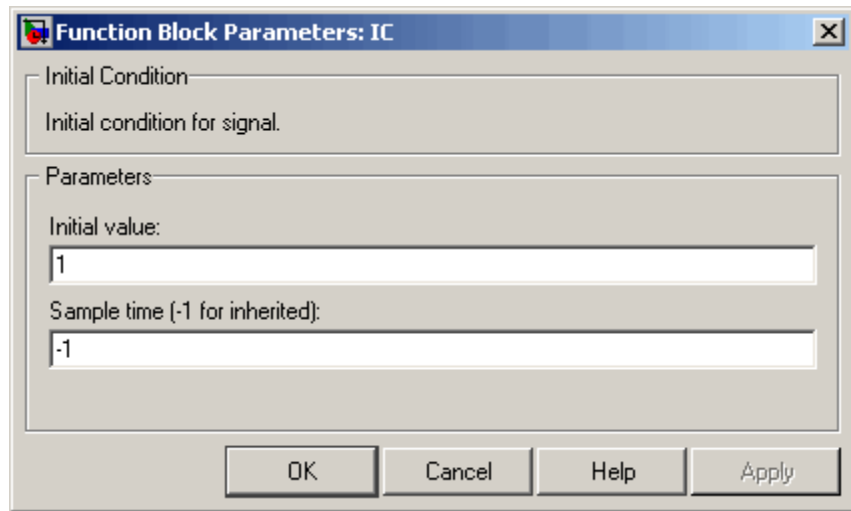
---

The IC block is useful for providing an initial guess for the algebraic state variables in a loop. For more information, see “Algebraic Loops” in the “How Simulink Works” chapter of *Simulink User’s Guide*.

**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 software.

## Parameters and Dialog Box



### Initial value

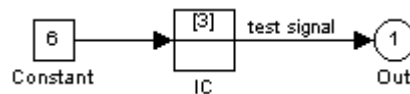
Specify the initial value for the input signal.

### Sample time (-1 for inherited)

Specify the time interval between samples. To inherit the sample time, set this parameter to -1. See “How to Specify the 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. Afterward, the signal value is 6.

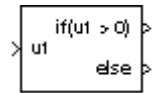
<b>Characteristics</b>		
Direct Feedthrough		Yes
Sample Time		Specified in the <b>Sample time</b> parameter
Scalar Expansion		Yes, of parameter only
Dimensionalized		Yes
Multidimensionalized		Yes
Zero Crossing		No



**Purpose** Model if-else control flow

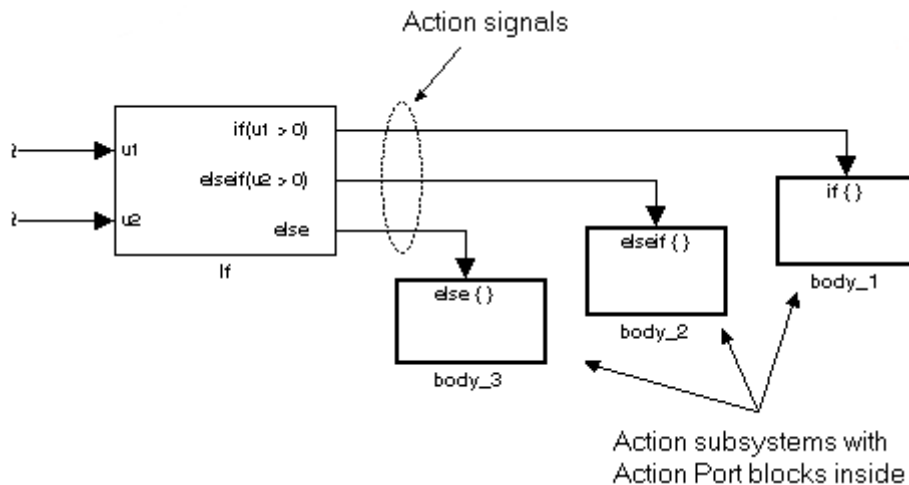
**Library** Ports & Subsystems

### 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.

- 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`.

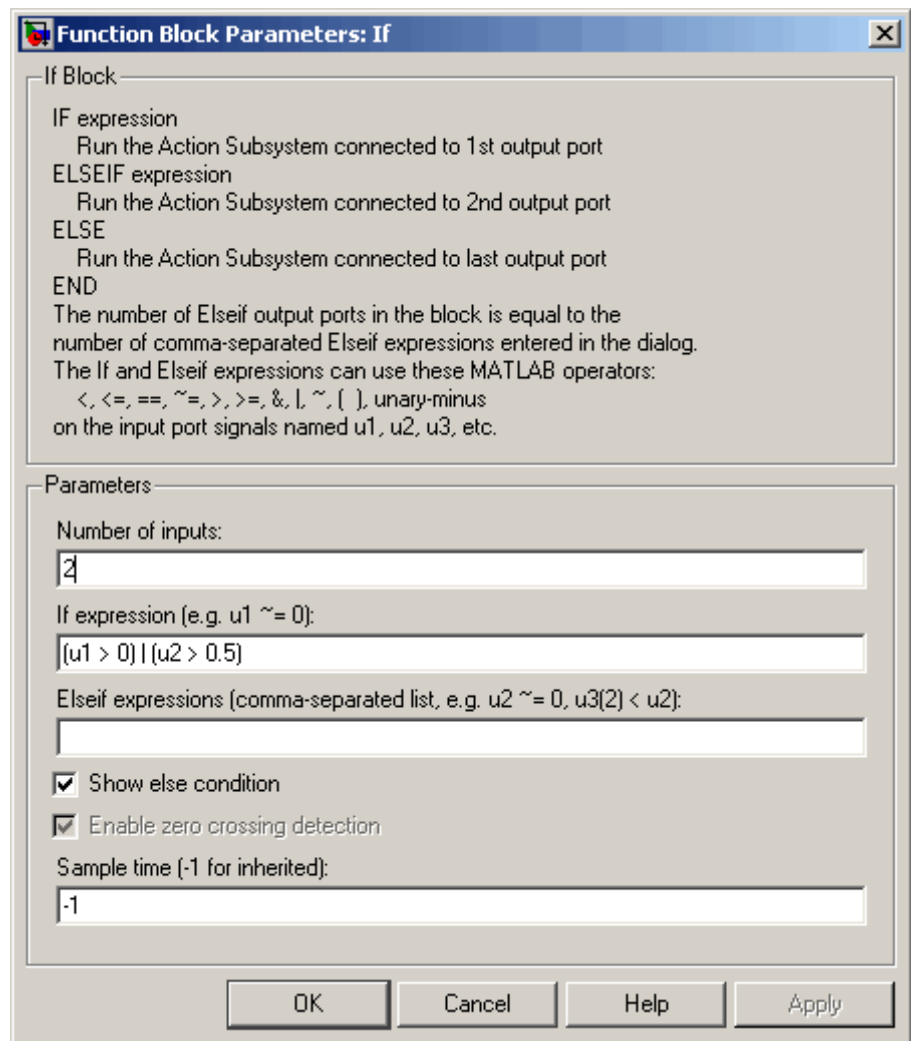
# If

---

## **Data Type Support**

Inputs  $u_1, u_2, \dots, u_n$  can be scalars or vectors of any built-in Simulink data type and must all be of the same data type. The inputs cannot be of any user-defined type, such as an enumerated type. 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. The expression must not contain data type expressions, e.g., `int8(6)`, and must not reference workspace variables whose data type is other than double or single.

---

**Note** You cannot tune the **If expression** during accelerated-mode simulation (see “Accelerating Models”), in referenced models executing in Accelerator mode, or in code generated from the model. The If block also does not support custom storage classes.

---

## 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. The expression must not contain data type expressions, e.g., `int8(6)`, and must not reference workspace variables whose data type is other than double or single.

---

**Note** You cannot tune the **Elseif expression** during accelerated-mode simulation (see “Accelerating Models”), in referenced models executing in Accelerator mode, or in code generated from the model. The If block also does not support custom storage classes.

---

**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 Simulink documentation.

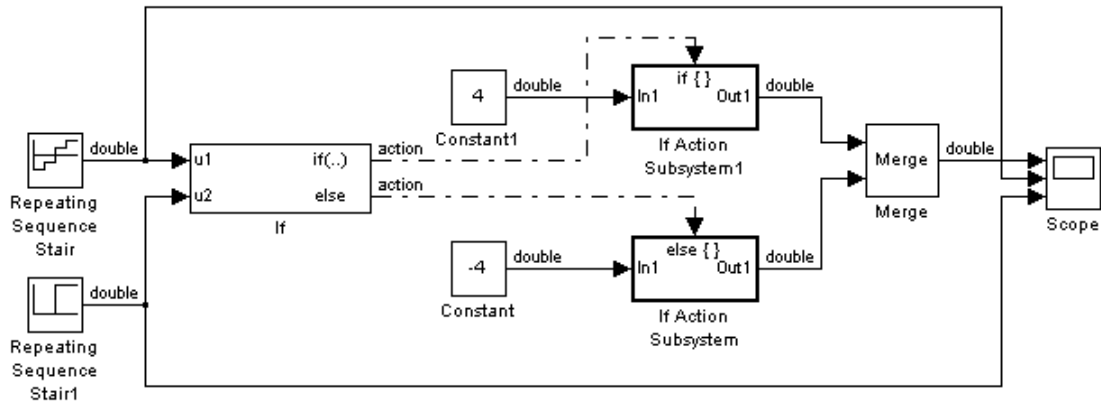
**Sample time**

Specify the sample time of the input signal. See “How to Specify the 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.



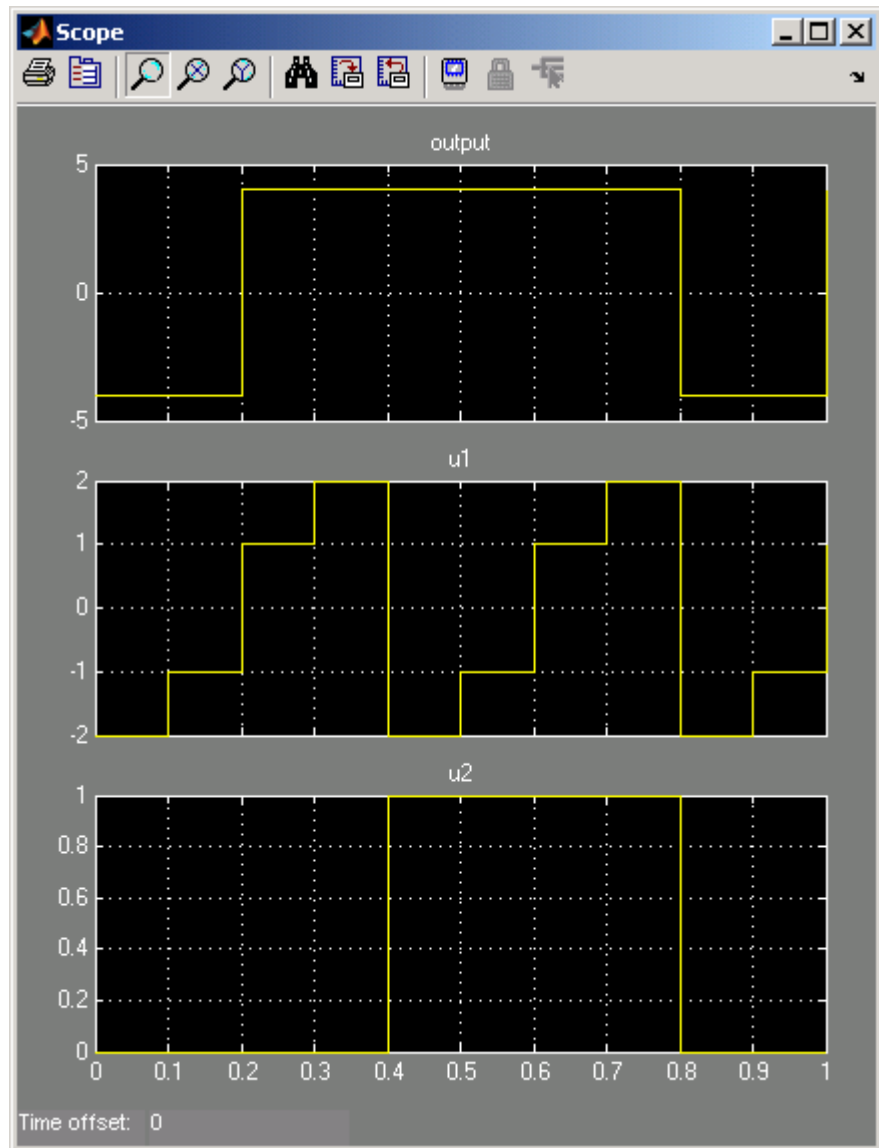
In this model, the If Action subsystems use their default configurations. The block and simulation parameters for the model are set to their default values except as follows:

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

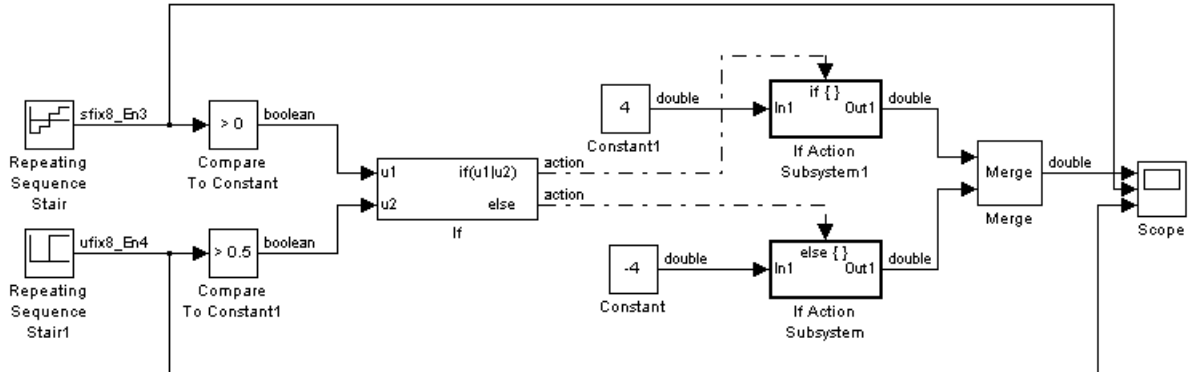


<b>Block or Dialog</b>	<b>Parameter</b>	<b>Setting</b>
	<b>If expression</b>	(u1 > 0)   (u2 > 0.5)
	<b>Show else condition</b>	selected
Constant	<b>Constant value</b>	-4
Constant1	<b>Constant value</b>	4
Scope	<b>Number of axes</b>	3
	<b>Time range</b>	1

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

# If

Block	Parameter	Setting
	Enable zero crossing detection	unselected
Compare To Constant1	Operator	>
	Constant value	0.5
	Output data type mode	Boolean
	Enable zero crossing detection	unselected
If	Number of inputs	2
	If expression	u1   u2

## Characteristics

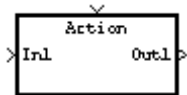
Direct Feedthrough	Yes
Sample Time	Inherited from driving block
Scalar Expansion	No
Dimensionalized	Yes
Zero-Crossing Detection	Yes, if enabled

**Purpose**

Represent subsystem whose execution is triggered by 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.

---

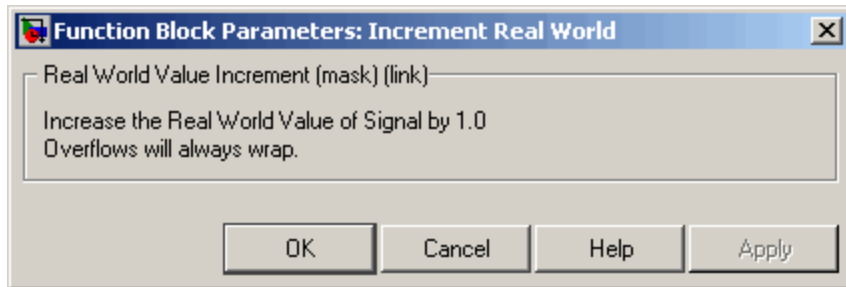
For more information, see the If block and Modeling with Control Flow Blocks in the “Creating a Model” chapter of the Simulink documentation.

# Increment Real World

---

- Purpose** Increase real world value of 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 numeric data type supported by Simulink software, 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

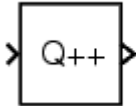
Increase stored integer value of signal by one

## Library

Additional Math & Discrete / Additional Math: Increment - Decrement

## Description

The Increment Stored Integer block increases the stored integer value of a signal by one.

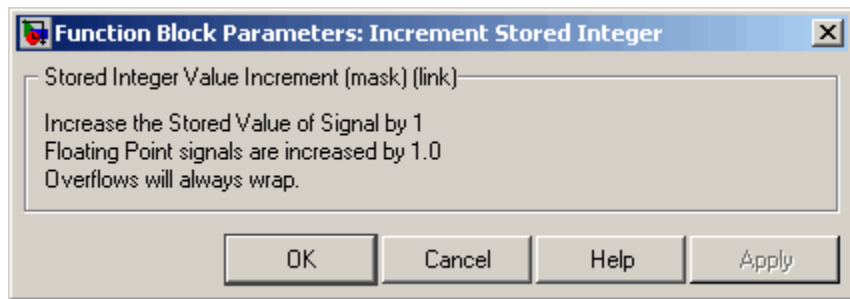


Floating-point signals are also increased by one, and overflows always wrap.

## Data Type Support

The Increment Stored Integer block accepts signals of any numeric data type supported by Simulink software, including fixed-point data types.

## Parameters and Dialog Box



## Characteristics

Direct Feedthrough	Yes
Scalar Expansion	No

## See Also

Decrement Stored Integer, Increment Real World

# Index Vector

---

**Purpose**

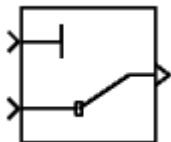
Switch output between different inputs based on value of first input

**Library**

Signal Routing

**Description**

The Index Vector block is an implementation of the Multiport Switch block. See Multiport Switch for more information.





**Purpose**

Create input port for subsystem or external input

**Library**

Ports & Subsystems, Sources

**Description**

Inport blocks are the links from outside a system into the system.

Simulink software 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 software 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 “How to Specify the Sample Time” for more information.

**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 a 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.

**Limitation:** You cannot use a top-level (root) inport to supply fixed-point data that is contained in a structure. Consider using a `Simulink.Timeseries` object instead of a structure.

## 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.

You can use a subsystem inport to supply fixed-point data in a structure or in any other format.

## 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.
- 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.

## Connecting Buses to Root Level Inports

If you want a root level Inport of a model to produce a bus signal, you must select the Inport's **Specify properties via bus object** parameter and set the Inport's **Bus object for validating input bus** parameter to the name of a bus object that defines the bus that the Inport produces. If the bus contains mixed data types, the Inport's data type must be auto. See "Using Bus Objects" for more information.

## Data Type Support

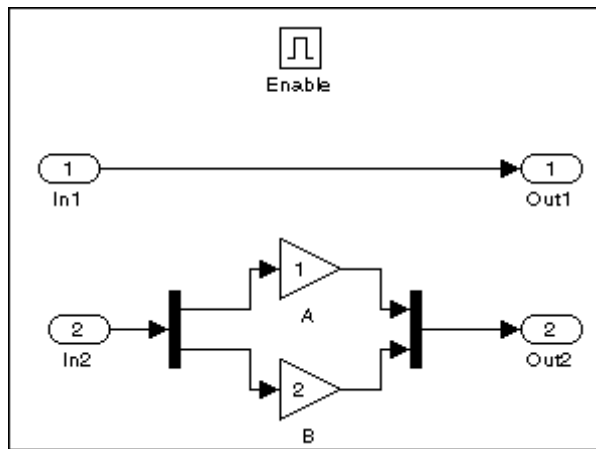
The Inport block accepts complex or real signals of any data type supported by Simulink software, including fixed-point and enumerated data types. For a discussion on the data types supported by Simulink software, see "Data Types Supported by Simulink".

**Limitation:** You cannot use a top-level (root) inport to supply fixed-point data that is contained in a structure. Consider using a `Simulink.Timeseries` object instead of a structure.

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.

# Inport

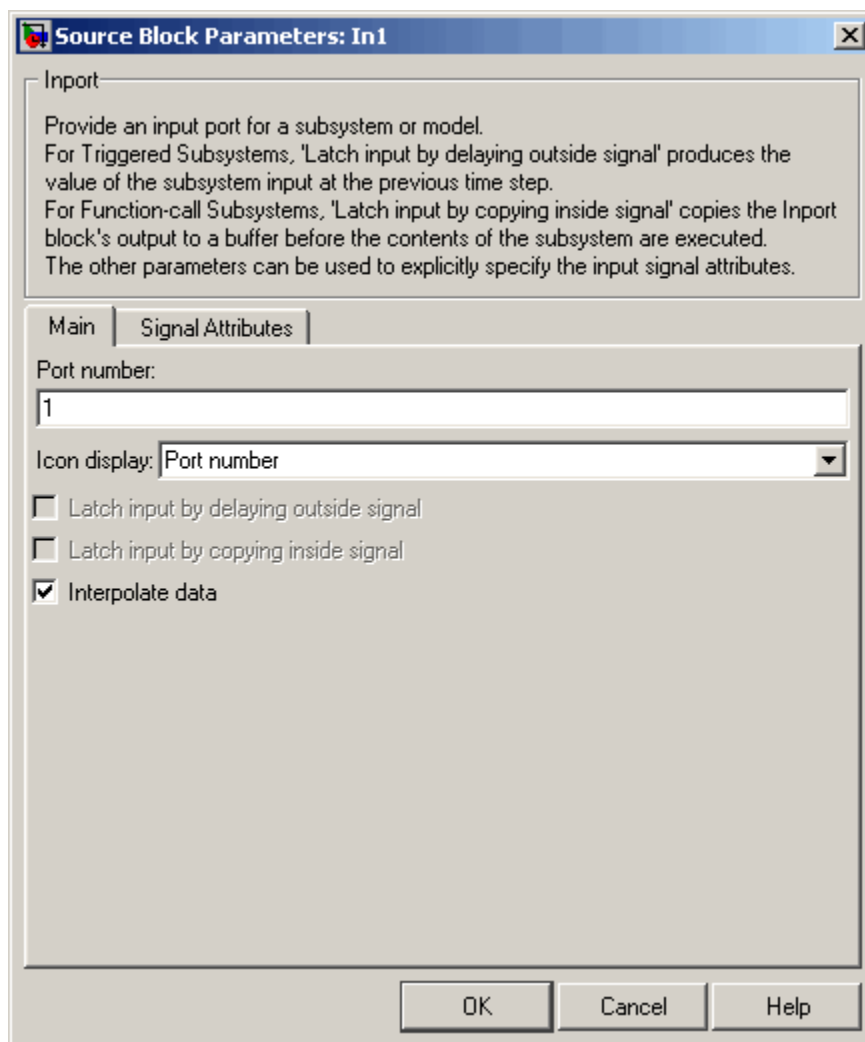
The elements of a signal array connected to a root-level Inport block must be of the same numeric and data types. Signal elements connected to a subsystem input port can be of differing numeric and data types except in the following circumstance: If the subsystem contains an Enable or Trigger block or 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.

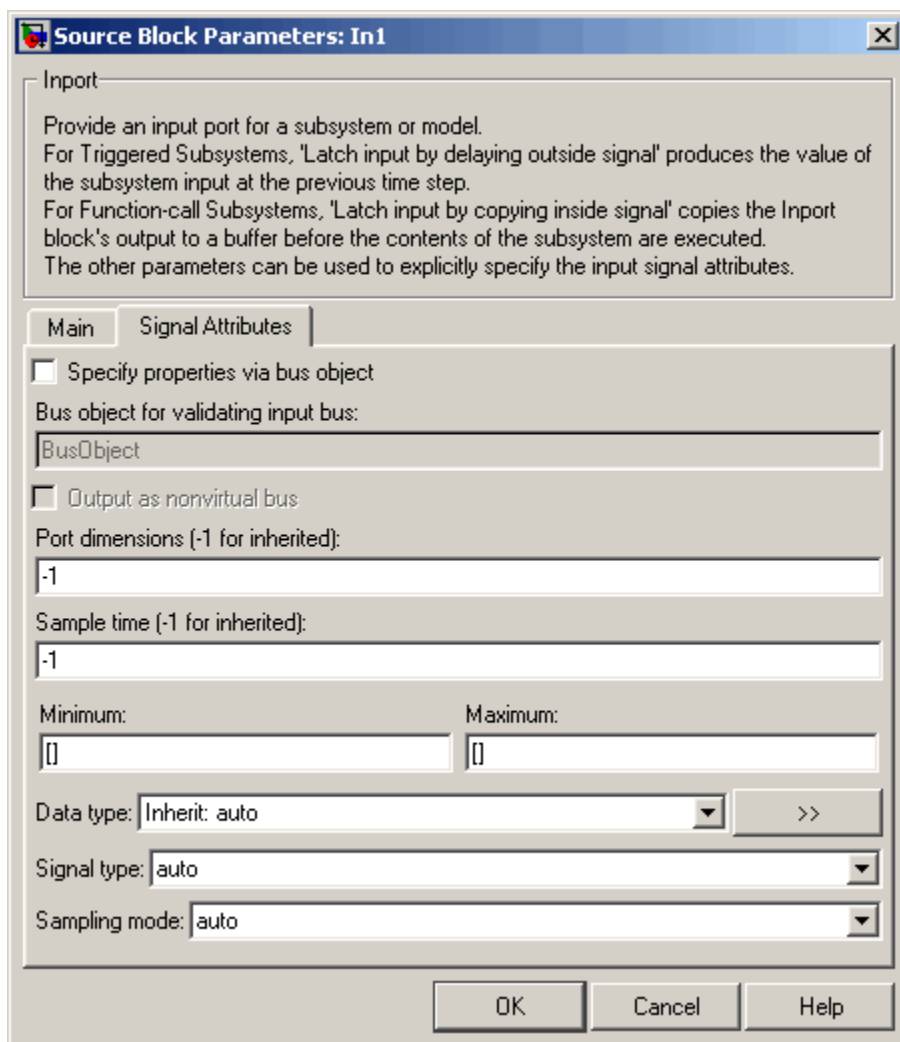
## Parameters and Dialog Box

The **Main** pane of the Inport block dialog appears as follows:



The **Signal Attributes** pane of the Inport block dialog appears as follows:

# Inport



## **Show data type assistant**

Display the **Data Type Assistant**.

### **Settings**

The **Data Type Assistant** helps you set the **Output data type** parameter.

See “Specifying Block Output Data Types” in *Simulink User’s Guide* for more information.

### **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

## **Port number**

Specify the port number of the block.

## **Settings**

**Default:** 1

This parameter controls the order in which the port that corresponds to the block appears on the parent subsystem or model block.

## **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.



## **Icon display**

Specify the information to be displayed on the icon of this input port.

### **Settings**

**Default:** Port number

Signal name

Display the name of the signal connected to this port (or signals if the input is a bus).

Port number

Display port number of this port.

Port number and signal name

Display both the port number and the names of the signals connected to this port.

### **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

## Latch input by delaying outside signal

Output the value of the input signal at the previous time step.

### Settings

**Default:** Off



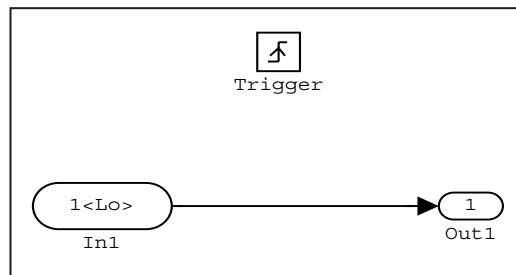
Output the value of the input signal at the previous time step.



Do not output the value of the input signal at the previous time step.

### Tips

- This option applies only to triggered subsystems and is enabled only if the Inport block resides in a triggered subsystem.
- Selecting this check box enables Simulink software to resolve data dependencies among triggered subsystems that are part of a loop.
- Type `s1_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>`.



### Command-Line Information

See “Block-Specific Parameters” on page 8-96 for the command-line information.

## Latch input by copying inside signal

Copy the block's signal output into a buffer before executing the contents of the subsystem and use this copy as the block's output during execution of the subsystem.

### Settings

**Default:** Off

On

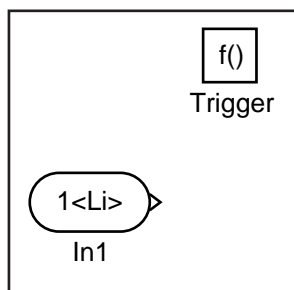
Copy the block's signal output into a buffer before executing the contents of the subsystem and use this copy as the block's output during execution of the subsystem.

Off

Do not copy the block's signal output into a buffer before executing the contents of the subsystem to use as the block's output during execution of the subsystem.

### Tips

- This parameter applies only to function-call subsystems and is enabled only if the Inport block resides in a function-call subsystem.
- This parameter ensures that the subsystem's inputs, including those generated within the subsystem's context, will not change during execution of the subsystem.
- The Inport block indicates that this option is selected by displaying `<Li>`.



## **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

## Interpolate data

Cause the block to interpolate or extrapolate output at time steps for which no corresponding workspace data exists when loading data from the workspace.

### Settings

**Default:** On

On

Cause the block to interpolate or extrapolate output at time steps for which no corresponding workspace data exists when loading data from the workspace.

Off

Do not cause the block to interpolate or extrapolate output at time steps for which no corresponding workspace data exists when loading data from the workspace.

### Command-Line Information

See “Block-Specific Parameters” on page 8-96 for the command-line information.

## Specify properties via bus object

Use a bus object to define the structure of the bus that is input or output by this block.

### Settings

**Default:** Off

On

Use a bus object to define the structure of the bus that is input or output by this block.

Off

Do not use a bus object to define the structure of the bus that is input or output by this block.

### Tips

Selecting this parameter is required if the bus is nonvirtual (including a nonvirtual bus that was converted from a virtual bus as described in “Automatic Bus Conversion”) and is optional otherwise.

### Dependencies

This parameter enables **Bus object for validating input bus**.

This parameter enables **Output as nonvirtual bus in parent model**.

### Command-Line Information

See “Block-Specific Parameters” on page 8-96 for the command-line information.

## **Bus object for validating input bus**

Specify the name of the bus object that defines the structure that a bus must have to be connected to this port.

### **Settings**

**Default:** BusObject

A bus object is an instance of class `Simulink.Bus` that is defined in the base workspace.

### **Tips**

At the beginning of a simulation or when you update the model's diagram, Simulink software checks whether the bus connected to this port has the specified structure. If not, Simulink software displays an error message.

### **Dependencies**

This parameter is enabled by **Specify properties via bus object**.

### **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

## Output as nonvirtual bus

Output a nonvirtual bus.

### Settings

**Default:** Off



On

Output a nonvirtual bus.



Off

Output a virtual bus.

### Tips

- 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.
- All signals in a nonvirtual bus must have the same sample time, even if the elements of the associated bus object specify inherited sample times. Any bus operation that would result in a nonvirtual bus that violates this requirement generates an error. Therefore, if you select this option all signals in the bus must have the same sample time. You can use a Rate Transition block to change the sample time of an individual signal, or of all signals in a bus, to allow the signal or bus to be included in a nonvirtual bus.

### Dependencies

This parameter is enabled by **Specify properties via bus object**.

### Command-Line Information

See “Block-Specific Parameters” on page 8-96 for the command-line information.



**Port dimensions (-1 for inherited)**

Specify the dimensions of the input signal to the block.

**Settings**

**Default:** -1

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

**Dependencies**

This parameter is enabled by clearing **Specify properties via bus object**.

**Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

## **Sample time (-1 for inherited)**

Specify the time interval between samples.

### **Settings**

**Default:** -1

To inherit the sample time, set this parameter to -1.

See “How to Specify the Sample Time” in the online documentation for more information.

### **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

## **Lock output scaling against changes by the autoscaling tool**

Select to lock scaling of outputs.

### **Settings**

**Default:** Off

On

Lock scaling of outputs.

Off

Do not lock scaling of outputs.

### **Dependencies**

This parameter is enabled when you enter an expression for the **Output data type** or **Data type** parameter.

### **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

## **Signal type**

Specify the numeric type of the external input.

### **Settings**

**Default:** auto

auto

Accept either `real` or `complex` as the numeric type.

real

Specify the numeric type as a real number.

complex

Specify the numeric type as a complex number.

### **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

## **Sampling mode**

Specify whether the output signal is `Sample based` or `Frame based`.

### **Settings**

**Default:** `auto`

`auto`

Accept any sampling mode.

`Sample based`

The output signal is sample-based.

`Frame based`

The output signal is frame-based.

### **Tips**

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

### **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

## **Minimum**

Specify the minimum value that the block should output.

## **Settings**

**Default:** []

The default value, [], is equivalent to `-Inf`. Simulink software uses this value to perform:

- Simulation range checking (see “Checking Signal Ranges”)
- Automatic scaling of fixed-point data types

## **Tip**

This number must be a double scalar value.

## **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

## **Maximum**

Specify the maximum value that the block should output.

### **Settings**

**Default:** []

The default value, [], is equivalent to  $-\text{Inf}$ . Simulink software uses this value to perform:

- Simulation range checking (see “Checking Signal Ranges”)
- Automatic scaling of fixed-point data types

### **Tip**

This number must be a double scalar value.

### **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

## Data type

Specify the output data type of the external input.

### Settings

**Default:** Inherit: auto

Inherit: auto

A rule that inherits a data type

double

Data type is double.

single

Data type is single.

int8

Data type is int8.

uint8

Data type is uint8.

int16

Data type is int16.

uint16

Data type is uint16.

int32

Data type is int32.

uint32

Data type is uint32.

boolean

Data type is boolean.

fixdt(1,16,0)

Data type is fixed point fixdt(1,16,0).

fixdt(1,16,2<sup>0</sup>,0)

Data type is fixed point fixdt(1,16,2<sup>0</sup>,0).



Enum: <class name>  
Data type is enumerated.

<data type expression>  
The name of a data type object, for example  
Simulink.NumericType

### **Tips**

This parameter can also be an expression that evaluates to a data type, for example, `float('single')`

### **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

## Mode

Select the category of data to specify

## Settings

**Default:** Inherit (Constant, Data Type Conversion, Discrete Time Integrator, Gain, Inport, Outport, Product, Saturation, Sum, Switch),  
**Built in** (Logical Operator, Relational Operator)

### Inherit

Inheritance rules for data types. Selecting **Inherit** enables a second menu/text box to the right. Below are the possible values, which can vary by block:

- Inherit from 'Constant value' (Constant block default)
- Inherit via internal rule (Discrete-Time Integrator, Gain, Product, Sum, Switch block default)
- Inherit via back propagation (Data Type Conversion block default)
- auto (Inport, Outport block default)
- Logical (see Configuration Parameters: Optimization)
- Same as first input
- Same as input (Saturation block default)
- Same as accumulator

### Built in

Built-in data types. Selecting **Built in** enables a second menu/text box to the right. Below are the possible values, which can vary by block:

- double (Constant, Data Type Conversion, Discrete-Time Integrator, Gain, Inport, Outport, Product, Saturation, Sum, Switch block default)
- single

- int8
- uint8
- int16
- uint16
- int32
- uint32
- boolean (Logical Operator, Relational Operator block default)

#### Fixed point

Fixed-point data types.

#### Enumerated

Enumerated data types. This option is available on some blocks. Selecting Enumerated enables a second menu/text box to the right. Below are the possible values, which can vary by block:

- <class name>

#### Expression

Expressions that evaluate to data types. Selecting Expression enables a second menu/text box to the right. Below are the possible values, which can vary by block:

- <data type expression>

#### Dependency

This parameter is enabled by the **Show data type assistant** button.

#### Command-Line Information

See “Block-Specific Parameters” on page 8-96 for the command-line information.

#### See Also

See “Using the Data Type Assistant” in the *Simulink User’s Guide*.

## **Signedness**

Specify whether you want the fixed-point data to be signed or unsigned.

### **Settings**

**Default:** Signed

Signed

Specify the fixed-point data to be signed.

Unsigned

Specify the fixed-point data to be unsigned.

### **Dependencies**

This parameter is enabled by selecting **Mode** > Fixed point.

### **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

### **See Also**

See “Specifying a Fixed-Point Data Type” in the *Simulink User’s Guide* for more information.

**Word length**

Specify the bit size of the word that will hold the quantized integer.

**Settings**

**Default:** 16

**Minimum:** 0

**Maximum:** 32

Large word sizes represent large values with greater precision than small word sizes.

**Dependencies**

This parameter is enabled by selecting **Mode** > Fixed point.

**Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

**See Also**

See “Specifying a Fixed-Point Data Type” in the *Simulink User’s Guide* for more information.

## Scaling

Specify the method for scaling your fixed-point data to avoid overflow conditions and minimize quantization errors.

## Settings

**Default:** Best precision (Constant), Binary point (Data Type Conversion, Discrete-Time Integrator, Gain, Inport, Outport, Product, Saturation, Sum, Switch), Integer (Logical Operator, Relational Operator)

Binary point

Specify binary point location.

Slope and bias

Enter slope and bias.

Best precision

Specify best-precision values. This option appears for some blocks.

Integer

Specify integer. This setting has the same result as specifying a binary point location and setting fraction length to 0. This option appears for some blocks.

## Dependencies

This parameter is enabled by selecting **Mode** > Fixed point.

Selecting Binary point enables:

- **Fraction length**
- **Calculate Best-Precision Scaling**

Selecting Slope and bias enables:

- **Slope**
- **Bias**
- **Calculate Best-Precision Scaling**

**Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

**See Also**

See “Specifying a Fixed-Point Data Type” in the *Simulink User’s Guide* for more information.

## **Fraction length**

Specify fraction length for fixed-point data type.

### **Settings**

**Default:** 0

Binary points can be positive or negative integers.

### **Dependencies**

This parameter is enabled by selecting **Scaling** > Binary point.

### **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

### **See Also**

See “Specifying a Fixed-Point Data Type” in the *Simulink User’s Guide* for more information.



## **Slope**

Specify slope for the fixed-point data type.

### **Settings**

**Default:**  $2^0$

Specify any positive real number.

### **Dependencies**

This parameter is enabled by selecting **Scaling** > Slope and bias.

### **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

### **See Also**

See “Specifying a Fixed-Point Data Type” in the *Simulink User’s Guide* for more information.

## **Bias**

Specify bias for the fixed-point data type.

## **Settings**

**Default:** 0

Specify any real number.

## **Dependencies**

This parameter is enabled by selecting **Scaling** > Slope and bias.

## **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

## **See Also**

See “Specifying a Fixed-Point Data Type” in the *Simulink User’s Guide* for more information.

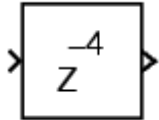
## **Characteristics**

Sample Time	Specified in the <b>Sample time</b> parameter
Dimensionalized	Yes
Multidimensionalized	Yes

**Purpose** Delay signal N sample periods

**Library** Discrete

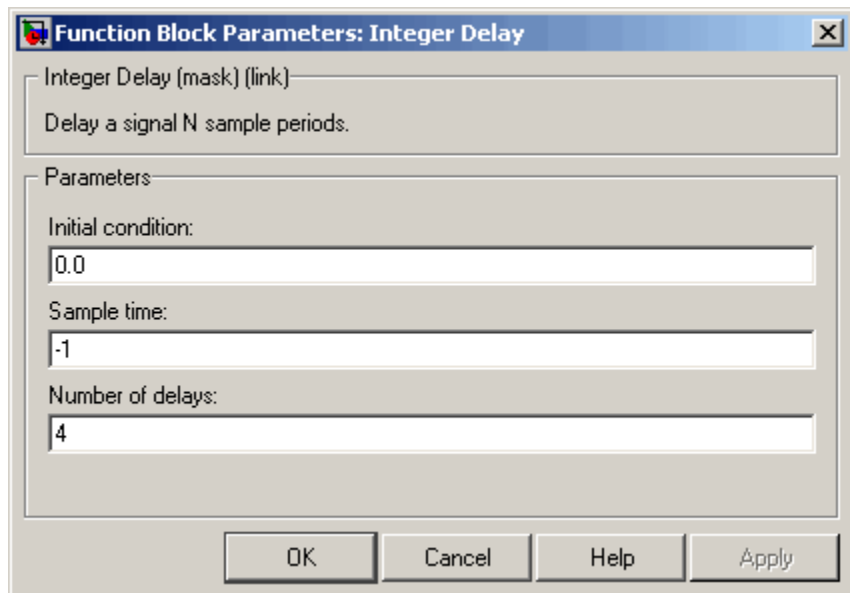
**Description** The Integer Delay block delays its input by N sample periods.



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 software, including fixed-point and enumerated data types.

## Parameters and Dialog Box



# Integer Delay

---

## 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 “How to Specify the Sample Time” in the online documentation for more information.

## Number of delays

The number of periods to delay the input signal.

---

**Note** This number cannot exceed the maximum value of a 32-bit integer divided by the input data type size (in bytes).

---

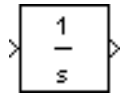
## Characteristics

Direct Feedthrough	No
Sample Time	Specified in the <b>Sample time</b> parameter
Scalar Expansion	Yes, of input or initial conditions

**Purpose** Integrate 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 software can use a number of different numerical integration methods to compute the Integrator block's output, each with advantages in particular applications. Use the **Solver** pane of the Configuration Parameters dialog box (see "Solver Pane") to select the technique best suited to your application.

Simulink software 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 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.

Use the parameter dialog box to:

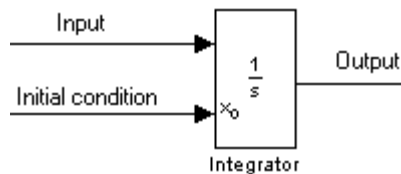
- Define upper and lower limits on the integral
- Create an input that resets the block's output (state) to its initial value, depending on how the input changes
- Create an optional state output so that the value of the block's output can trigger a block reset

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** 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.



---

**Note** If the integrator limits its output (see “Limiting the Integral” on page 2-547), 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.

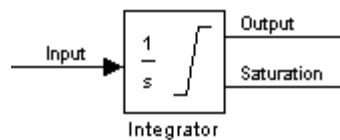
---

## 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. This action 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 block determines output 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.



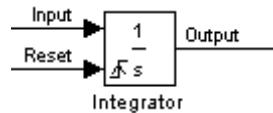
The signal has one of three values:

- 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 check box, 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.



- Select **rising** to reset the state when the reset signal rises from a zero to a positive value or from a negative to a positive value.
- Select **falling** to reset the state when the reset signal falls from a positive value to zero or from a positive to a negative value.
- Select **either** to reset the state when the reset signal changes from a zero to a nonzero value or changes sign.
- Select **level** to reset the state when the reset signal is nonzero at the current time step or changes from nonzero at the previous time step to zero at the current time step.
- Select **level hold** to reset the state when the reset signal is nonzero at the current time step.

The reset port has direct feedthrough. If the block output feeds back into this port, either directly or through a series of blocks with direct feedthrough, an algebraic loop results (see “Algebraic Loops”). Use the Integrator block’s state port to feed back the block’s output without creating an algebraic loop.

---

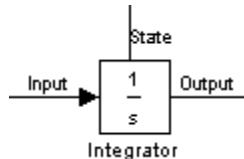
**Note** To be compliant with the Motor Industry Software Reliability Association (MISRA®) software standard, your model must use Boolean signals to drive the external reset ports of Integrator blocks.

---



## About the State Port

Selecting the **Show state port** check box on the Integrator block's parameter dialog box causes an additional output port, the state port, to appear at the top of 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. Use the state port to avoid creating algebraic loops in these modeling scenarios:

- Self-resetting integrators (see “Creating Self-Resetting Integrators” on page 2-550)
- Handing off a state from one enabled subsystem to another (see “Handing Off States Between Enabled Subsystems” on page 2-551)

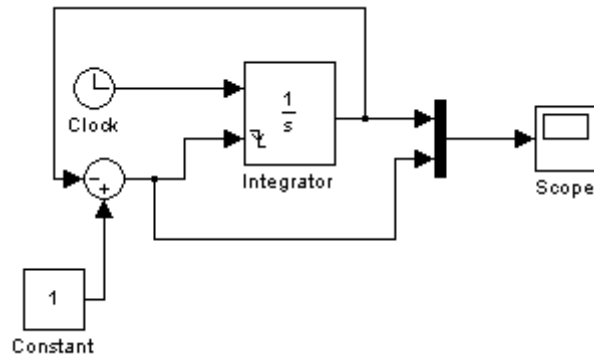
---

**Note** When updating a model, Simulink software checks that the state port applies to one of these two scenarios. If not, an error message appears. Also, you cannot log the output of this port in a referenced model that executes in Accelerator mode. If logging is enabled for the port, Simulink software generates a "signal not found" warning during execution of the referenced model.

---

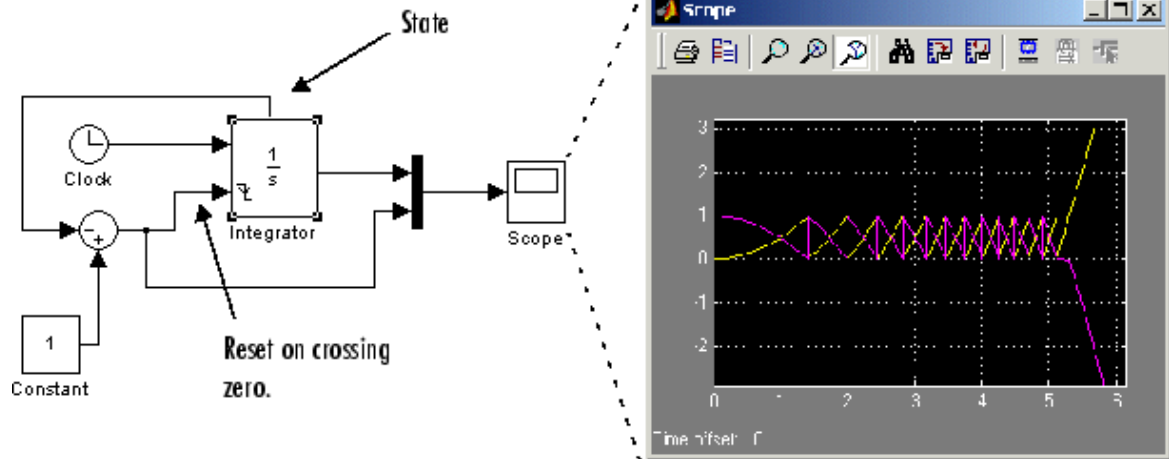
## Creating Self-Resetting Integrators

The Integrator block's state port helps you avoid an algebraic loop when creating an integrator that resets itself based on the value of its output. Consider, for example, the following model.



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. However, the model creates an algebraic loop. To compute the integrator block's output, Simulink software needs to know the value of the block's reset signal, and vice versa. Because the two values are mutually dependent, Simulink software cannot determine either. Therefore, an error message appears if you try to simulate or update this model.

The following model uses the integrator's state port to avoid the algebraic loop.

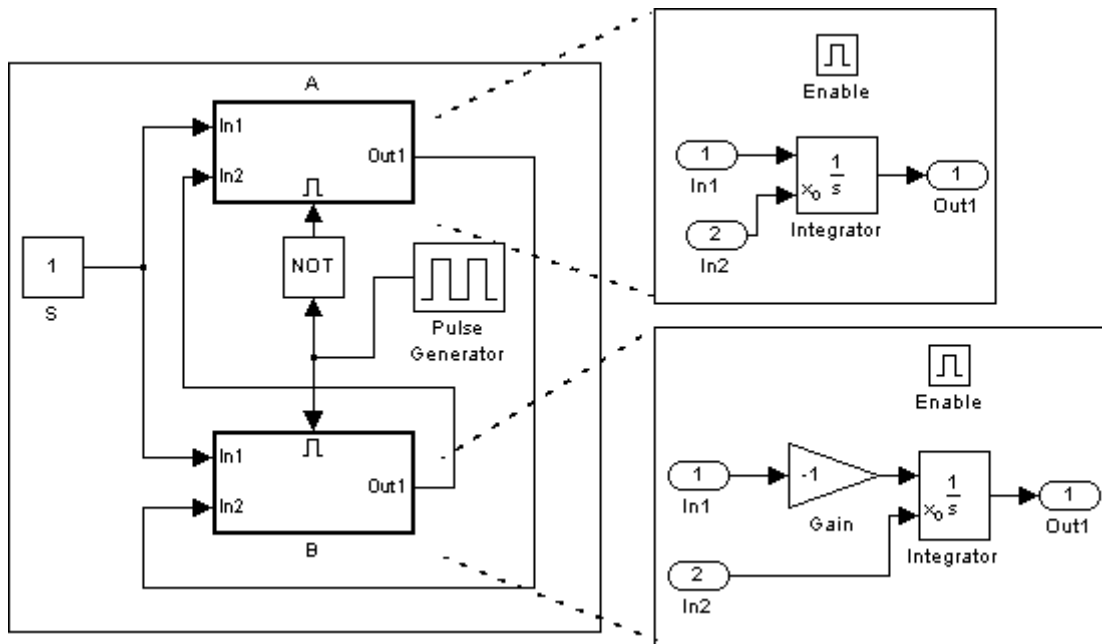


In this version, the value of the reset signal depends on the value of the state port. The value of the state port is available earlier in the current time step than the value of the integrator block's output port. Thus, Simulink software can determine whether the block needs to be reset before computing the block's output, thereby avoiding the algebraic loop.

## Handing Off States Between Enabled Subsystems

The state port helps you avoid an algebraic loop when passing a state between two enabled subsystems. Consider, for example, the following model.

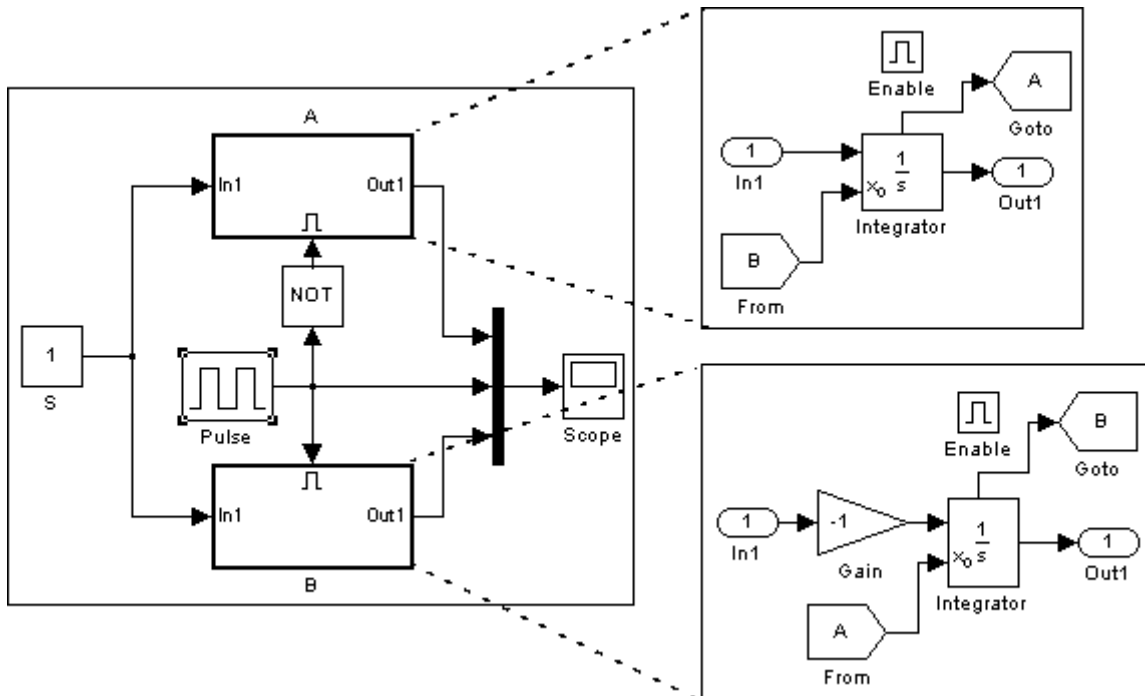
# Integrator



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, which 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.

This connection is intended to enable continuous integration of the input signal as execution alternates between two subsystems. However, the connection creates an algebraic loop. To compute the output of A, Simulink software needs to know the output of B, and vice versa. Because the outputs are mutually dependent, Simulink software cannot compute them. Therefore, an error message appears if you try to simulate or update 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 software 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 `sldemo_clutch` model.

---

**Note** Simulink software does not permit three or more enabled subsystems to hand off a model state. If Simulink software detects that a model is handing off a state among more than two enabled subsystems, it generates an error.

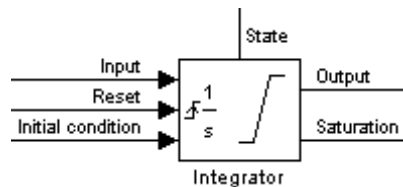
---

## Specifying the Absolute Tolerance for the Block's Outputs

By default Simulink software 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.

## Selecting All Options

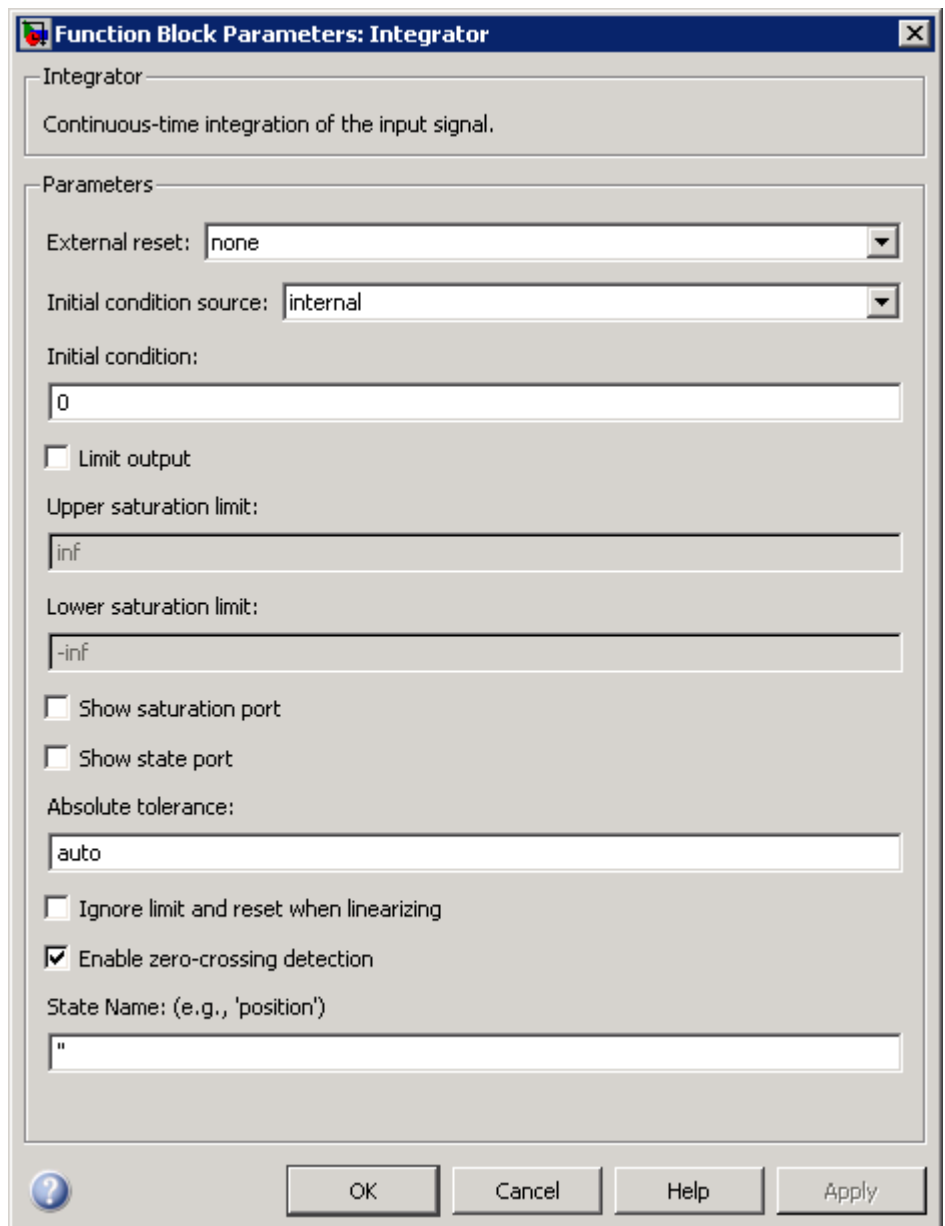
When you select all options, the block icon looks like this.



## 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`.

## Parameters and Dialog Box



**Function Block Parameters: Integrator**

Integrator  
Continuous-time integration of the input signal.

Parameters

External reset:

Initial condition source:

Initial condition:

Limit output

Upper saturation limit:

Lower saturation limit:

Show saturation port

Show state port

Absolute tolerance:

Ignore limit and reset when linearizing

Enable zero-crossing detection

State Name: (e.g., 'position')

? OK Cancel Help Apply

## External reset

Reset the states to their initial conditions when a trigger event occurs in the reset signal.

### Settings

**Default:** none

none

Do not reset the state to initial conditions.

rising

Reset the state when the reset signal rises from a zero to a positive value or from a negative to a positive value.

falling

Reset the state when the reset signal falls from a positive value to zero or from a positive to a negative value.

either

Reset the state when the reset signal changes from a zero to a nonzero value or changes sign.

level

Reset the state when the reset signal is nonzero at the current time step or changes from nonzero at the previous time step to zero at the current time step.

level hold

Reset the state when the reset signal is nonzero at the current time step.

### Command-Line Information

See “Block-Specific Parameters” on page 8-96 for the command-line information.



## Initial condition source

Get the initial conditions of the states.

### Settings

**Default:** internal

internal

Get the initial conditions of the states from the **Initial condition** parameter.

external

Get the initial conditions of the states from an external block.

### Tips

Simulink software does not allow the initial condition of this block to be inf or NaN.

### Dependencies

Selecting internal enables the **Initial condition** parameter.

Selecting external disables the **Initial condition** parameter.

### Command-Line Information

See “Block-Specific Parameters” on page 8-96 for the command-line information.

## **Initial condition**

Specify the states' initial conditions.

### **Settings**

**Default:** 0

**Minimum:** value of **Output minimum** parameter

**Maximum:** value of **Output maximum** parameter

### **Tips**

Simulink software does not allow the initial condition of this block to be inf or NaN.

### **Dependencies**

This parameter is enabled by setting **Initial condition source** to internal.

This parameter is disabled by setting **Initial condition source** to external.

### **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

## Limit output

Limit the block's output to a value between the **Lower saturation limit** and **Upper saturation limit** parameters.

### Settings

**Default:** Off

On

Limit the block's output to a value between the **Lower saturation limit** and **Upper saturation limit** parameters.

Off

Do not limit the block's output to a value between the **Lower saturation limit** and **Upper saturation limit** parameters.

### Dependencies

This parameter enables **Upper saturation limit**.

This parameter enables **Lower saturation limit**.

### Command-Line Information

See "Block-Specific Parameters" on page 8-96 for the command-line information.

## **Upper saturation limit**

Specify the upper limit for the integral.

### **Settings**

**Default:** inf

**Minimum:** value of **Output minimum** parameter

**Maximum:** value of **Output maximum** parameter

### **Dependencies**

This parameter is enabled by **Limit output**.

### **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

## **Lower saturation limit**

Specify the lower limit for the integral.

### **Settings**

**Default:** -inf

**Minimum:** value of **Output minimum** parameter

**Maximum:** value of **Output maximum** parameter

### **Dependencies**

This parameter is enabled by **Limit output**.

### **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

## Show saturation port

Add a saturation output port to the block.

### Settings

**Default:** Off

On

Add a saturation output port to the block.

Off

Do not add a saturation output port to the block.

### Command-Line Information

See “Block-Specific Parameters” on page 8-96 for the command-line information.

## Show state port

Add an output port to the block for the block's state.

### Settings

**Default:** Off



On

Add an output port to the block for the block's state.



Off

Do not add an output port to the block for the block's state.

### Command-Line Information

See “Block-Specific Parameters” on page 8-96 for the command-line information.

## **Absolute tolerance**

Compute the block's outputs with respect to absolute tolerance.

### **Settings**

**Default:** auto

- If you enter auto, Simulink software determines the absolute tolerance
- If you enter a numeric value, Simulink software uses the specified value to compute the block's outputs.

### **Tips**

Note that a numeric value overrides the setting for the absolute tolerance in the **Configuration Parameters** dialog box.

### **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.



## Ignore limit and reset when linearizing

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.

### Settings

**Default:** Off



On

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.



Off

Do not 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.

### Tips

This allows you to linearize a model around an operating point that causes the integrator to reset or saturate.

### Command-Line Information

See “Block-Specific Parameters” on page 8-96 for the command-line information.

## Enable zero-crossing detection

Use 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.

### Settings

**Default:** On



On

Use 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.



Off

Do not use 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.

### Tips

If this option, **Limit output**, and zero-crossing detection for the model as a whole are selected, the Integrator block uses zero crossings as described. See “How Blocks Work with Zero-Crossing Detection” in the “How Simulink Works” chapter of the Simulink documentation for more information.

### Command-Line Information

See “Block-Specific Parameters” on page 8-96 for the command-line information.

## State Name (e.g., 'position')

Use this to assign a unique name to each state.

### Settings

Default: ' '

- If left blank, no name is assigned.

### Tips

- To assign a name to a single state, enter the name between quotes, for example, 'velocity' .
- The state names apply only to the selected block.
- To assign names to multiple states, enter a comma-delimited list surrounded by braces. For example, { 'a' , 'b' , 'c' } . Each name must be unique.
- The number of states must be evenly divided by the number of state names. There can be fewer names than states, but there cannot be more names than states.
- For example, you can specify two names in a system with four states. Simulink software will assign the first name to the first two states and the second name to the last two.
- To assign state names with a variable that has been defined in the MATLAB workspace, enter the variable without quotes. A variable can be a string, cell, or structure.

### Command-Line Information

See “Block-Specific Parameters” on page 8-96 for the command-line information.

## Characteristics

Direct Feedthrough	Yes, of the reset and external initial condition source ports
Sample Time	Continuous

# Integrator

---

Scalar Expansion	Yes, of parameters
States	Inherited from driving block or parameter
Dimensionalized	Yes
Zero Crossing	Yes, if enabled and you select the <b>Limit output</b> option, one for detecting reset, one each to detect upper and lower saturation limits, one when leaving saturation

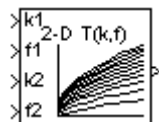
## Purpose

Use output of Prelookup block to accelerate approximation of N-dimensional function

## Library

Lookup Tables

## Description



The Interpolation Using Prelookup block is intended for use with the Prelookup block. The Prelookup block calculates the index and interval fraction that specifies how its input value relates to the breakpoint data set. You feed the resulting index and fraction values into an Interpolation 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. However, the Prelookup and Interpolation Using Prelookup blocks offer greater flexibility that can provide more efficient simulation and code generation.

To use this block, you must define a set of output values as the **Table data** parameter. In normal use, these table values correspond to the breakpoint data sets specified in Prelookup blocks. The Interpolation Using Prelookup block generates its output by looking up or estimating table values based on the index and interval fraction values (denoted on the block as  $k$  and  $f$ , respectively) fed into the block by each Prelookup block:

- If the inputs match the values of indices specified in breakpoint data sets, the Interpolation Using Prelookup block outputs the table value at the intersection of the row, column, and higher dimension breakpoints.
- If the inputs do not match the values of indices specified in breakpoint data sets, the Interpolation Using Prelookup block generates output by interpolating appropriate table values. If the inputs are beyond the range of breakpoint data sets, the Interpolation Using Prelookup block can extrapolate its output value.

The Interpolation Using Prelookup block can perform interpolation on a portion of its table. The **Number of sub-table selection dimensions** parameter lets you specify that interpolation occur only on a subset of its

# Interpolation Using Prelookup

---

**Table data** parameter. For example, if your 3-D table data constitutes a stack of 2-D tables to be interpolated, set the **Number of sub-table selection dimensions** parameter to 1. The block displays an input port (labeled as `sel`) used to select and interpolate the 2-D tables.

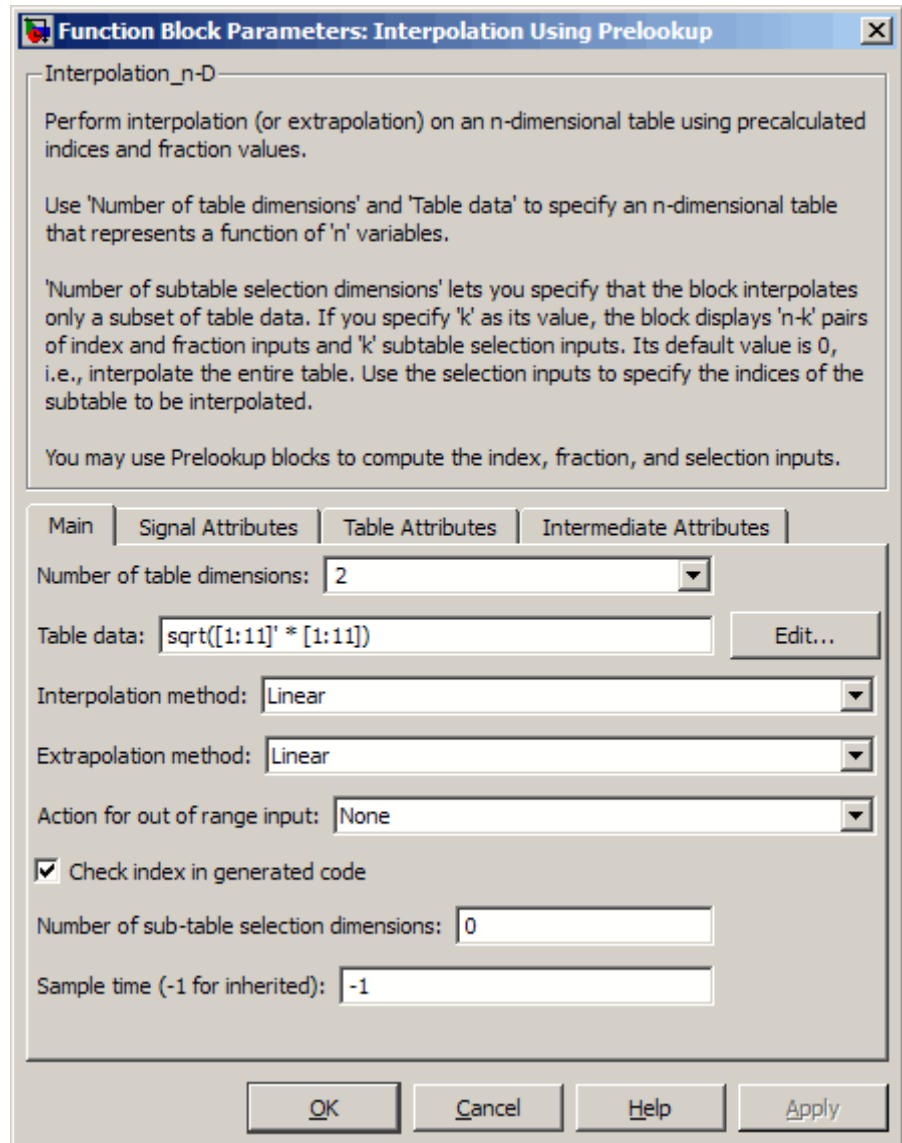
## Data Type Support

The Interpolation Using Prelookup block accepts real signals of any numeric data type supported by Simulink software, except `Boolean`. The Interpolation Using Prelookup block supports fixed-point data types for signals, table data, and intermediate results.

For a discussion on the data types supported by Simulink software, see “Data Types Supported by Simulink” in the Simulink documentation.

## Parameters and Dialog Box

The **Main** pane of the Interpolation Using Prelookup block dialog box appears as follows:



# Interpolation Using Prelookup

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## 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. Enter an integer between 1 and 30 into this field.

## Table data

The table of output values. During simulation, the matrix size must match the dimensions defined by the **Number of table dimensions** parameter. Note that during block diagram editing, you can enter an empty matrix (specified as []) or an undefined workspace variable as the **Table data** parameter. Use this behavior to postpone specifying a correctly-dimensioned matrix for the **Table data** parameter and continue editing the block diagram. For information about how to construct multidimensional arrays in MATLAB software, see “Multidimensional Arrays” in the MATLAB online documentation.

Click the **Edit** button to open the Lookup Table Editor (see “Lookup Table Editor” in the Simulink documentation).

## Interpolation method

None - Flat or Linear. See “Interpolation Methods” in the Simulink documentation for more information.

## Extrapolation method

None - Clip or Linear. See “Extrapolation Methods” in the Simulink documentation for more information. The **Extrapolation method** parameter is visible only if you select Linear as the **Interpolation method** parameter.

---

**Note** The Interpolation Using Prelookup block does not support Linear extrapolation if its input or output signals specify integer or fixed-point data types.

---



## 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

## Check index in generated code (Real-Time Workshop license required)

Specifies whether Real-Time Workshop software generates code that checks the validity of the index values fed to this block.

## Valid index input may reach last index

Specifies how the index and interval fraction inputs to the block (labeled respectively as **k** and **f** on the block) access the last elements of the  $n$ -dimensional table specified by the **Table data** parameter. If enabled, the block returns the value of the last element in a particular dimension of its table when **k** indexes the last table element in the corresponding dimension and **f** is 0. If disabled, the block returns the value of the last element in a particular dimension of its table when **k** indexes the next-to-last table element in the corresponding dimension and **f** is 1. Note that index values are zero-based.

This parameter is visible only if the **Interpolation method** specifies **Linear** and the **Extrapolation method** is **None - Clip**.

# Interpolation Using Prelookup

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**Note** If you enable the **Valid index input may reach last index** parameter for an Interpolation Using Prelookup block, you must also enable the **Use last breakpoint for input at or above upper limit** parameter for all Prelookup blocks that feed it. This action allows the blocks to use the same indexing convention when accessing the last elements of their **Breakpoint data** and **Table data** parameters.

---

## **Number of sub-table selection dimensions**

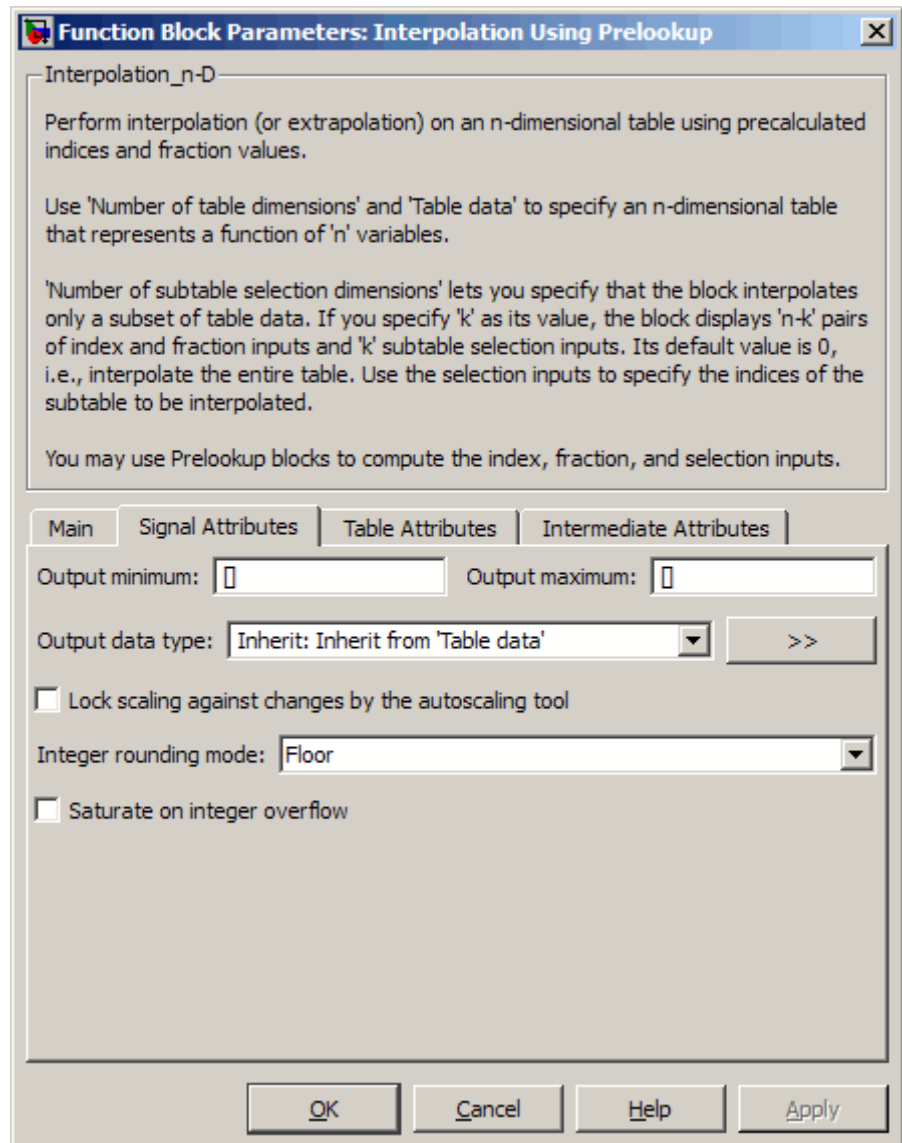
Specifies the number of dimensions of the subtable used to compute this block's output. Specify 0 (the default) to interpolate the entire table, which disables subtable selection.

## **Sample time**

Specify the time interval between samples. To inherit the sample time, set this parameter to -1. See “How to Specify the Sample Time” in the Simulink documentation for more information.

The **Signal Attributes** pane of the Interpolation Using Prelookup block dialog box appears as follows:

# Interpolation Using Prelookup



# Interpolation Using Prelookup

---

## Output minimum

Specify the minimum value that the block should output. The default value, [], is equivalent to `-Inf`. Simulink software uses this value to perform:

- Parameter range checking (see “Checking Parameter Values”)
- Simulation range checking (see “Checking Signal Ranges”)
- Automatic scaling of fixed-point data types

## Output maximum

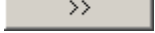
Specify the maximum value that the block should output. The default value, [], is equivalent to `Inf`. Simulink software uses this value to perform:

- Parameter range checking (see “Checking Parameter Values”)
- Simulation range checking (see “Checking Signal Ranges”)
- Automatic scaling of fixed-point data types

## Output data type

Specify the output data type. You can set it to:

- A rule that inherits a data type, for example, `Inherit: Inherit via back propagation`
- The name of a built-in data type, for example, `single`
- The name of a data type object, for example, a `Simulink.NumericType` object
- An expression that evaluates to a data type, for example, `fixdt(1,16,0)`

Click the **Show data type assistant** button  to display the **Data Type Assistant**, which helps you set the **Output data type** parameter.

See “Specifying Block Output Data Types” in the *Simulink User’s Guide* for more information.

## **Lock scaling against changes by the autoscaling tool**

Select to lock scaling of data.

## **Integer rounding mode**

Select the rounding mode for fixed-point operations. For more information, see “Rounding” in the *Simulink Fixed Point User’s Guide*.

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.

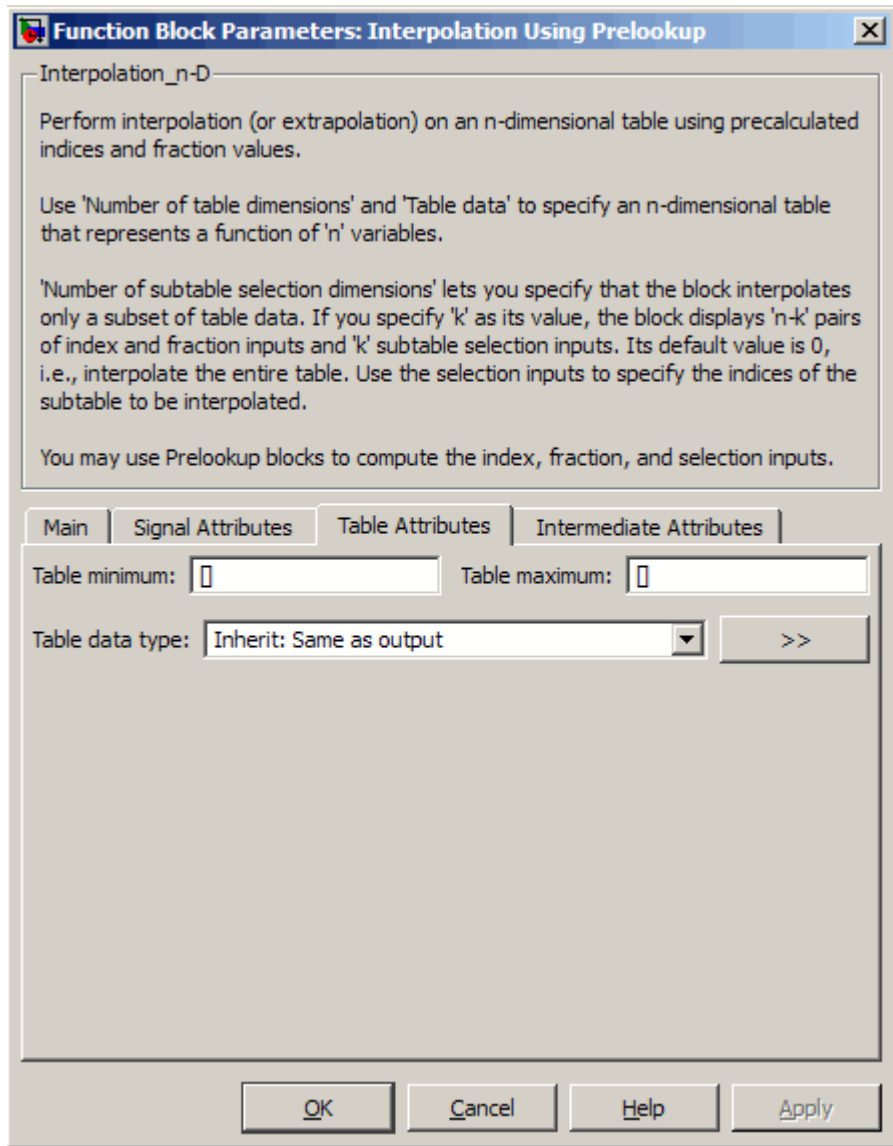
## **Saturate on integer overflow**

Select to have overflows saturate. Otherwise, overflows wrap.

When you select this check box, saturation applies to every internal operation on the block, not just the output or result. In general, the code generation process can detect when overflow is not possible, in which case, no saturation code is generated.

The **Table Attributes** pane of the Interpolation Using Prelookup block dialog box appears as follows:

# Interpolation Using Prelookup



## Table minimum

Specify the minimum value for table data. The default value, [], is equivalent to `-Inf`.


## Table maximum

Specify the maximum value for table data. The default value, [], is equivalent to `Inf`.

## Table data type

Specify the table data type. You can set it to:

- A rule that inherits a data type, for example, `Inherit: Same as output`
- The name of a built-in data type, for example, `single`
- The name of a data type object, for example, a `Simulink.NumericType` object
- An expression that evaluates to a data type, for example, `fixdt(1,16,0)`

Click the **Show data type assistant** button  to display the **Data Type Assistant**, which helps you set the **Table data type** parameter.

---

**Tip** Specify a table data type different from the output data type for these cases:

- Lower memory requirement for storing table data that uses a smaller type than the output signal
  - Sharing of prescaled table data between two Interpolation Using Prelookup blocks with different output data types
  - Sharing of custom storage table data in Real-Time Workshop generated code for blocks with different output data types
-

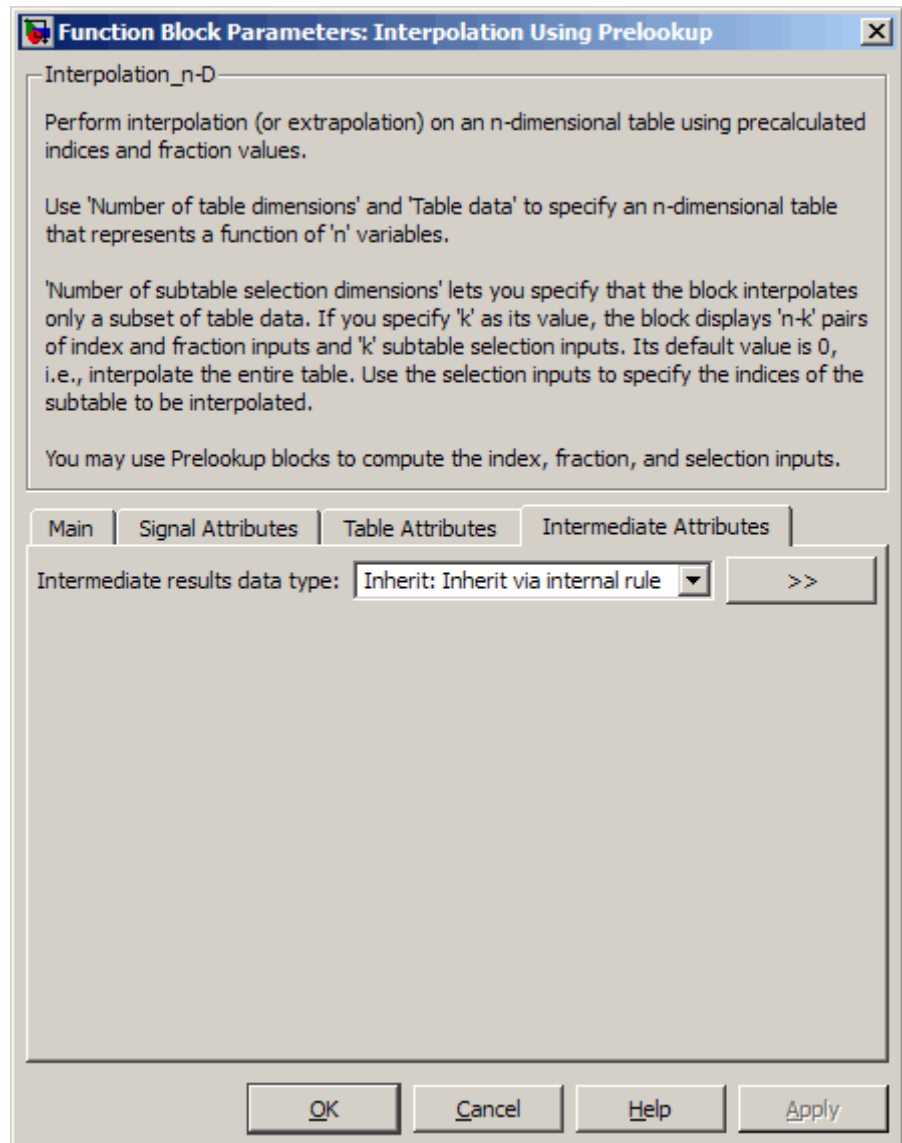
# Interpolation Using Prelookup

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The **Intermediate Attributes** pane of the Interpolation Using Prelookup block dialog box appears as follows:



# Interpolation Using Prelookup



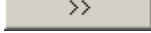
# Interpolation Using Prelookup

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## Intermediate results data type

Specify the intermediate results data type. You can set it to:

- A rule that inherits a data type, for example, `Inherit: Same as output`
- The name of a built-in data type, for example, `single`
- The name of a data type object, for example, a `Simulink.NumericType` object
- An expression that evaluates to a data type, for example, `fixdt(1,16,0)`

Click the **Show data type assistant** button  to display the **Data Type Assistant**, which helps you set the **Intermediate results data type** parameter.

---

**Tip** Use this parameter to specify higher precision for internal computations than for table data or output data.

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## Characteristics

Direct Feedthrough	Yes
Sample Time	Specified in the <b>Sample time</b> parameter
Scalar Expansion	Yes
Dimensionalized	Yes
Zero Crossing	No

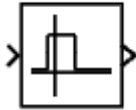
## See Also

Prelookup

**Purpose** Determine if signal is in specified interval

**Library** Logic and Bit Operations

## Description

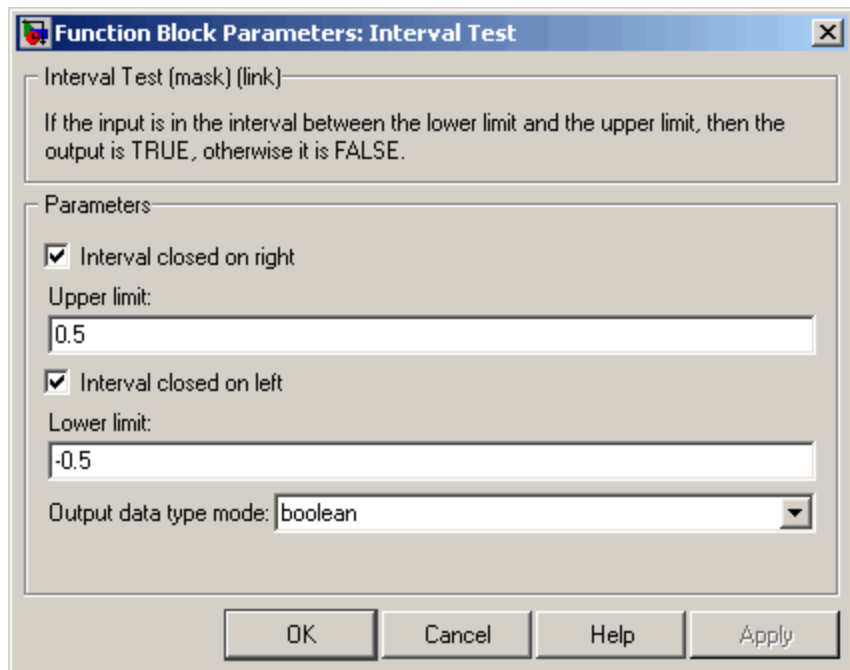


The Interval Test block outputs TRUE if the input is between the values specified by the **Lower limit** and **Upper limit** parameters. The block outputs FALSE if the input is outside those values. The output of the block when the input is equal to the **Lower limit** or the **Upper limit** is determined 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 software, including fixed-point and enumerated data types.

## Parameters and Dialog Box



# Interval Test

---

## 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

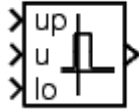
## See Also

Interval Test Dynamic

**Purpose** Determine if signal is in specified interval

**Library** Logic and Bit Operations

## Description

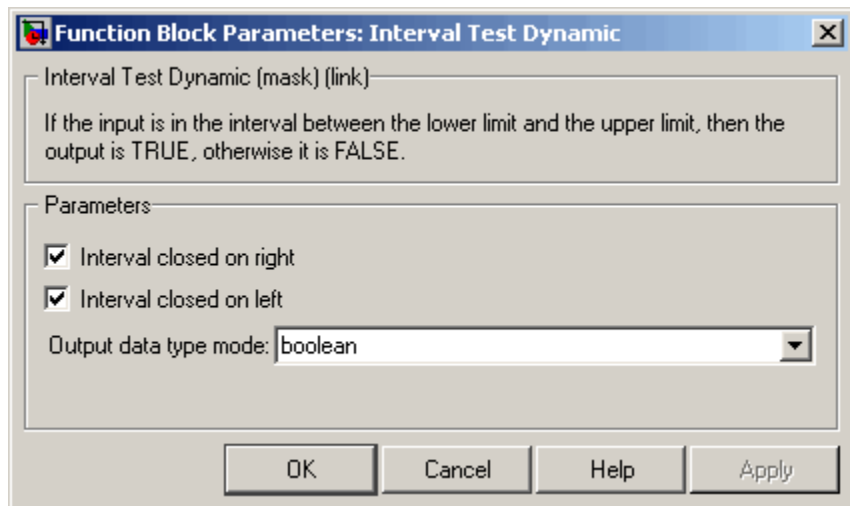


The Interval Test Dynamic block outputs TRUE if the input is between the values of the external signals up and lo. The block outputs FALSE if the input is outside those values. The output of the block when the input is equal to the signal up or the signal lo is determined by whether the boxes next to **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 software, including fixed-point and enumerated 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 Test Dynamic

---

## 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

**Purpose**

Use Level-2 M-file S-function in 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.

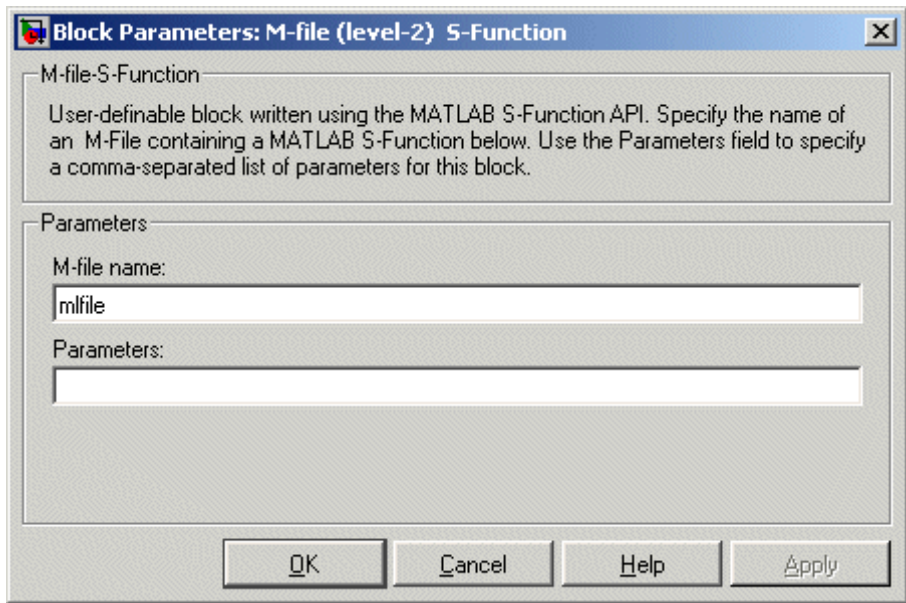
If a model includes a Level-2 M-File S-Function block, and an error occurs in the S-function, the Level-2 M-File S-Function block displays M-file stack trace information for the error in a dialog box. Click **OK** to remove the dialog box.

**Data Type Support**

Depends on the M-file that defines the behavior of a particular instance of this block.

# Level-2 M-File S-Function

## 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



## Level-2 M-File S-Function

---

Multidimensionalized	Yes
Zero Crossing	No

# Logical Operator

---

**Purpose** Perform specified logical operation on input

**Library** Logic and Bit Operations

**Description**

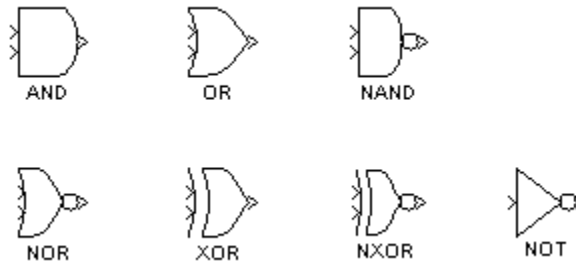


The Logical Operator block performs the specified logical operation on its inputs. An input value is TRUE (1) if it is nonzero and FALSE (0) if it is zero.

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
NXOR	TRUE if an even 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 software 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** parameter. 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.

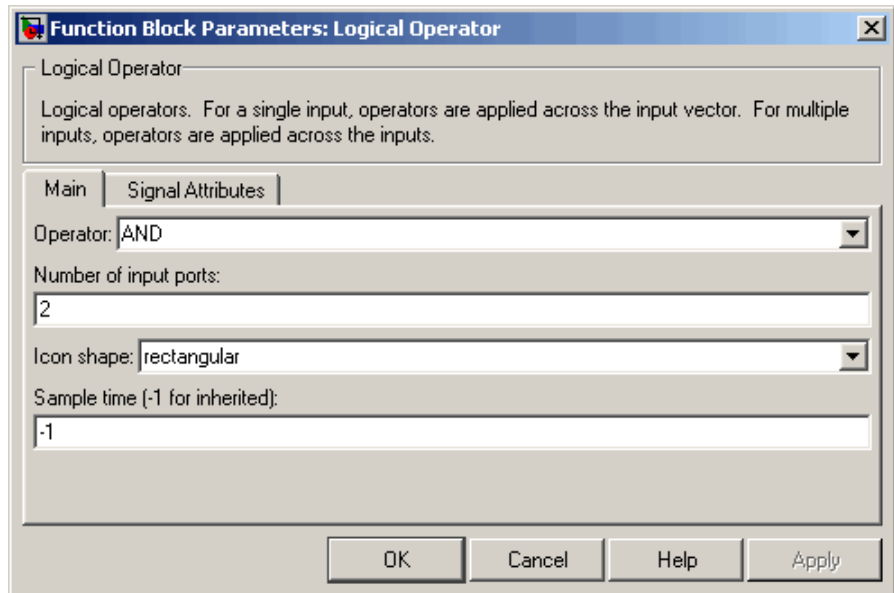
## **Data Type Support**

The Logical Operator block accepts real signals of any numeric data type supported by Simulink software, including fixed-point data types.

For a discussion on the data types supported by Simulink software, see “Data Types Supported by Simulink” in the Simulink documentation.

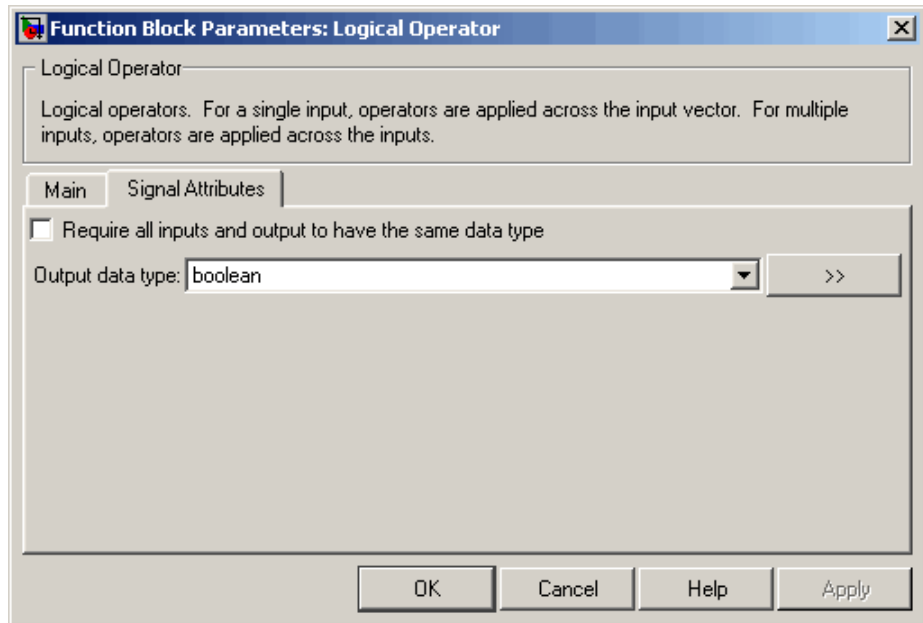
## Parameters and Dialog Box

The **Main** pane of the Logical Operator block dialog box appears as follows:



# Logical Operator

The **Signal Attributes** pane of the Logical Operator block dialog box appears as follows:



## **Show data type assistant**

Display the **Data Type Assistant**.

### **Settings**

The **Data Type Assistant** helps you set the **Output data type** parameter.

See “Specifying Block Output Data Types” in *Simulink User’s Guide* for more information.

### **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

# Logical Operator

---

## **Operator**

Select logical operator to apply to block inputs.

## **Settings**

**Default:** AND

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

NXOR

TRUE if an even number of inputs are TRUE

NOT

TRUE if the input is FALSE

## **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.



## **Number of input ports**

Specify number of block inputs.

### **Settings**

**Default:** 2

- The value must be appropriate for the selected operator.

### **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

# Logical Operator

---

## **Icon shape**

Specify shape of the block icon.

## **Settings**

**Default:** rectangular

rectangular

Result in a rectangular block that displays the name of the selected operator.

distinctive

Use the graphic symbol for the selected operator as specified by the IEEE standard.

## **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

## **Sample time (-1 for inherited)**

Enter the discrete interval between sample time hits or specify another appropriate sample time such as continuous or inherited.

### **Settings**

**Default:** -1

By default, the block inherits its sample time based upon the context of the block within the model. To set a different sample time, enter a valid sample time based upon the table in “Types of Sample Time”.

See also “How to Specify the Sample Time” in the online documentation for more information.

### **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

# Logical Operator

---

## **Require all inputs and output to have the same data type**

Require all inputs and the output to have the same data type.

### **Settings**

**Default:** Off

On

Require all inputs and the output to have the same data type.

Off

Do not require all inputs and the output to have the same data type.

### **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

## Output data type

Specify the output data type.

### Settings

**Default:** boolean

**Inherit:** Logical (see Configuration Parameters: Optimization)

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.

---

boolean

Output data type is boolean.

fixdt(1,16)

Output data type is fixdt(1,16).

<data type expression>

Use the name of a data type object (for example, Simulink.NumericType)

---

**Tip** To enter a built-in data type (double, single, int8, uint8, int16, uint16, int32, or uint32), enclose the expression in single quotes. For example, enter 'double' instead of double.

---

## Command-Line Information

See “Block-Specific Parameters” on page 8-96 for the command-line information.

# Logical Operator

---

## Mode

Select the category of data to specify

## Settings

**Default:** Inherit (Constant, Data Type Conversion, Discrete Time Integrator, Gain, Inport, Outport, Product, Saturation, Sum, Switch),  
**Built in** (Logical Operator, Relational Operator)

### Inherit

Inheritance rules for data types. Selecting **Inherit** enables a second menu/text box to the right. Below are the possible values, which can vary by block:

- Inherit from 'Constant value' (Constant block default)
- Inherit via internal rule (Discrete-Time Integrator, Gain, Product, Sum, Switch block default)
- Inherit via back propagation (Data Type Conversion block default)
- auto (Inport, Outport block default)
- Logical (see Configuration Parameters: Optimization)
- Same as first input
- Same as input (Saturation block default)
- Same as accumulator

### Built in

Built-in data types. Selecting **Built in** enables a second menu/text box to the right. Below are the possible values, which can vary by block:

- double (Constant, Data Type Conversion, Discrete-Time Integrator, Gain, Inport, Outport, Product, Saturation, Sum, Switch block default)
- single

- int8
- uint8
- int16
- uint16
- int32
- uint32
- boolean (Logical Operator, Relational Operator block default)

## Fixed point

Fixed-point data types.

## Enumerated

Enumerated data types. This option is available on some blocks. Selecting Enumerated enables a second menu/text box to the right. Below are the possible values, which can vary by block:

- <class name>

## Expression

Expressions that evaluate to data types. Selecting Expression enables a second menu/text box to the right. Below are the possible values, which can vary by block:

- <data type expression>

## Dependency

This parameter is enabled by the **Show data type assistant** button.

## Command-Line Information

See “Block-Specific Parameters” on page 8-96 for the command-line information.

## See Also

See “Using the Data Type Assistant” in the *Simulink User’s Guide*.

# Logical Operator

---

## **Signedness**

Specify whether you want the fixed-point data to be signed or unsigned.

### **Settings**

**Default:** Signed

Signed

Specify the fixed-point data to be signed.

Unsigned

Specify the fixed-point data to be unsigned.

### **Dependencies**

This parameter is enabled by selecting **Mode** > Fixed point.

### **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

### **See Also**

See “Specifying a Fixed-Point Data Type” in the *Simulink User’s Guide* for more information.



## Word length

Specify the bit size of the word that will hold the quantized integer.

### Settings

**Default:** 16

**Minimum:** 0

**Maximum:** 32

Large word sizes represent large values with greater precision than small word sizes.

### Dependencies

This parameter is enabled by selecting **Mode** > Fixed point.

### Command-Line Information

See “Block-Specific Parameters” on page 8-96 for the command-line information.

### See Also

See “Specifying a Fixed-Point Data Type” in the *Simulink User’s Guide* for more information.

# Logical Operator

---

## Scaling

Specify the method for scaling your fixed-point data to avoid overflow conditions and minimize quantization errors.

## Settings

**Default:** Best precision (Constant), Binary point (Data Type Conversion, Discrete-Time Integrator, Gain, Inport, Outport, Product, Saturation, Sum, Switch), Integer (Logical Operator, Relational Operator)

Binary point

Specify binary point location.

Slope and bias

Enter slope and bias.

Best precision

Specify best-precision values. This option appears for some blocks.

Integer

Specify integer. This setting has the same result as specifying a binary point location and setting fraction length to 0. This option appears for some blocks.

## Dependencies

This parameter is enabled by selecting **Mode** > Fixed point.

Selecting Binary point enables:

- **Fraction length**
- **Calculate Best-Precision Scaling**

Selecting Slope and bias enables:

- **Slope**
- **Bias**
- **Calculate Best-Precision Scaling**

## Command-Line Information

See “Block-Specific Parameters” on page 8-96 for the command-line information.

## See Also

See “Specifying a Fixed-Point Data Type” in the *Simulink User’s Guide* for more information.

## Characteristics

Direct Feedthrough	Yes
Sample Time	Specified in the <b>Sample time</b> parameter
Scalar Expansion	Yes, of inputs
Dimensionalized	Yes
Multidimensionalized	Yes
Zero Crossing	No

# Lookup Table

---

**Purpose** Approximate one-dimensional function

**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**.

---

**Tip** Evenly-spaced input data can make Real-Time Workshop generated code division-free. For more information, see `fixpt_evenspace_cleanup` in the Simulink documentation and “Identify questionable fixed-point operations” in the Real-Time Workshop documentation.

---

For more information about size and monotonicity requirements, see “Characteristics of Lookup Table Data” in *Simulink User's Guide*. To learn how to model a discontinuous function using a Lookup Table block, see “Representation of Discontinuities in Lookup Tables”.

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 **Lookup 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.

---

**Note** If the **Lookup method** parameter specifies **Interpolation-Extrapolation**, Real-Time Workshop code generation can occur for this block only if its input and output signals have the same floating-point data type.

---

- **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.

# Lookup Table

---

---

**Note** If the input value is exactly halfway between two points in the **Vector of input values**, the nearest input is the point with the higher numerical value.

Suppose that you define the **Vector of input values** as [0 2] and the **Table data** as [0 1]. If your input value is 1, the Use Input Nearest method chooses the nearest input to be 2, and the corresponding output is 1.

---

- **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 Lookup Table icon displays a graph of the input vector versus the output vector. If you change a parameter on the block's dialog box, the graph is automatically redrawn when you click the **OK** or **Apply** button.

To avoid parameter saturation errors, the Simulink Fixed Point software's automatic scaling script 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.

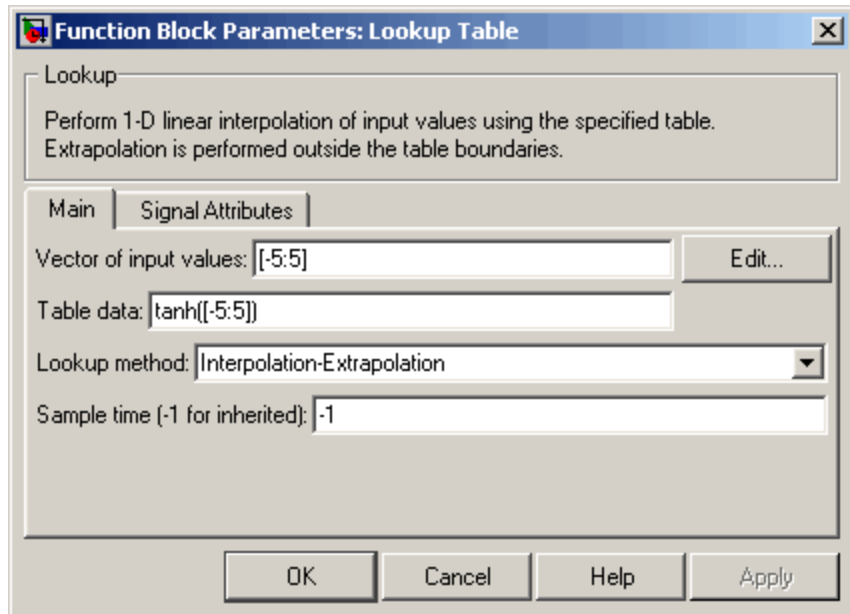
## Data Type Support

The Lookup Table block supports all numeric data types supported by Simulink software, including fixed-point data types.

For a discussion on the data types supported by Simulink software, see “Data Types Supported by Simulink” in the Simulink documentation.

## Parameters and Dialog Box

The **Main** pane of the Lookup Table block dialog box appears as follows:



### Vector of input values

Specify the vector of input values. The input values vector must be the same size as the **Table data**. Also, the input values vector must be strictly monotonically increasing after conversion to the input's fixed-point data type. However, the input values vector may be monotonically increasing if the input and output signals

# Lookup Table

---

are both either `single` or `double`, and if the lookup method is `Interpolation-Extrapolation`. 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 offline to the input signal's data type using round-to-nearest and saturation.

Click the **Edit** button to open 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 **Vector of input values**.

The **Table data** parameter is converted offline to the **Output data type** using the specified rounding and saturation.

## **Lookup method**

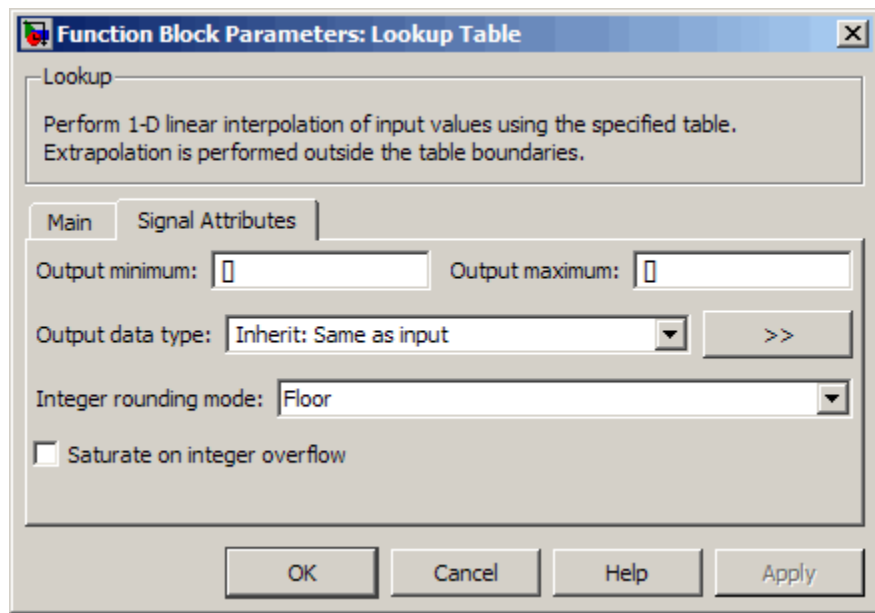
Specify the lookup method. See Description for a discussion of the options for this parameter. For an example that demonstrates values that the Lookup Table block returns based on different lookup methods, see “Example Output” in *Simulink User's Guide*.

## **Sample time (-1 for inherited)**

Specify the time interval between samples. To inherit the sample time, set this parameter to `-1`. See “How to Specify the Sample Time” in the online documentation for more information.

The **Signal Attributes** pane of the Lookup Table block dialog box appears as follows:





## Output minimum

Specify the minimum value that the block should output. The default value, [ ], is equivalent to  $-\text{Inf}$ . Simulink software uses this value to perform:

- Parameter range checking (see “Checking Parameter Values”)
- Simulation range checking (see “Checking Signal Ranges”)
- Automatic scaling of fixed-point data types

## Output maximum

Specify the maximum value that the block should output. The default value, [ ], is equivalent to  $\text{Inf}$ . Simulink software uses this value to perform:

- Parameter range checking (see “Checking Parameter Values”)
- Simulation range checking (see “Checking Signal Ranges”)

# Lookup Table


---

- Automatic scaling of fixed-point data types

## Output data type

Specify the output data type. You can set it to:

- A rule that inherits a data type, for example, `Inherit: Inherit via back propagation`
- The name of a built-in data type, for example, `single`
- The name of a data type object, for example, a `Simulink.NumericType` object
- An expression that evaluates to a data type, for example, `fixdt(1,16,0)`

Click the **Show data type assistant** button  to display the **Data Type Assistant**, which helps you set the **Output data type** parameter.

See “Specifying Block Output Data Types” in *Simulink User’s Guide* for more information.

## Lock output scaling against changes by the autoscaling tool

Select to lock scaling of outputs. This parameter is visible only if you enter an expression for the **Output data type** parameter.

## Integer rounding mode

Select the rounding mode for fixed-point lookup table calculations that occur during simulation or execution of code generated from the model. For more information, see “Rounding” in the *Simulink Fixed Point User’s Guide*.

Note that this option does not affect rounding of block parameter values, such as **Table data**. Simulink software 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.

When you select this check box, saturation applies to every internal operation on the block, not just the output or result. In general, the code generation process can detect when overflow is not possible, in which case, no saturation code is generated.

## Example

See “Example of a Logarithm Lookup Table” in the *Simulink User’s Guide* for a demonstration of the Lookup Table block.

## Characteristics

Direct Feedthrough	Yes
Sample Time	Specified in the <b>Sample time</b> parameter
Scalar Expansion	No
Dimensionalized	Yes
Zero Crossing	No

## See Also

Lookup Table (2-D), Lookup Table (n-D)

# Lookup Table (2-D)

---

**Purpose** Approximate two-dimensional function

**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 first input port corresponds to the first table dimension,  $x$ . (See “How to Rotate a Block” in the Simulink documentation for a description of the port order for various block orientations.)

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.

---

**Tip** Evenly-spaced input data can make Real-Time Workshop generated code division-free. For more information, see `fixpt_evenspace_cleanup` in the Simulink documentation and “Identify questionable fixed-point operations” in the Real-Time Workshop documentation.

---

The block generates output based on the input values using one of these methods selected from the **Lookup 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 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.

---

**Note** If the **Lookup method** parameter specifies **Interpolation-Extrapolation**, Real-Time Workshop can generate code for this block only if its input and output signals have the same floating-point data type.

---

- **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

## Lookup Table (2-D)

---

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 “Representation of Discontinuities in Lookup Tables” in *Simulink User’s Guide*.

To avoid parameter saturation errors, the Simulink Fixed Point software’s automatic scaling script 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 action prevents the data from being saturated to different values.

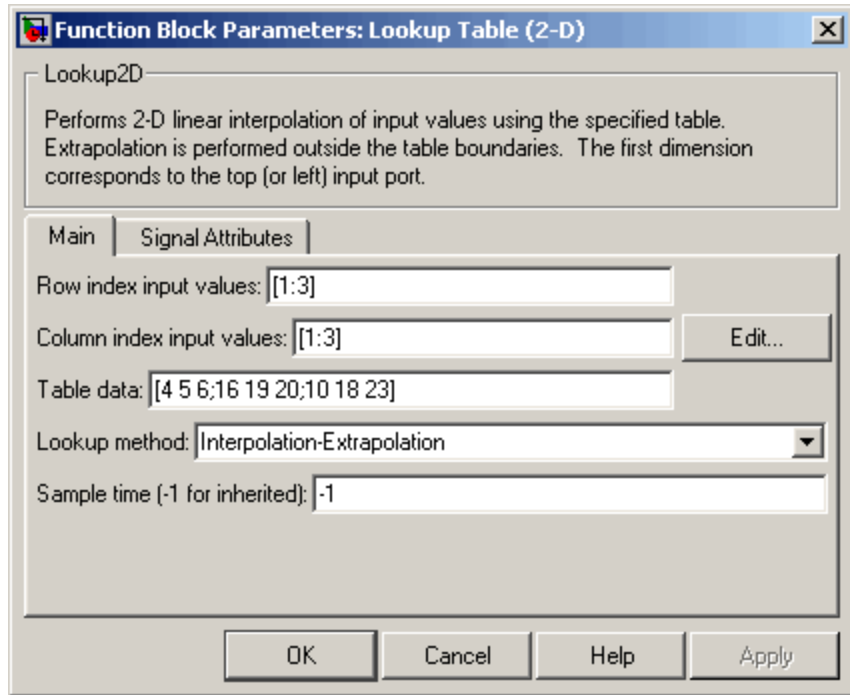
### Data Type Support

The Lookup Table (2-D) block supports all numeric data types supported by Simulink software, including fixed-point data types.

For a discussion on the data types supported by Simulink software, 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 box appears as follows:



### Row index input values

The row values for the table, entered as a vector. The vector values must increase monotonically.

The **Row index input values** parameter is converted offline to the corresponding input signal's data type using round-to-nearest and saturation.

### Column index input values

The column values for the table, entered as a vector. The vector values must increase monotonically.

## Lookup Table (2-D)

---

The **Column index input values** parameter is converted offline to the corresponding input signal's data type using round-to-nearest and saturation.

Click the **Edit** button to open 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.

The **Table data** parameter is converted offline to the **Output data type** using the specified rounding and saturation.

### **Lookup method**

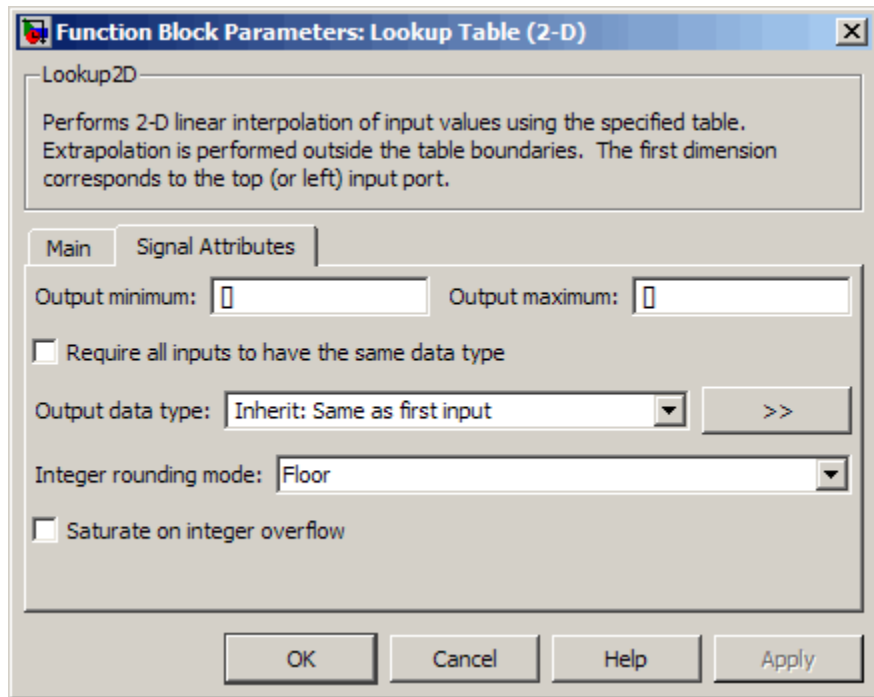
Specify the lookup method. See Description for a discussion of the options for this parameter.

### **Sample time (-1 for inherited)**

Specify the time interval between samples. To inherit the sample time, set this parameter to -1. See “How to Specify the Sample Time” in the online documentation for more information.

The **Signal Attributes** pane of the Lookup Table (2-D) block dialog box appears as follows:





## Output minimum

Specify the minimum value that the block should output. The default value, [], is equivalent to  $-\text{Inf}$ . Simulink software uses this value to perform:

- Parameter range checking (see “Checking Parameter Values”)
- Simulation range checking (see “Checking Signal Ranges”)
- Automatic scaling of fixed-point data types

## Output maximum

Specify the maximum value that the block should output. The default value, [], is equivalent to  $\text{Inf}$ . Simulink software uses this value to perform:

## Lookup Table (2-D)

---

- Parameter range checking (see “Checking Parameter Values”)
- Simulation range checking (see “Checking Signal Ranges”)
- Automatic scaling of fixed-point data types

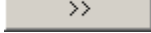
### **Require all inputs to have the same data type**

Select to require all inputs to have the same data type.

### **Output data type**

Specify the output data type. You can set it to:

- A rule that inherits a data type, for example, `Inherit: Inherit via back propagation`
- The name of a built-in data type, for example, `single`
- The name of a data type object, for example, a `Simulink.NumericType` object
- An expression that evaluates to a data type, for example, `fixdt(1,16,0)`

Click the **Show data type assistant** button  to display the **Data Type Assistant**, which helps you set the **Output data type** parameter.

See “Specifying Block Output Data Types” in *Simulink User’s Guide* for more information.

### **Lock output scaling against changes by the autoscaling tool**

Select to lock scaling of outputs. This parameter is visible only if you enter an expression for the **Output data type** parameter.

### **Integer rounding mode**

Select the rounding mode for fixed-point operations. For more information, see “Rounding” in the *Simulink Fixed Point User’s Guide*.

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.

When you select this check box, saturation applies to every internal operation on the block, not just the output or result. In general, the code generation process can detect when overflow is not possible, in which case, no saturation code is generated.

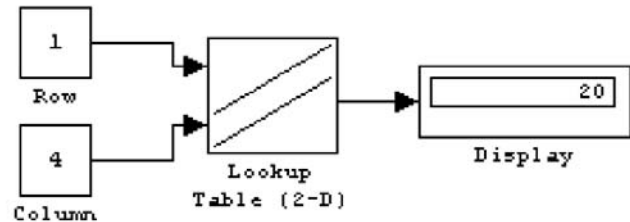
## Examples

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).

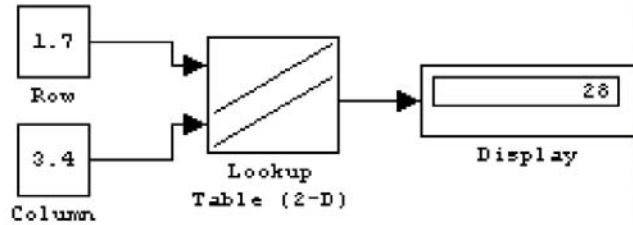
	3	4
1	10	20
2	30	40



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.

# Lookup Table (2-D)

	3	3.4	4
1	10	14	20
1.7	24	28	34
2	30	34	40



## Characteristics

Direct Feedthrough	Yes
Sample Time	Specified in the <b>Sample time</b> 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)

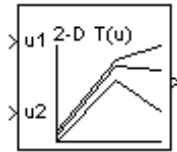
## Purpose

Approximate N-dimensional function

## Library

Lookup Tables

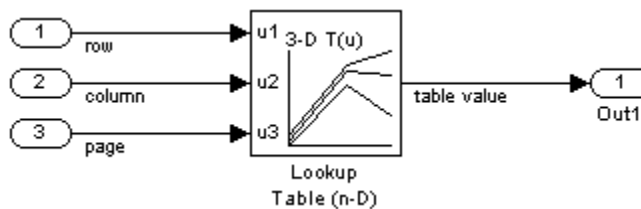
## Description



The Lookup Table (n-D) block evaluates a sampled representation of a function in N variables,  $y = F(x_1, x_2, x_3, \dots, x_n)$ , where the function  $F$  might be known only empirically. The block efficiently maps its inputs to an output value by looking up or interpolating a table of values as defined by the block's parameters. The block supports flat (constant), linear, and cubic spline interpolation methods. You can apply any of these methods to 1-D, 2-D, 3-D, or higher dimensional tables.

To use this block, specify the number of dimensions of your lookup table using the **Number of table dimensions** parameter. In the **Breakpoints for dimension** parameter, enter a breakpoint vector that corresponds to each dimension of your lookup table. Define the associated set of output values as the **Table data** parameter. You can customize the block's lookup and estimation behaviors by specifying, for example, values for its **Index search method**, **Interpolation method**, and **Extrapolation method** parameters.

The first block input identifies the first dimension (row) breakpoints, the next block input identifies the second dimension (column) breakpoints, and so on. See "How to Rotate a Block" in the *Simulink User's Guide* for a description of the port order for various block orientations.



# Lookup Table (n-D)

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**Tip** Evenly-spaced input data can make Real-Time Workshop generated code division-free. For more information, see `fixpt_evenspace_cleanup` in the Simulink documentation and “Identify questionable fixed-point operations” in the Real-Time Workshop documentation.

---

During simulation, the Lookup Table (n-D) block generates its output by looking up or estimating table values based on its input values:

- If the inputs match the values of indices specified in breakpoint vectors, the Lookup Table (n-D) block outputs the table value at the intersection of the row, column, and higher dimension breakpoints.
- If the inputs do not match the values of indices specified in breakpoint vectors, the Lookup Table (n-D) block generates output by interpolating appropriate table values. If the inputs are beyond the range of breakpoint vectors, the block can extrapolate its output values.

Alternatively, you can use the Interpolation Using Prelookup block with the Prelookup block to perform the equivalent operation of a Lookup Table (n-D) block. This combination of blocks offers greater flexibility that can result in more efficient simulation 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 want the  $k$ th element of a table,  $y = table(k)$ .

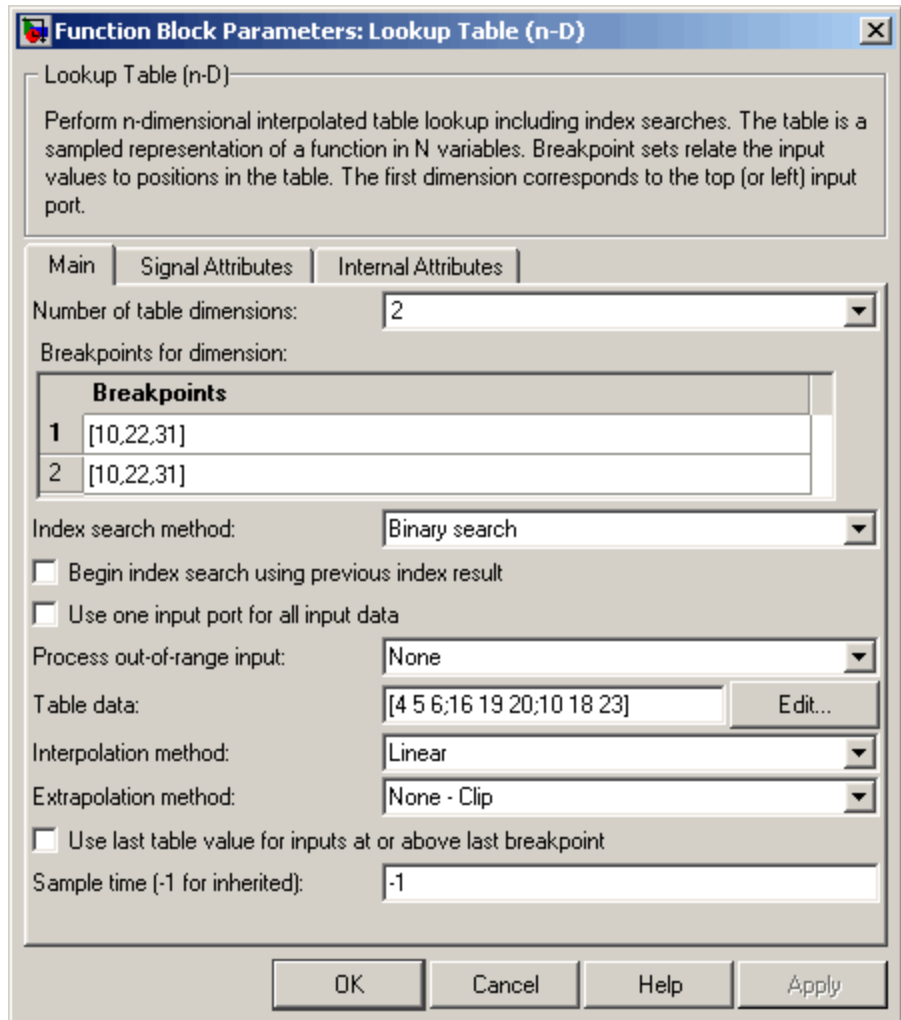
## Data Type Support

The Lookup Table (n-D) block supports all numeric data types supported by Simulink software, including fixed-point data types. For a discussion on the data types supported by Simulink software, see “Data Types Supported by Simulink” in the Simulink documentation.

Inputs for indexing must be real; table data can be complex.

## Parameters and Dialog Box

The **Main** pane of the Lookup Table (n-D) block dialog box appears as follows:



# Lookup Table (n-D)

---

## Number of table dimensions

Enter the number of dimensions of the **Table data** parameter by specifying an integer from 1 to 30. This determines the number of independent variables for the table and hence the number of block inputs. It also determines the number of dimensions that appear in the **Breakpoints for dimension** parameter.

## Breakpoints for dimension

Define breakpoint sets that correspond to the dimensions of the **Table data** parameter. For each dimension, specify breakpoints as a 1-by-n or n-by-1 vector whose values are strictly monotonically increasing.

The breakpoint sets are converted offline to their corresponding input signal's data type using round-to-nearest and saturation.

## Index search method

Select **Evenly spaced points**, **Linear search**, or **Binary search** (the default). Each search method has speed advantages in different circumstances:

- If the breakpoint data is evenly spaced, e.g., 10, 20, 30, ..., you can achieve the greatest speed by selecting **Evenly spaced points** to calculate the table indices.
- For irregularly spaced breakpoint sets, if the input signals do not vary much from one time step to the next, selecting **Linear search** in combination with **Begin index search using previous index result** produces 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** produces the best performance.

A suboptimal choice of index search method can lead to slow performance of models that rely heavily on lookup tables.



---

**Note** The Evenly spaced points algorithm uses only the first two breakpoints to determine the offset and spacing of the remaining points.

---

### **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 at the previous time step. For inputs that change slowly with respect to the interval size, enabling this option can improve performance. Otherwise, the linear search and binary search methods might take significantly longer, especially for large breakpoint sets.

### **Use one input port for all input data**

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 many lookup tables.

### **Process 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

### **Table data**

The table of output values. During simulation, the matrix size must match the dimensions defined by the **Number of table dimensions** parameter. However, during block diagram editing, you can enter either an empty matrix (specified as `[]`) or an undefined workspace variable as the **Table data** parameter. This technique allows you to postpone specifying a

# Lookup Table (n-D)

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correctly dimensioned matrix for the **Table data** parameter and continue editing the block diagram. For information about how to construct multidimensional arrays in MATLAB software, see “Multidimensional Arrays” in the MATLAB online documentation.

The **Table data** parameter is converted offline to the **Output data type** using the specified rounding and saturation.

Click the **Edit** button to open the Lookup Table Editor (see “Lookup Table Editor” in the *Simulink User’s Guide* for more information).

## **Interpolation method**

Select **None - Flat**, **Linear** (the default), or **Cubic spline**. See “Interpolation Methods” in the *Simulink User’s Guide* for more information.

## **Extrapolation method**

Select **None - Clip**, **Linear** (the default), or **Cubic spline**. See “Extrapolation Methods” in the *Simulink User’s Guide* for more information.

## **Use last table value for inputs at or above last breakpoint**

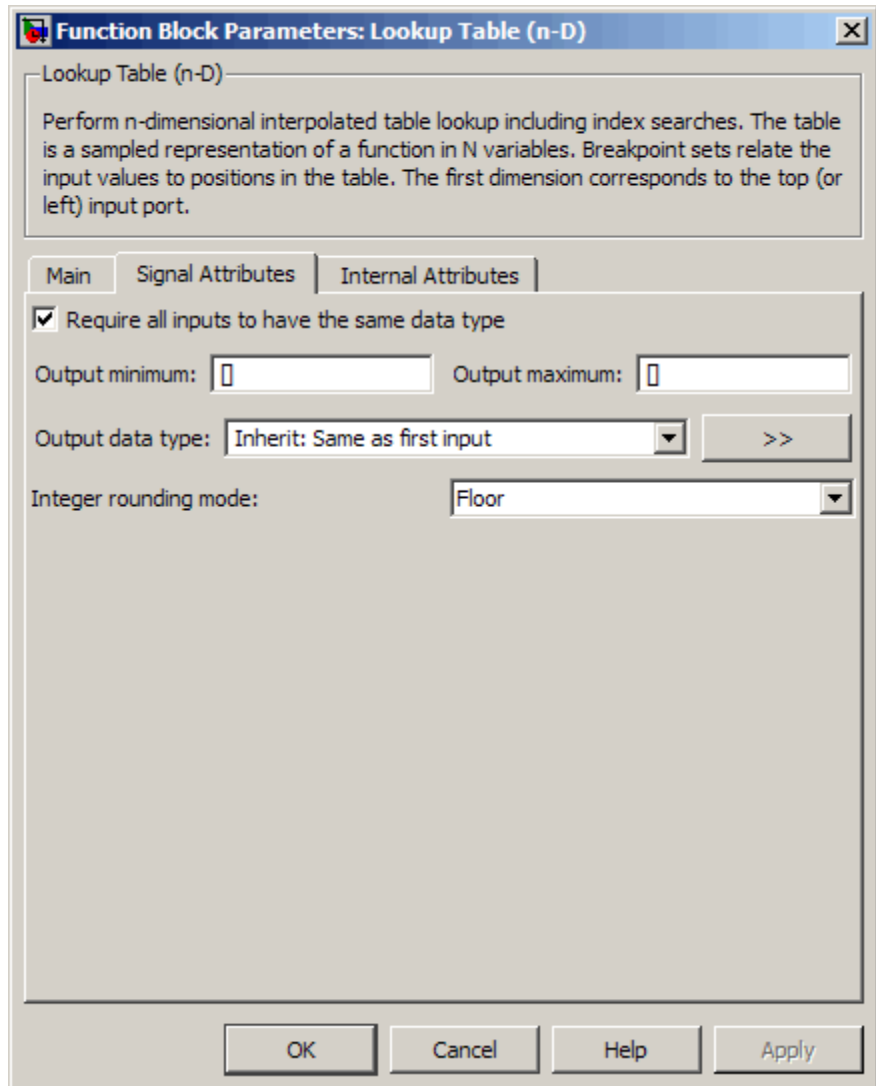
Specify the indexing convention that the block uses internally to address the last element of a breakpoint vector and its corresponding table value. If selected, the block addresses the end of a breakpoint vector and its table value using the last element’s index and 0 for the interval fraction. Otherwise, the block addresses those same values using the index of the next-to-last breakpoint and 1 for the interval fraction.

This parameter is visible only if the **Interpolation method** specifies **Linear** and the **Extrapolation method** is **None - Clip**.

## **Sample time (-1 for inherited)**

Specify the time interval between samples. To inherit the sample time, set this parameter to -1. See “How to Specify the Sample Time” in *Simulink User’s Guide* for more information.

The **Signal Attributes** pane of the Lookup Table (n-D) block dialog box appears as follows:



# Lookup Table (n-D)

---

## **Require all inputs to have the same data type**

Select to require all inputs to have the same data type.

## **Output minimum**

Specify the minimum value that the block should output. The default value, [], is equivalent to `-Inf`. Simulink software uses this value to perform:

- Parameter range checking (see “Checking Parameter Values”)
- Simulation range checking (see “Checking Signal Ranges”)
- Automatic scaling of fixed-point data types

## **Output maximum**


Specify the maximum value that the block should output. The default value, [], is equivalent to `Inf`. Simulink software uses this value to perform:

- Parameter range checking (see “Checking Parameter Values”)
- Simulation range checking (see “Checking Signal Ranges”)
- Automatic scaling of fixed-point data types

## **Output data type**

Specify the output data type. You can set it to:

- A rule that inherits a data type, for example, `Inherit: Inherit via back propagation`
- The name of a built-in data type, for example, `single`
- The name of a data type object, for example, a `Simulink.NumericType` object
- An expression that evaluates to a data type, for example, `fixdt(1,16,0)`

Click the **Show data type assistant** button  to display the **Data Type Assistant**, which helps you set the **Output data type** parameter.

See “Specifying Block Output Data Types” in *Simulink User’s Guide* for more information.

### **Lock output scaling against changes by the autoscaling tool**

Select to lock scaling of outputs. This parameter is visible only if you enter an expression for the **Output data type** parameter.

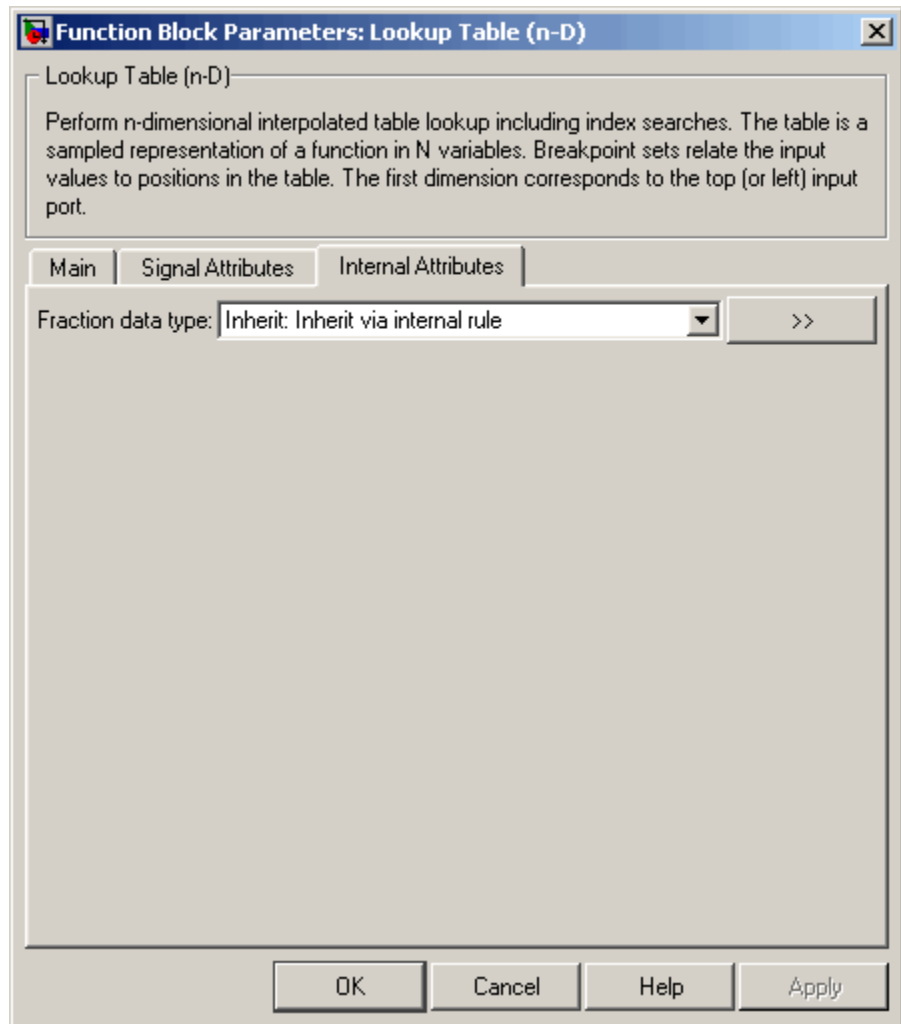
### **Integer rounding mode**

Select the rounding mode for fixed-point lookup table calculations that occur during simulation or execution of code generated from the model. For more information, see “Rounding” in the *Simulink Fixed Point User’s Guide*.

Note that this option does not affect rounding of values of block parameters, such as **Table data**. Simulink software 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.

The **Internal Attributes** pane of the Lookup Table (n-D) block dialog box appears as follows:


# Lookup Table (n-D)



## Fraction data type

Specify the fraction data type. You can set it to:

- A rule that inherits a data type, for example, `Inherit: Inherit via internal rule`
- The name of a built-in data type, for example, `single`
- The name of a data type object, for example, a `Simulink.NumericType` object
- An expression that evaluates to a data type, for example, `fixdt(1,16,0)`

Click the **Show data type assistant** button  to display the **Data Type Assistant**, which helps you set the **Fraction data type** parameter.

See “Using the Data Type Assistant” in *Simulink User’s Guide* for more information.

## Characteristics

Direct Feedthrough	Yes
Sample Time	Specified in the <b>Sample time</b> parameter
Scalar Expansion	Yes
Dimensionalized	Yes
Zero Crossing	No

## See Also

Lookup Table, Lookup Table (2-D), Lookup Table Dynamic

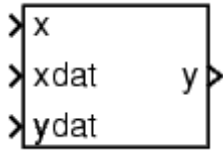
# Lookup Table Dynamic

---

**Purpose** Approximate one-dimensional function using dynamically specified table

**Library** Lookup Tables

**Description** The Lookup Table Dynamic block computes an approximation to a function  $y=f(x)$  given  $x$ ,  $y$  data vectors. The lookup method can use interpolation, extrapolation, or the original values of the input.



Using the Lookup Table Dynamic block, you can change the table data without stopping the simulation. For example, you can incorporate new table data if the physical system you are simulating changes.

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.

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.



---

**Tip** Evenly-spaced input data can make Real-Time Workshop generated code division-free. For more information, see `fixpt_evenspace_cleanup` in the Simulink documentation and “Identify questionable fixed-point operations” in the Real-Time Workshop documentation.

---

The block generates output based on the input values using one of these methods selected from the **Lookup 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.

---

**Note** Real-Time Workshop software cannot generate code for this block if its **Lookup Method** parameter specifies **Interpolation-Extrapolation**.

---

- **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

# Lookup Table Dynamic

---

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.

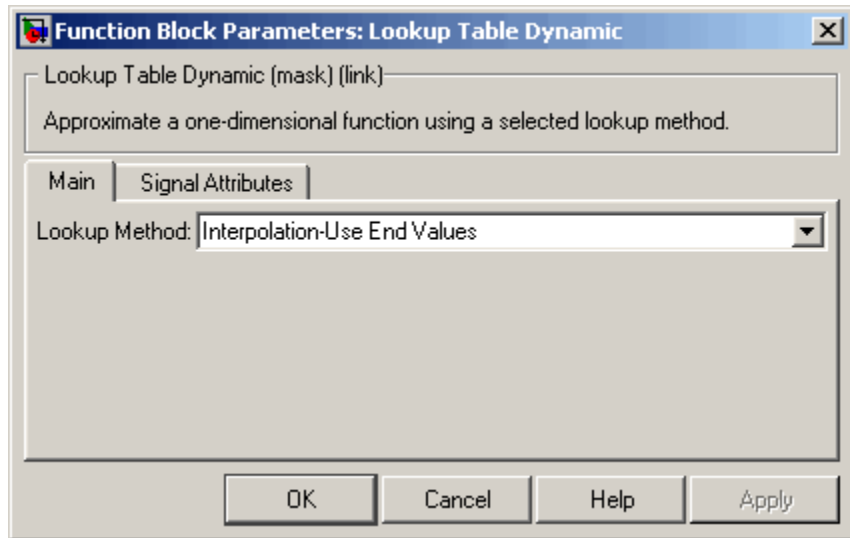
---

## Data Type Support

The Lookup Table Dynamic block accepts signals of any numeric data type supported by Simulink software, including fixed-point data types.

## Parameters and Dialog Box

The **Main** pane of the Lookup Table Dynamic block dialog box appears as follows:

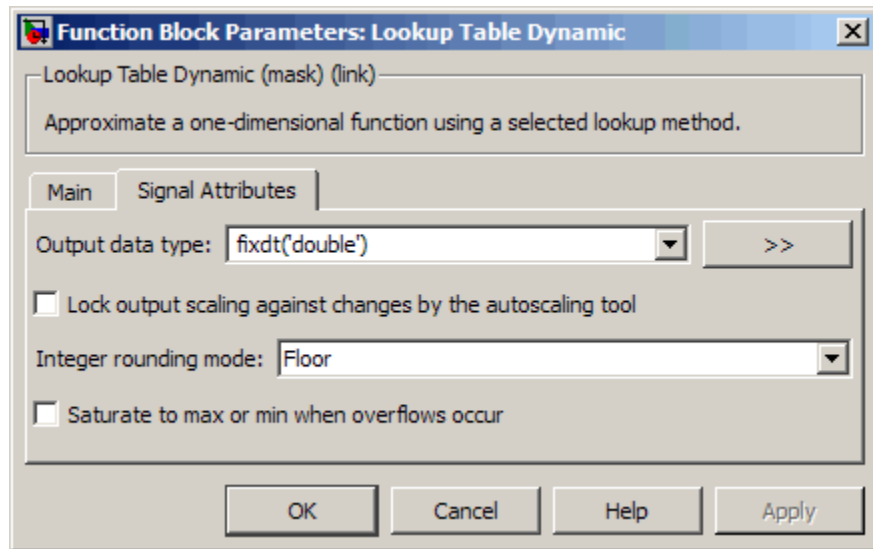


### Lookup Method

Specify the lookup method.

The **Signal Attributes** pane of the Lookup Table Dynamic block dialog box appears as follows:

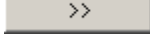
# Lookup Table Dynamic



## Output data type

Specify the output data type. You can set it to:

- A rule that inherits a data type, for example, `Inherit: Inherit via back propagation`
- The name of a built-in data type, for example, `single`
- The name of a data type object, for example, a `Simulink.NumericType` object
- An expression that evaluates to a data type, for example, `fixdt('double')`

Click the **Show data type assistant** button  to display the **Data Type Assistant**, which helps you set the **Output data type** parameter.

See “Specifying Block Output Data Types” in the *Simulink User’s Guide* for more information.

**Lock output scaling against changes by the autoscaling tool**

Select to lock scaling of outputs. This parameter is visible only if you enter an expression for the **Output data type** parameter.

**Integer rounding mode**

Select the rounding mode for fixed-point operations. For more information, see “Rounding” in the *Simulink Fixed Point User’s Guide*.

**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)

# Magnitude-Angle to Complex

---

**Purpose** Convert magnitude and/or a phase angle signal to complex signal

**Library** Math Operations

## Description



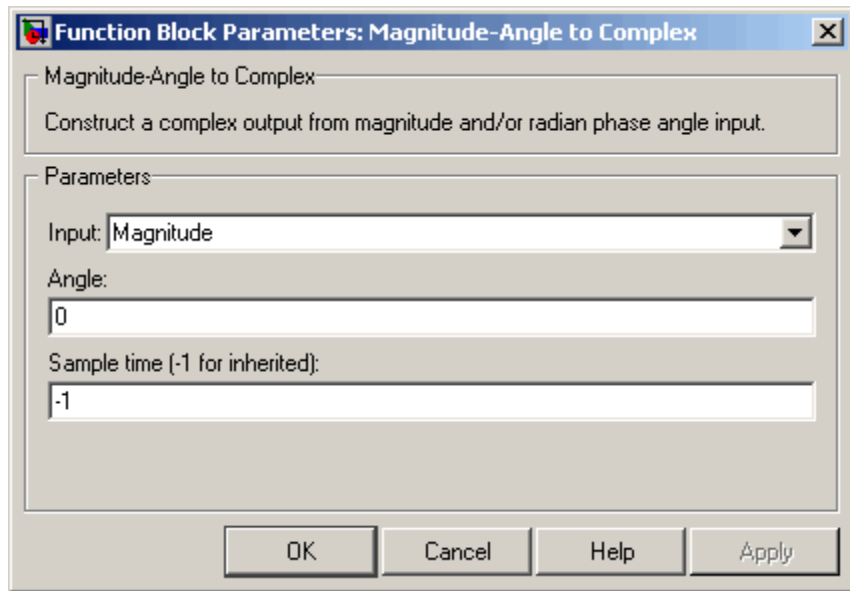
The Magnitude-Angle to Complex block converts magnitude and/or phase angle inputs to a complex-valued output signal. The inputs must be real-valued signals of type `double` or `single`. The angle input is assumed to be in radians. The complex output signal has the same data type as the block inputs.

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



### 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 “How to Specify the Sample Time” in the online documentation for more information.

## Characteristics

Direct Feedthrough	Yes
Sample Time	Inherited from driving block

# Magnitude-Angle to Complex

---

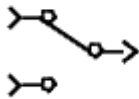
Scalar Expansion	Yes, of the input when the function requires two inputs
Dimensionalized	Yes
Multidimensionalized	Yes
Zero Crossing	No



**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 Support**

The Manual Switch block accepts real or complex signals of any data type supported by Simulink software, including fixed-point and enumerated data types.

For a discussion on the data types supported by Simulink software, see “Data Types Supported by Simulink” in the Simulink documentation.

**Parameters and Dialog Box**

None

**Characteristics**

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

# Math Function

---

**Purpose** Perform 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.

Function	Description	Mathematical Expression	MATLAB Equivalent
exp	Exponential	$e^u$	exp
log	Natural logarithm	$\ln u$	log
10 <sup>u</sup>	Array power of base 10	$10^u$	10.^u (see power)
log10	Common (base 10) logarithm	$\log u$	log10
magnitude <sup>2</sup>	Complex modulus	$ u ^2$	(abs(u)).^2 (see abs and power)
square	Array power 2	$u^2$	u.^2 (see power)
sqrt	Square root	$u^{0.5}$	sqrt
pow	Array power	$u^v$	power
conj	Complex conjugate	$\bar{u}$	conj
reciprocal	Array reciprocal	$1/u$	1./u (see rdivide)
hypot	Square root of sum squares	$(u^2+v^2)^{0.5}$	hypot
rem	Remainder after division	—	rem

Function	Description	Mathematical Expression	MATLAB Equivalent
mod	Modulus after division	—	mod
transpose	Array transpose	$u^T$	<code>u.'</code> (see arithmetic operators)
hermitian	Complex conjugate transpose	$u^H$	<code>u'</code> (see arithmetic operators)

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 software automatically draws the appropriate number of input ports.

---

**Tip** 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 function 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 <sup>2</sup>	yes	yes	yes	yes

# Math Function

---

Function	single	double	built-in integer	fixed point
square	yes	yes	yes	yes
sqrt	yes	yes	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` and `sqrt`, which do not accept complex fixed-point inputs. Also, `sqrt` does not accept fixed-point inputs that are negative or have nontrivial slope and nonzero bias. The output signal type of the block is real or complex, depending on the setting of the **Output signal type** parameter.

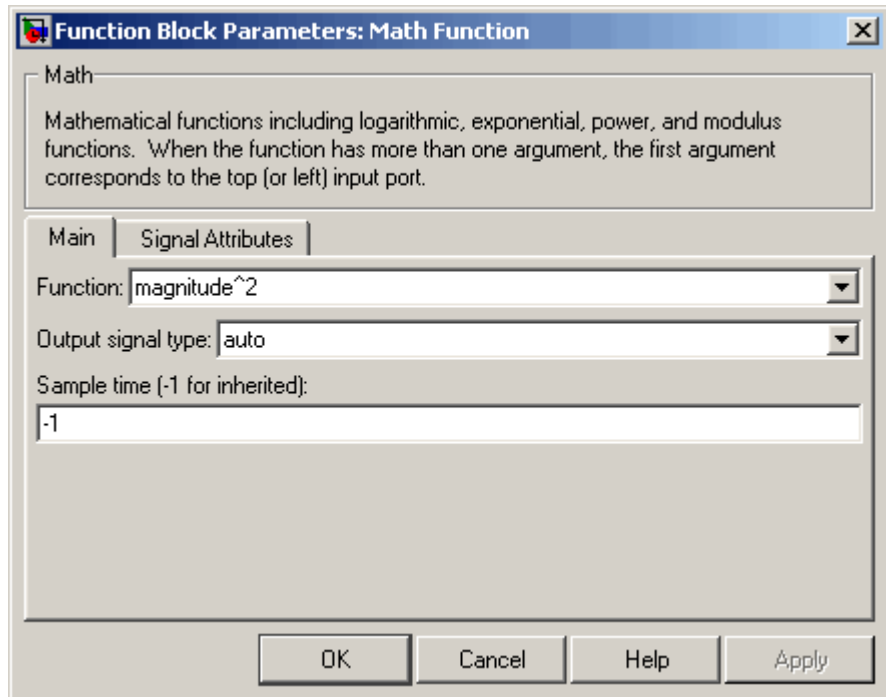
---

**Note** The `magnitude^2`, `square`, and `reciprocal` functions do not support Real-Time Workshop code generation for fixed-point data types with nonzero bias.

---

## Parameters and Dialog Box

The **Main** pane of the Math Function block dialog box appears as follows:



### Function

Specify the mathematical function. See Description for more information about the options for this parameter.

### Output signal type

Select the output signal type of the Math Function block as real, complex, or auto.

# Math Function

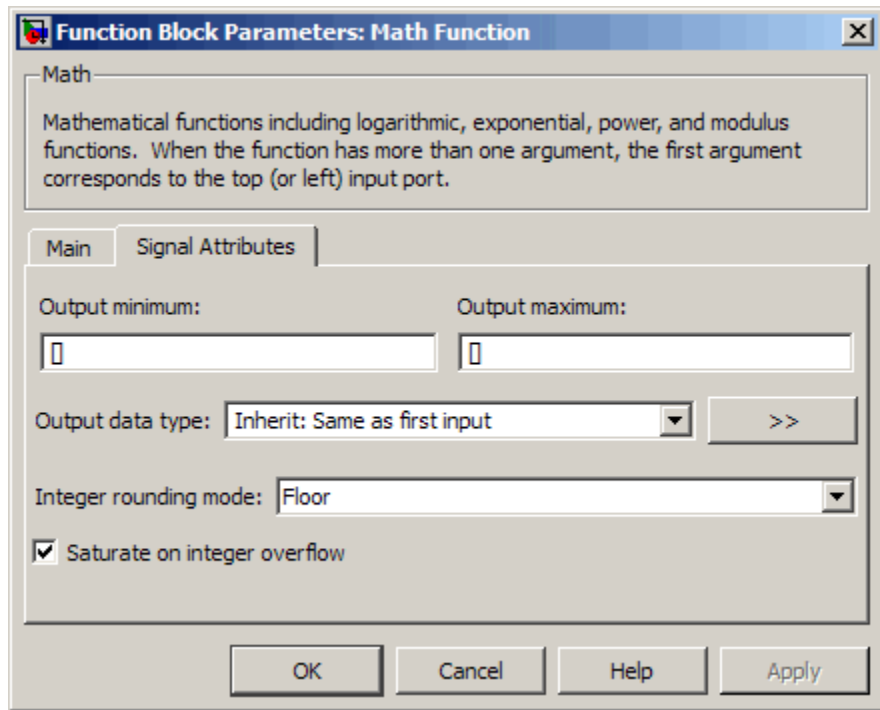
---

	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
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 “How to Specify the Sample Time” in the online documentation for more information.

The **Signal Attributes** pane of the Math Function block dialog box appears as follows:



**Note** Some parameters on this pane are available only when the function you select in the **Function** parameter supports fixed-point data types.

### Output minimum

Specify the minimum value that the block should output. The default value, [], is equivalent to  $-\text{Inf}$ . Simulink software uses this value to perform:

- Simulation range checking (see “Checking Signal Ranges”)
- Automatic scaling of fixed-point data types

## Output maximum


Specify the maximum value that the block should output. The default value, [], is equivalent to `Inf`. Simulink software uses this value to perform:

- Simulation range checking (see “Checking Signal Ranges”)
- Automatic scaling of fixed-point data types

## Output data type

Specify the output data type. You can set it to:

- A rule that inherits a data type, for example, `Inherit: Inherit via back propagation`
- The name of a built-in data type, for example, `single`
- The name of a data type object, for example, a `Simulink.NumericType` object
- An expression that evaluates to a data type, for example, `fixdt(1,16,0)`

Click the **Show data type assistant** button  to display the **Data Type Assistant**, which helps you set the **Output data type** parameter.

See “Specifying Block Output Data Types” in *Simulink User’s Guide* for more information.

## Lock output scaling against changes by the autoscaling tool

Select to lock scaling of outputs. This parameter is visible only if you enter an expression for the **Output data type** parameter.

## Integer rounding mode

Select the rounding mode for fixed-point operations. For more information, see “Rounding” in the *Simulink Fixed Point User’s Guide*.



## Saturate on integer overflow

If selected, fixed-point overflows saturate. Otherwise, overflows wrap.

When you select this check box, saturation applies to every internal operation on the block, not just the output or result. In general, the code generation process can detect when overflow is not possible, in which case, no saturation code is generated.

## Characteristics

Direct Feedthrough	Yes
Sample Time	Specified in the <b>Sample time</b> parameter
Scalar Expansion	Yes, of the input when the function requires two inputs
Dimensionalized	Yes
Multidimensionalized	Yes, for all functions except hermitian and transpose
Zero Crossing	No

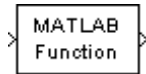
# MATLAB Fcn

---

**Purpose** Apply MATLAB function or expression to 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)
```

---

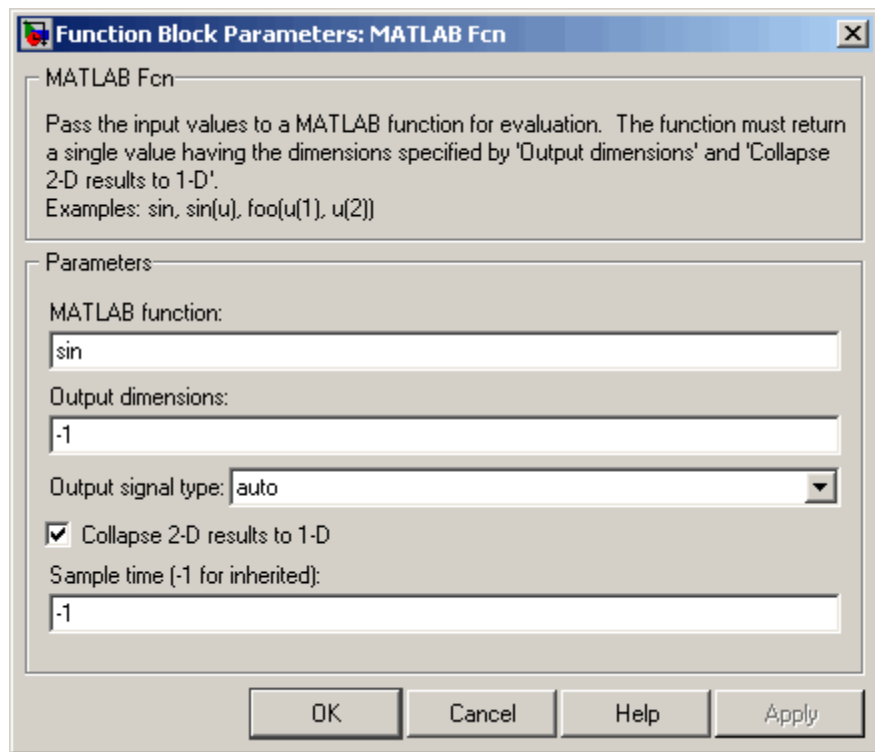
**Note** This block is slower than the Fcn block because it calls the MATLAB parser during each integration step. Consider using built-in blocks (such as the Fcn block or the Math Function block) instead, or writing the function as an M-file or MEX-file S-function, then accessing it using the S-Function 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 "How to Specify the 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

# Matrix Concatenate, Vector Concatenate

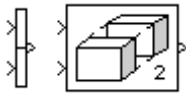
## Purpose

Concatenate input signals of same data type to create 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 multidimensional array concatenation mode, depending on the setting of its **Mode** parameter. In either case, the inputs are concatenated from the top to bottom, or left to right, input ports.

### Vector Mode

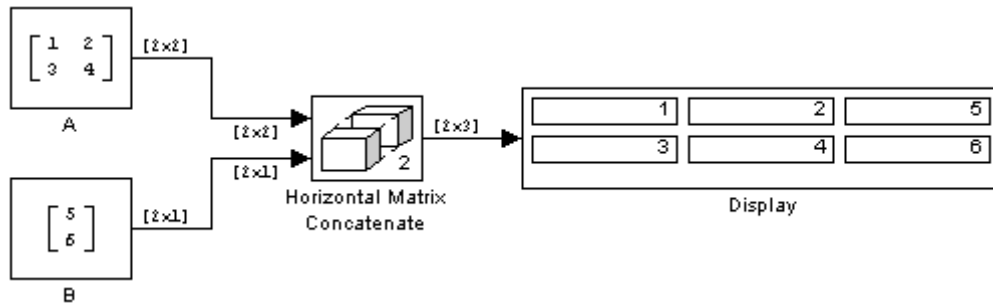
In vector mode, all input signals must be either vectors or row vectors [ $1 \times M$  matrices] or column vectors [ $M \times 1$  matrices] or a combination of vectors and either row or column vectors. The output is a vector if all inputs are vectors.

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

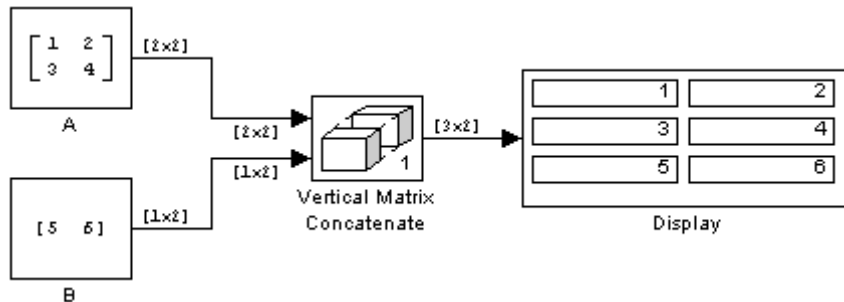
### Multidimensional Array Mode

Multidimensional array mode accepts vectors and arrays of any size. It assumes that the trailing dimensions are all ones for input signals with lower dimensionality. For example, if the output is 4-D and the input is  $[2 \times 3]$  (2-D) this block treats the input as  $[2 \times 3 \times 1 \times 1]$ . The output is always an array. The block's **Concatenate dimension** parameter allows you to specify the output dimension along which the block concatenates its input arrays. If you set the **Concatenate dimension** parameter to 2 and inputs are 2-D matrices, the block performs horizontal matrix concatenation and places the input matrices side-by-side to create the output matrix, e.g.,

# Matrix Concatenate, Vector Concatenate



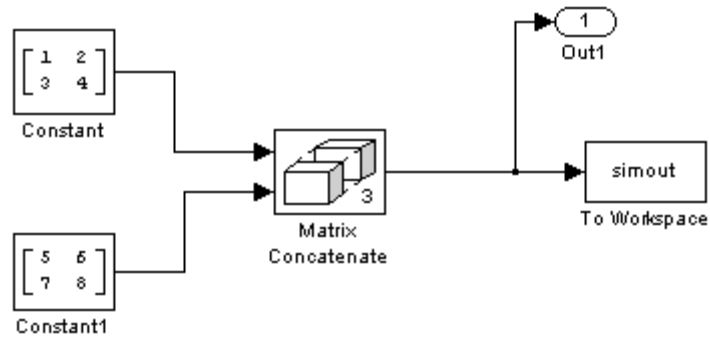
If you set the **Concatenate dimension** parameter to 1 and inputs are 2-D matrices, the block performs vertical matrix concatenation and stacks the input matrices on top of each other to create the output matrix, e.g.,



For horizontal concatenation, the input matrices must have the same column dimension; for vertical concatenation, the same row dimension. All input signals must have the same dimension for all dimensions other than the concatenation dimensions.

If you set the **Mode** parameter to Multidimensional array, the **Concatenate dimension** parameter to 3, and the inputs are 2-D matrices, the block performs multidimensional matrix concatenation, e.g.,

# Matrix Concatenate, Vector Concatenate



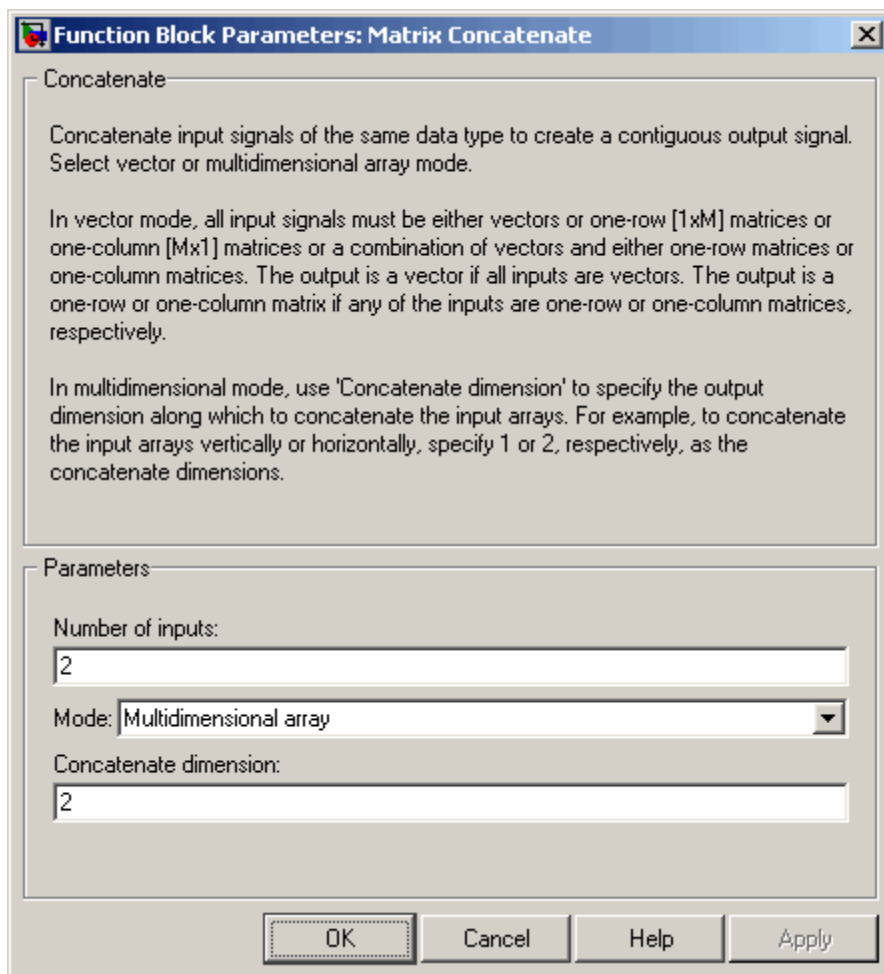
## Data Type Support

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

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

# Matrix Concatenate, Vector Concatenate

## Parameters and Dialog Box



### Number of inputs

Number of inputs on this block.

### Mode

Specifies the type of concatenation performed by this block.  
Options are:



# Matrix Concatenate, Vector Concatenate

---

- Vector (see “Vector Mode” on page 2-657)
- Multidimensional array (see “Multidimensional Array Mode” on page 2-657)

## Concatenate dimension

Specifies the output dimension along which to concatenate the input arrays. For example, to concatenate the input arrays vertically or horizontally, specify 1 or 2, respectively. This option appears only if you select `Multidimensional array` for the **Mode** parameter.

## Characteristics

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

## See Also

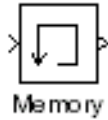
`cat` in the MATLAB reference documentation

# Memory

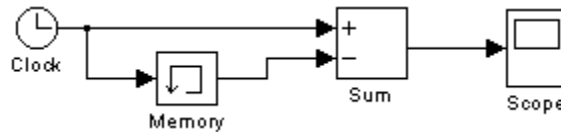
**Purpose** Output input from previous time step

**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.



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.



---

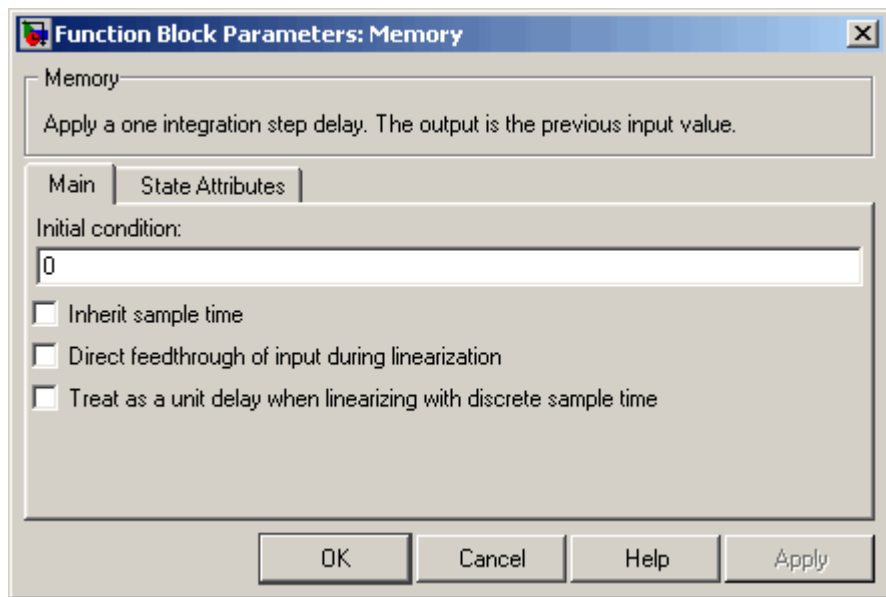
**Note** Avoid using the Memory block when integrating with `ode15s` or `ode113`, unless the input to the block does not change.

---

**Data Type Support** The Memory block accepts real or complex signals of any data type supported by Simulink software, including fixed-point and enumerated data types.

For a discussion on the data types supported by Simulink software, see “Data Types Supported by Simulink” in the Simulink documentation.

## 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 software 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, x0, x_str] = model([],[],[],'lincompile');
```

Next, terminate the compilation with the following command.

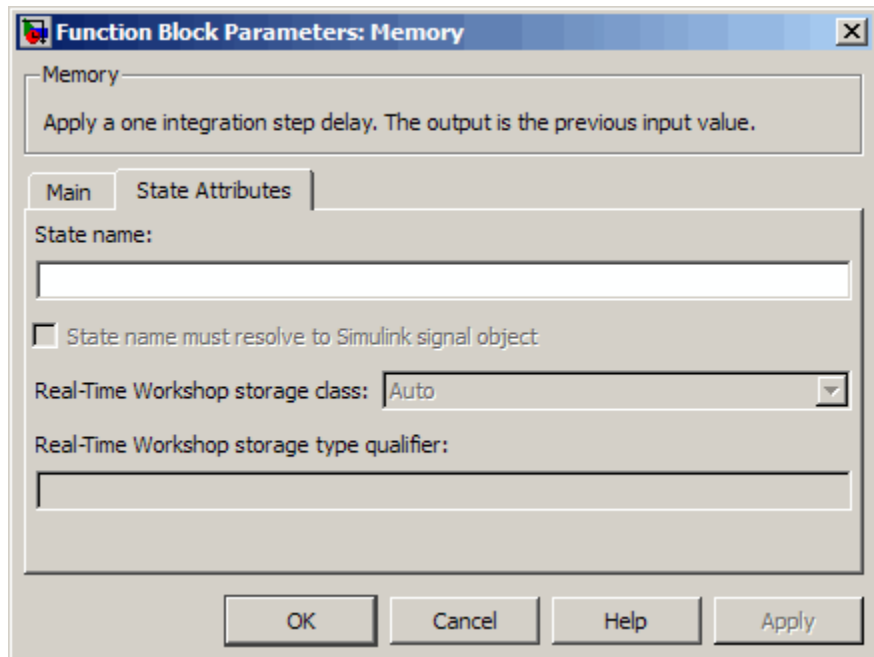
```
model([],[],[],'term');
```

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.

### **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 Attributes** pane of the Memory block dialog box appears as follows:



## State name

Use this parameter to assign a unique name to each state. The default is ' '. If left blank, no name is assigned. Consider the following when using this parameter:

- To assign a name to a single state, enter the name between quotes, for example, 'velocity' .
- The state names apply only to the selected block.
- To assign names to multiple states, enter a comma-delimited list surrounded by braces. For example, {'a', 'b', 'c'} . Each name must be unique.
- The number of states must be evenly divided by the number of state names. There can be fewer names than states, but there cannot be more names than states.

- For example, you can specify two names in a system with four states. Simulink software will assign the first name to the first two states and the second name to the last two.
- To assign state names with a variable that has been defined in the MATLAB workspace, enter the variable without quotes. A variable can be a string, cell, or structure.

This parameter enables **State name must resolve to Simulink signal object** when you click the **Apply** button.

### **State name must resolve to Simulink signal object**

Select this checkbox to require that state name resolve to Simulink signal object. This check box is cleared by default.

This parameter is enabled by **State name**.

Selecting this check box enables **Real-Time Workshop storage class**.

### **Real-Time Workshop storage class**

From the list, select state storage class.

#### Auto

Auto is the appropriate storage class for states that you do not need to interface to external code.

#### ExportedGlobal

State is stored in a global variable

#### ImportedExtern

*model\_private.h* declares the state as an extern variable.

#### ImportedExternPointer

*model\_private.h* declares the state as an extern pointer.

This parameter is enabled by **State name**.

Setting this parameter to `ExportedGlobal`, `ImportedExtern`, or `ImportedExternPointer` enables **Real-Time Workshop storage type qualifier**.

During simulation, the block uses the following values:

- The initial value of the signal object to which the state name is resolved
- Min and Max values of the signal object

See “Block State Storage and Interfacing” in the Real-Time Workshop Workshop documentation for more information.

## Bus Support

The Memory block is a bus-capable block. The input can be a virtual or nonvirtual bus signal subject to the following restrictions:

- **Initial condition** must be zero or a nonzero scalar.
- If **Initial condition** is zero and a **State name** is specified, the input cannot be a virtual bus.
- If **Initial condition** is a nonzero scalar, no **State name** can be specified.

All signals in a nonvirtual bus input to a Memory block must have the same sample time, even if the elements of the associated bus object specify inherited sample times. You can use a Rate Transition block to change the sample time of an individual signal, or of all signals in a bus. See Using Buses and Bus-Capable Blocks for more information.

## Characteristics

Bus-capable	Yes, with restrictions as noted above
Direct Feedthrough	No, except when <b>Direct feedthrough of input during linearization is enabled</b>

# Memory

---

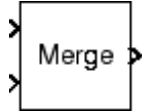
Sample Time	Continuous, but inherited from the driving block if you select the <b>Inherit sample time</b> check box
Scalar Expansion	Yes, of the <b>Initial condition</b> parameter
Dimensionalized	Yes
Multidimensionalized	Yes
Zero Crossing	No



**Purpose** Combine multiple signals into 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.

Use Merge blocks only to interleave input signals that update at different times into a combined signal in which the interleaved values retain their separate identities and times. To combine signals that update at the same time into an array or matrix signal, use a Concatenate block.

Merge blocks assume that all driving signals share the same signal memory. The shared signal memory should be accessed only in mutually exclusive fashion. Therefore, always use alternately executing subsystems to drive Merge blocks. See “Creating Alternately Executing Subsystems” for an example.

All signals that connect to a Merge block, or exist anywhere in a network of Merge blocks, are functionally the same signal, and are therefore subject to the restriction that a given signal can have at most one associated signal object. See `Simulink.Signal` and “Multiple Signal Objects” on page 7-143 for more information.

## Guidelines for Using Merge Block

When using the Merge block, consider the following:

- Always use conditionally executed subsystems to drive Merge blocks.
- Write your control logic to ensure that at most one of the driving conditionally executed subsystems executes at any time step.
- Do not connect more than one input of a Merge block to the same conditionally executed subsystem.
- Do not use a signal that inputs to a Merge block as an input to any other block.

# Merge

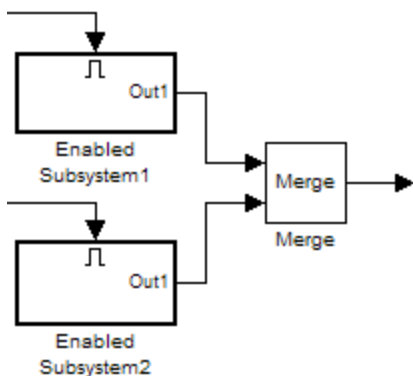
---

- Always connect a Merge block to at least two input signals.
- Ensure that all input signals have the same sample time.
- Always set the **Initial output** parameter of the Merge block, unless the output port of the Merge block connects to another Merge block.
- For all conditionally executed subsystem Output blocks that drive Merge blocks, Set the **Output when disabled** parameter to held.

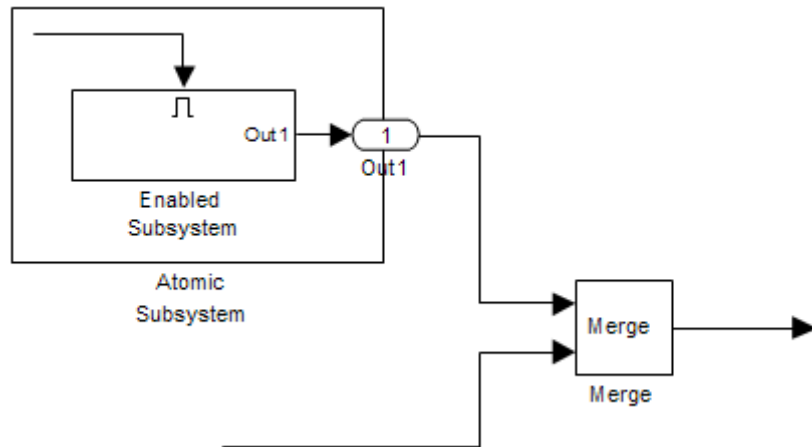
## Proper Merge Block Usage

For each input of a Merge block, the topmost non-atomic and non-virtual source must be a conditionally executed subsystem that is not an Iterator subsystem.

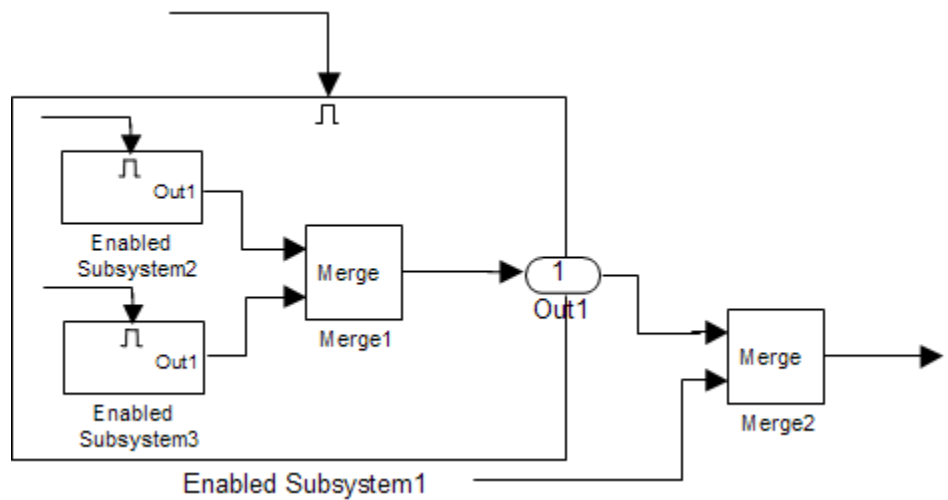
The following example shows proper Merge block usage, merging signals from two conditionally executed subsystems.



The following figure shows another valid example of Merge block usage, with the topmost non-atomic, non-virtual source being a conditionally executed subsystem.



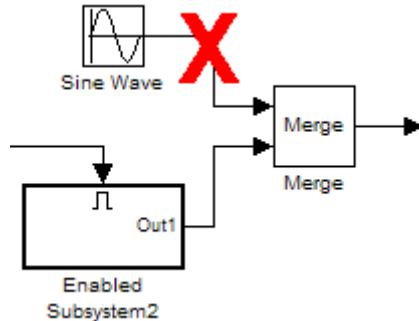
You can also use multiple merge blocks, as shown in the following example.



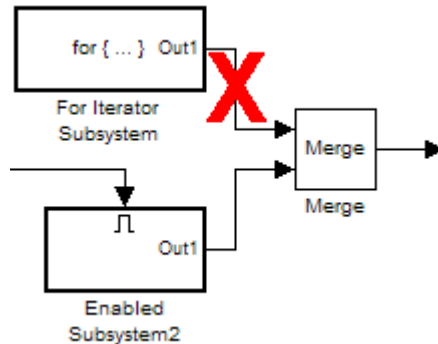
# Merge

---

The following example is *not allowed*, because one input of the Merge block is connected to a Sine Wave block (not to a conditionally executed subsystem).



Finally, the following example is also *not allowed*, because one input of the Merge block is connected to an Iterator subsystem.



You can use the Model Advisor to check for proper Merge block usage in your model. For more information, see “Check for proper Merge block usage” on page 10-24.

## Initial Output Value

You can specify an initial output value for the Merge block by setting the **Initial output** parameter. If you do not specify an initial output value

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.

---

**Note** If you are using simplified initialization mode, you *must* specify the **Initial output** value for all *root* Merge blocks. A root Merge block is any Merge block with an output port that does not connect to another Merge block.

---

For more information on simplified initialization mode, see “Underspecified initialization detection”.

### Single-Input Merge

Single-input merge is not supported. Each Merge block must have at least two inputs.

Only use Merge blocks for signals that require merging. If you were previously connecting a Merge block input to a Mux block, use a multi-input Merge block instead.



### Input Dimensions and Merge Offsets

The Merge block accepts only inputs of equal dimensions and outputs a signal of the same dimensions as the inputs, unless you select the **Allow unequal port widths** parameter.

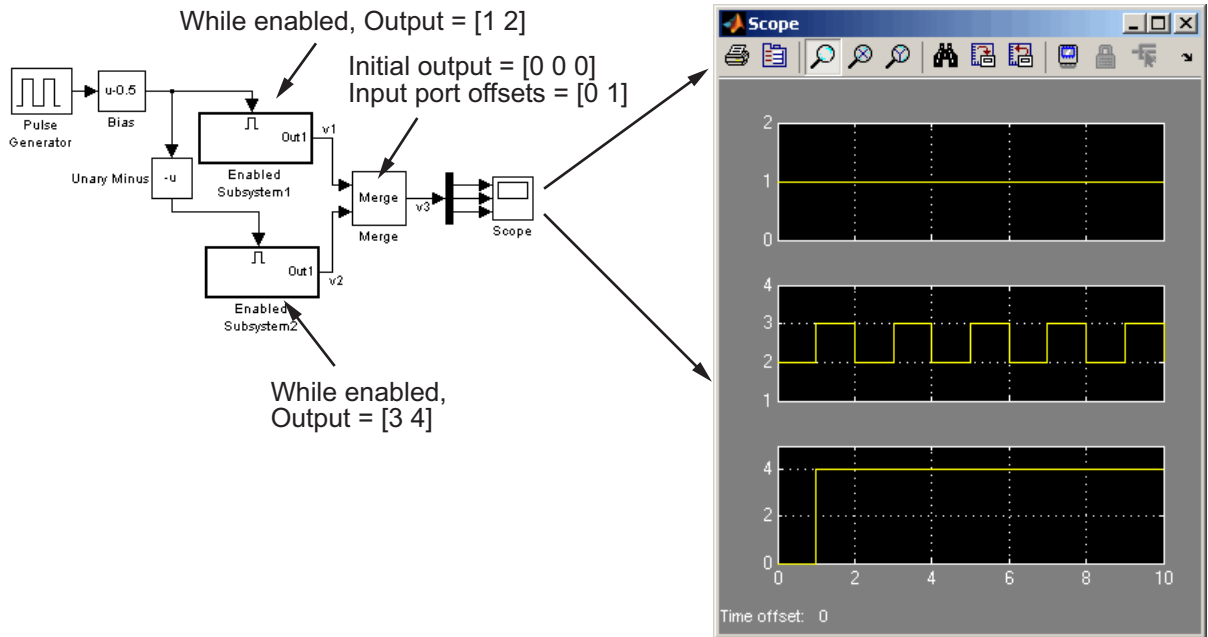
If you select **Allow unequal port widths**, the block accepts scalars and vectors (but not matrices) having differing numbers of elements. Further, the block allows you to specify an offset for each input signal relative to the beginning of the output signal. The width of the output signal is

$$\max(w_1+o_1, w_2+o_2, \dots, w_n+o_n)$$

# Merge

where  $w_1, \dots, w_n$  are the widths of the input signals and  $o_1, \dots, o_n$  are the offsets for the input signals. For example, the Merge block in the following diagram has a Merge block width of

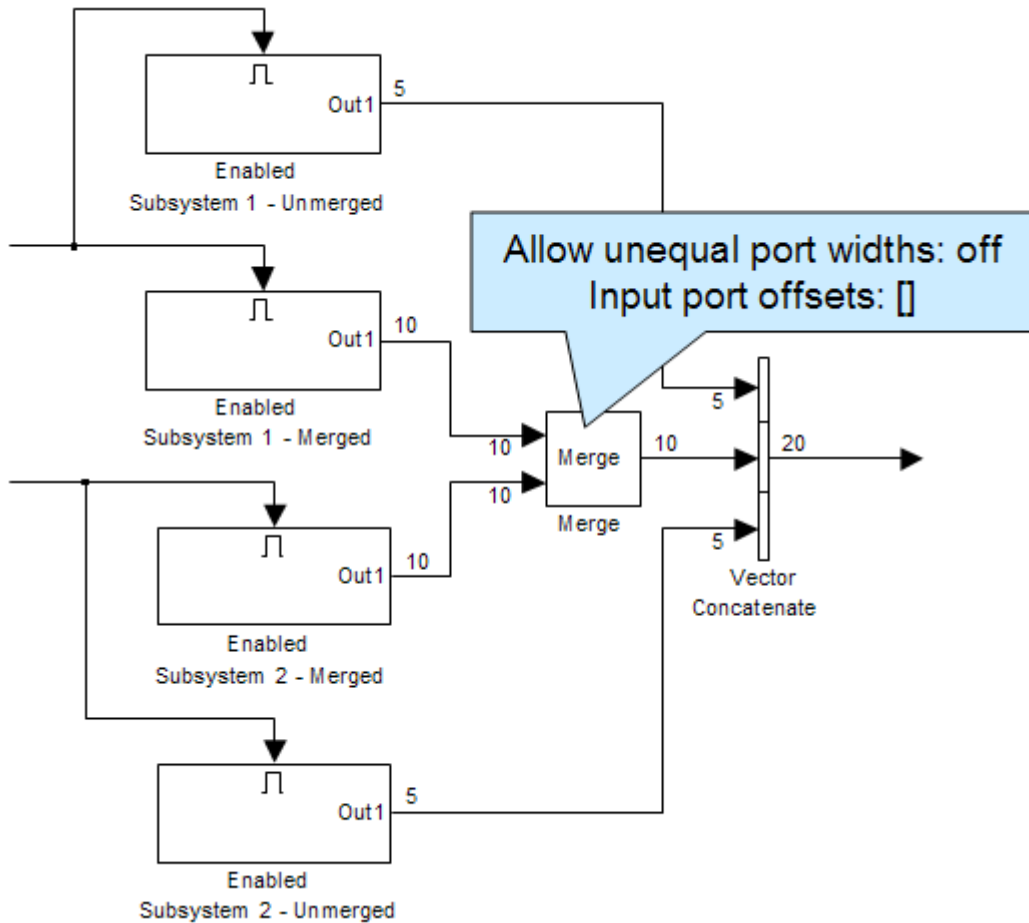
$$\max(2+0, 2+1)=3$$



In this example, the offset of  $v_1$  is 0 and the offset of  $v_2$  is 1. The Merge block maps the elements of  $v_1$  to the first two elements of  $v_3$  and the elements of  $v_2$  to the last two elements of  $v_3$ . Only the second element of  $v_3$  is effectively merged, as seen from the scopes output.

If you are using Simplified Initialization Mode, **Allow unequal port widths** must be deselected. The input port offsets for all input signals must be zero.

Consider using Merge blocks only for signal elements that require true merging. Other elements can be combined with merged elements using the Concatenate block, as shown in the following example.



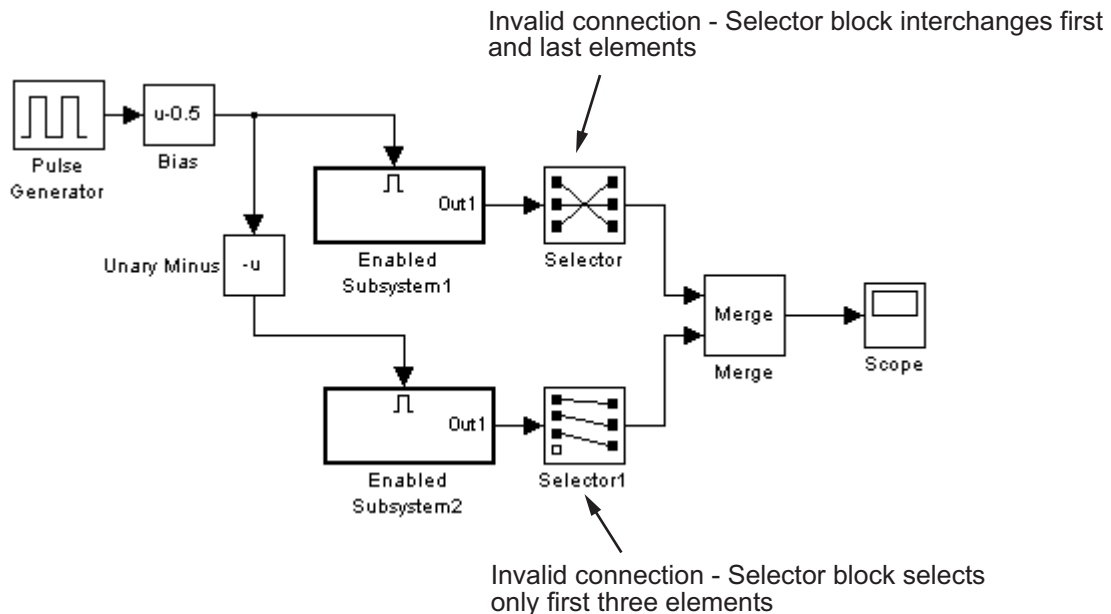
For more information on simplified initialization mode, see “Underspecified initialization detection”.

# Merge

## Combining or Reordering of Input Signals

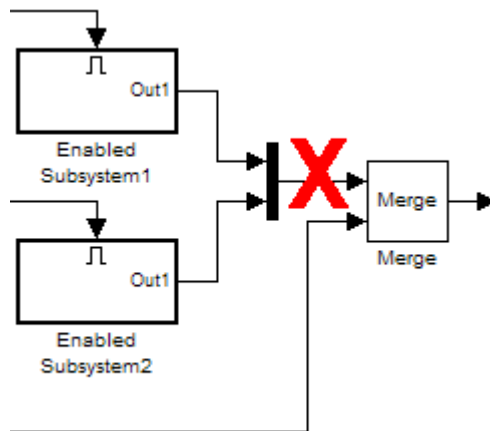
A Merge block does not accept input signals whose elements have been reordered or partially selected. In addition, you should not connect input signals to the Merge block that have been combined outside of a conditionally executed subsystem.

For example, in the following diagram, the Merge block does not accept the output of the first Selector block because the Selector block interchanges the first and last elements of the vector signal. It does not accept the output of the second Selector block because the Selector block selects only the first three elements.

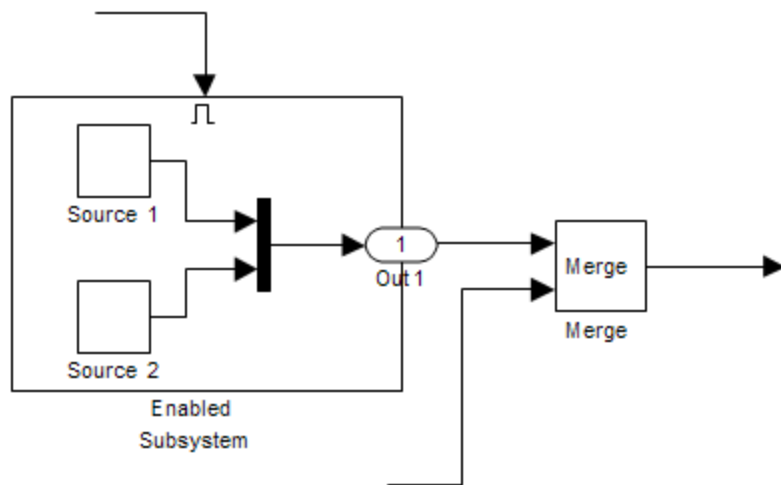


If you are using simplified initialization mode, the following example is also not allowed, because two signals are being combined outside of a conditionally executed subsystem.





You can, however, combine or reorder Merge block input signals within a conditionally executed subsystem. For example, the following diagram is valid.



For more information on simplified initialization mode, see “Underspecified initialization detection”.

### **Conditionally Executed Subsystem Output Reset**

The Outputs of conditionally executed subsystems being merged should not reset when disabled. This could cause multiple subsystems to update the Merge block at the same time. Specifically, the disabled subsystem updates the Merge block by resetting its output, while the enabled subsystem updates the Merge block by computing its output.

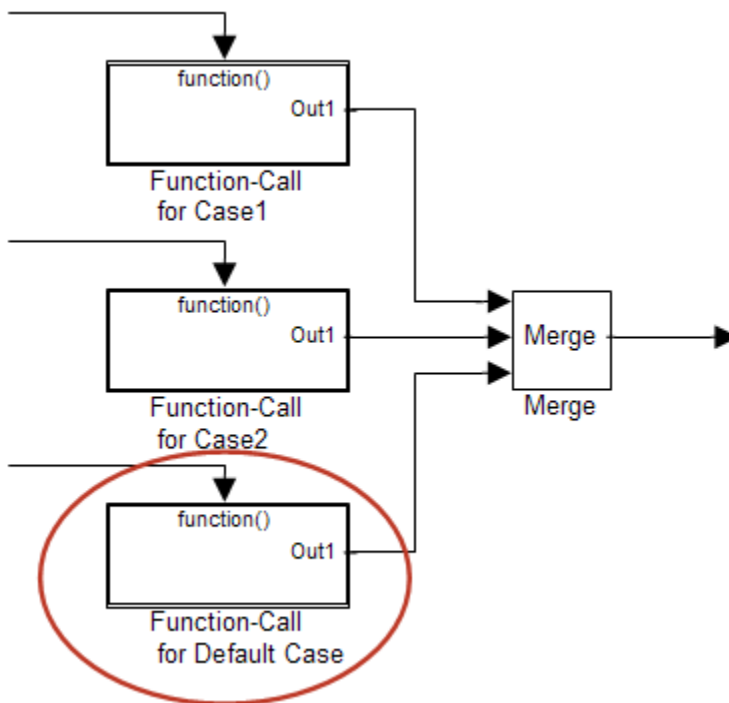
To prevent this, set the Output block parameter **Output when disabled** to `held` for each conditionally executed subsystem being merged.

---

**Note** If you are using Simplified Initialization Mode, you *must* set the Output block parameter **Output when disabled** to `held`.

---

Instead of resetting the subsystem output when it is disabled, add an additional subsystem for the default case, and use control logic to run this subsystem if nothing else runs. For example, see the following:



For more information on simplified initialization mode, see “Underspecified initialization detection”.

### 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 software 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.

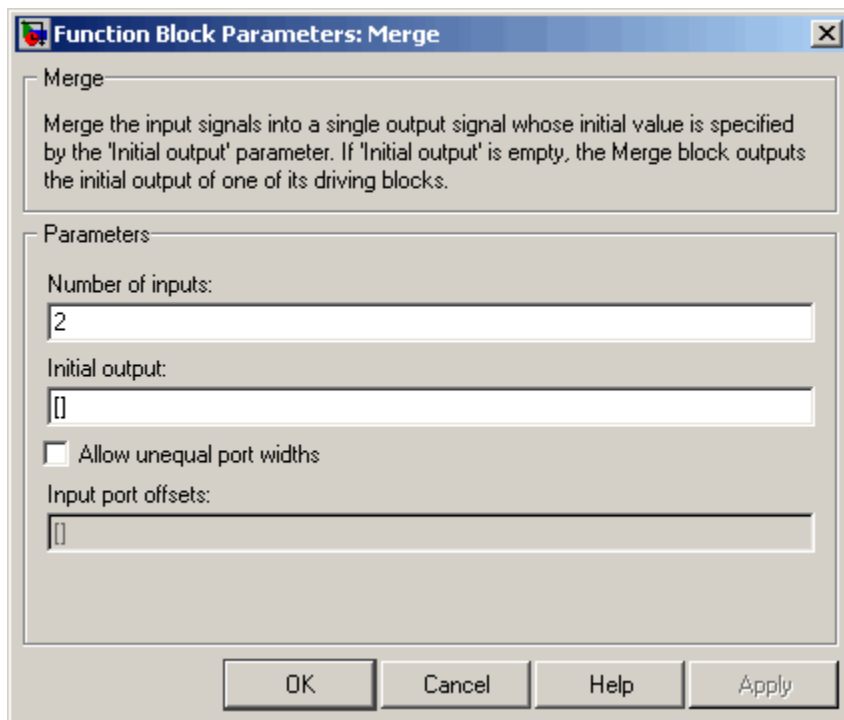
### Data Type Support

The Merge block accepts real or complex signals of any data type supported by Simulink software, including fixed-point and enumerated data types. All inputs must be of the same data type and numeric type.

# Merge

For a discussion on the data types supported by Simulink software, 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 software 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.

**Bus Support**

The Merge block is a bus-capable block. The inputs can be virtual or nonvirtual bus signals subject to the following restrictions:

- The number of inputs must be greater than one.
- **Initial output** must be zero or a nonzero scalar.
- **Allow unequal port widths** must be disabled.
- All inputs to the merge must be buses and must be equivalent (same hierarchy with identical names and attributes for all elements).

All signals in a nonvirtual bus input to a Merge block must have the same sample time, even if the elements of the associated bus object specify inherited sample times. You can use a Rate Transition block to change the sample time of an individual signal, or of all signals in a bus. See Using Buses and Bus-Capable Blocks for more information.

**Characteristics**

Bus-capable	Yes, with restrictions as noted above
Direct Feedthrough	Yes
Sample Time	Inherited from the driving block
Scalar Expansion	No
Dimensionalized	Yes
Multidimensionalized	Yes
Zero Crossing	No

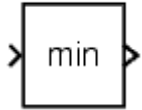
# MinMax

---

**Purpose** Output 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.

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, all nonscalar inputs must have the same dimensions. The block expands any scalar inputs to have the same dimensions as the nonscalar input(s). 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.

The MinMax block ignores any input value that is NaN, except where every input value is NaN. Where all input values are NaN, the output is NaN also, either as a scalar or as the value of each output vector element for which all corresponding input elements are NaN.

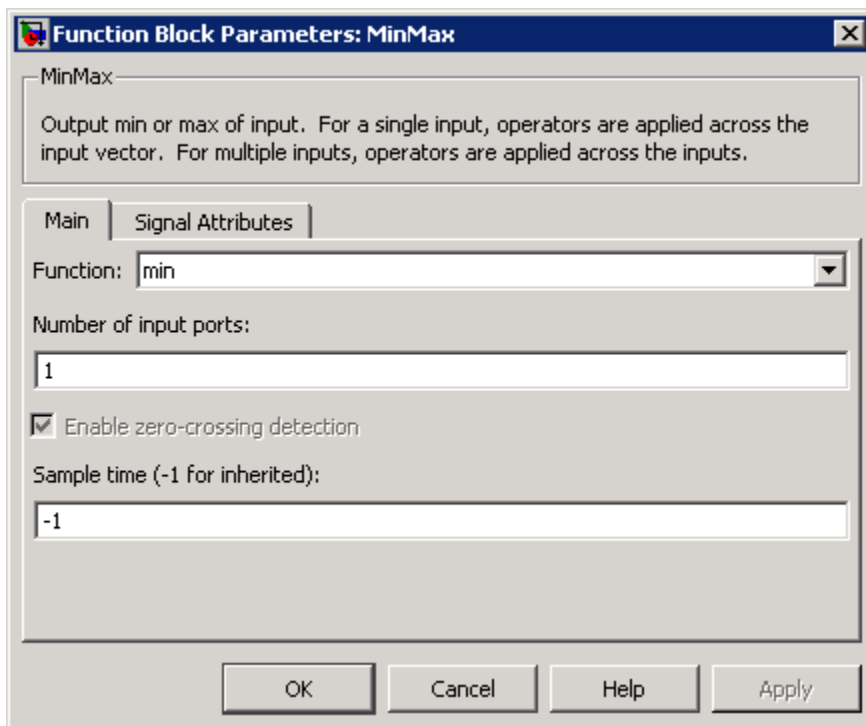
## Data Type Support

The MinMax block accepts and outputs real signals of any numeric data type supported by Simulink software, except **Boolean**. The MinMax block supports fixed-point data types.

For a discussion on the data types supported by Simulink software, see “Data Types Supported by Simulink” in the Simulink documentation.

## Parameters and Dialog Box

The **Main** pane of the MinMax block dialog box 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

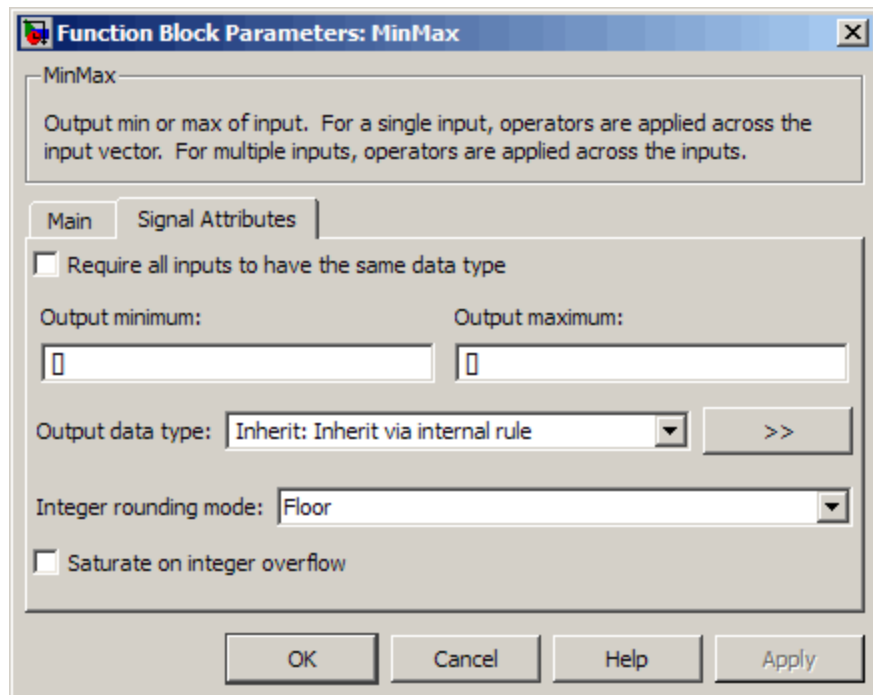
Select to enable zero-crossing detection to detect minimum and maximum values. For more information, see “How Blocks Work with Zero-Crossing Detection” in the “How Simulink Works” chapter of the Simulink documentation.

# MinMax

## Sample time (-1 for inherited)

Specify the time interval between samples. To inherit the sample time, set this parameter to -1. See “How to Specify the Sample Time” in the online documentation for more information.

The **Signal Attributes** pane of the MinMax block dialog box appears as follows:



## Require all inputs to have the same data type

Select this parameter to require that all inputs must have the same data type.



### Output minimum

Specify the minimum value that the block should output. The default value, [], is equivalent to `-Inf`. Simulink software uses this value to perform:

- Simulation range checking (see “Checking Signal Ranges”)
- Automatic scaling of fixed-point data types

### Output maximum

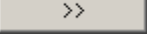
Specify the maximum value that the block should output. The default value, [], is equivalent to `Inf`. Simulink software uses this value to perform:

- Simulation range checking (see “Checking Signal Ranges”)
- Automatic scaling of fixed-point data types

### Output data type

Specify the output data type. You can set it to:

- A rule that inherits a data type, for example, `Inherit: Inherit via back propagation`
- The name of a built-in data type, for example, `single`
- The name of a data type object, for example, a `Simulink.NumericType` object
- An expression that evaluates to a data type, for example, `fixdt(1,16,0)`

Click the **Show data type assistant** button  to display the **Data Type Assistant**, which helps you set the **Output data type** parameter.

See “Specifying Block Output Data Types” in *Simulink User’s Guide* for more information.

### Lock output scaling against changes by the autoscaling tool

Select to lock scaling of outputs. This parameter is visible only if you enter an expression for the **Output data type** parameter.

## Integer rounding mode

Select the rounding mode for fixed-point operations. For more information, see “Rounding” in the *Simulink Fixed Point User’s Guide*.

## Saturate on integer overflow

Select to have overflows saturate.

When you select this check box, saturation applies to every internal operation on the block, not just the output or result. In general, the code generation process can detect when overflow is not possible, in which case, no saturation code is generated.

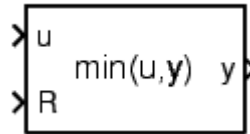
## Characteristics

Direct Feedthrough	Yes
Sample Time	Specified in the <b>Sample time</b> parameter
Scalar Expansion	Yes, of the inputs
Dimensionalized	Yes
Multidimensionalized	Yes
Zero-Crossing Detection	Yes, if enabled.

**Purpose** Determine minimum or maximum of 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.

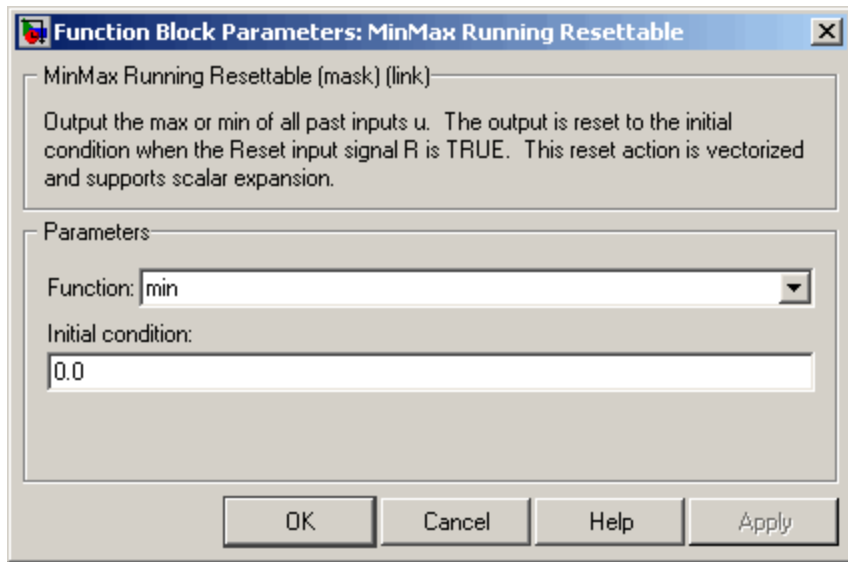
The input can be a scalar, vector, or matrix signal. If you specify a scalar **Initial condition** parameter, the block expands the parameter to have the same dimensions as a nonscalar input. The block outputs a signal having the same dimensions as the input. Each output element equals the running minimum or maximum of the corresponding input elements.

**Data Type Support** The MinMax Running Resettable block accepts and outputs real signals of any numeric data type supported by Simulink software, except Boolean. The MinMax Running Resettable block supports fixed-point data types.

For a discussion on the data types supported by Simulink software, see “Data Types Supported by Simulink” in the Simulink documentation.

# MinMax Running Resettable

## Parameters and Dialog Box



### Function

Specify whether the block outputs the minimum or the maximum.

### Initial condition

Initial condition.

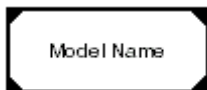
## Characteristics

Direct Feedthrough	Yes
Scalar Expansion	Yes

**Purpose** Include model as block in another model

**Library** Ports & Subsystems

## Description



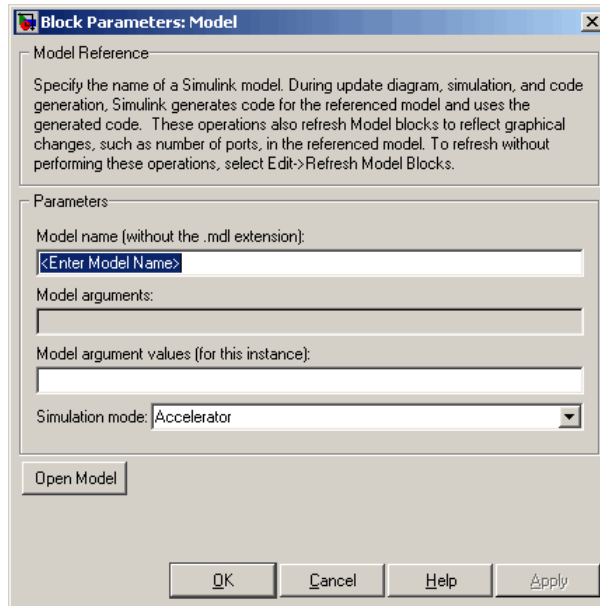
The Model block allows you to include a model as a block in another model. The Model block displays input ports and output ports corresponding to the included model's top-level input and output ports. This allows you to connect the included model to other blocks in the containing model. See “Referencing a Model” for more information.

A signal that connects to a Model block is functionally the same signal outside and inside the block, and is therefore subject to the restriction that a given signal can have at most one associated signal object. See `Simulink.Signal` and “Multiple Signal Objects” on page 7-143 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

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. See “Creating a Model Reference” for details.

### Model arguments

Names of model arguments accepted by the model referenced by this block. See “Using Model Arguments” for details.

### 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. See “Using Model Arguments” for details.

### Simulation mode

The simulation mode for the model referenced by this block.

#### Accelerator

Simulink software creates a MEX-file for the submodel, then executes the submodel by running the S-function.

#### Normal

Simulink software executes the submodel interpretively, as if the submodel were an atomic subsystem implemented directly within the parent model.

#### Processor-in-the-loop (PIL)

This feature requires Real-Time Workshop Embedded Coder software.

Simulink creates both a MEX-file and a model reference target for the submodel. The MEX-file executes the cross-compiled object code on the target processor (or equivalent instruction set simulator).

See “Referenced Model Simulation Modes” for details.

## Navigating a Model Block

Model blocks behave differently from other blocks when double-clicked. This customized behavior provides the results most likely to be useful given the current status of the Model block, as follows:

- Double-clicking the prototype Model block in the Ports & Subsystems library opens its Block Parameters dialog box for inspection, but does not allow you to specify parameter values.
- Double-clicking an unresolved Model block opens its Block Parameters dialog box. You can then resolve the block by specifying a **Model name**.
- Double-clicking a resolved Model block opens the model that the block references. You can also open the model by choosing **Open Model** from the **Context** or **Edit** menu.

## Model Blocks and Direct Feedthrough

To display the Block Parameters dialog box for a resolved Model block, choose **Model Reference Parameters** from the **Context** or **Edit** menu.

When a Model block is part of a cycle, and the block is a direct feedthrough block, an algebraic loop can result. An algebraic loop in a model is not necessarily an error, but it may not give the expected results. See:

- “Algebraic Loops” for information about direct feedthrough and algebraic loops.
- “Highlighting Algebraic Loops” for information about seeing algebraic loops graphically
- “Displaying Algebraic Loop Information” for information about tracing algebraic loops in the debugger.
- The “Diagnostics Pane: Solver” pane “Algebraic loop” option for information about detecting algebraic loops automatically.

### Direct Model Block Feedthrough Caused by Submodel Structure

A Model block may be a direct feedthrough block due to the structure of the referenced model. Where direct feedthrough results from submodel structure, and an unwanted algebraic loop results, you can:

- Automatically eliminate the algebraic loop using techniques described in:
  - “Minimize algebraic loop”
  - “Minimize algebraic loop occurrences”
  - “Eliminating Algebraic Loops”
- Manually insert one or more Unit Delay blocks as needed to break the algebraic loop.



## Direct Model Block Feedthrough Caused by Model Configuration

ERT-based targets provide the option **Configuration Parameters > Real-Time Workshop Pane > Interface > Single output/update function**. This option controls whether generated code has separate output and update functions, or a combined output/update function. See:

- “Embedded Model Functions” for information about separate and combined output and update functions.
- “Single output/update function” for information about specifying whether code has separate or combined functions.

When **Single output/update function** is enabled (the default) a Model block has a combined output/update function, which makes the block a direct feedthrough block for all inports regardless of the structure of the referenced model. Where an unwanted algebraic loop results, you can:

- Disable **Single output/update function**. The code for the Model block then has separate output and update functions, eliminating the direct feedthrough and hence the algebraic loop.
- Automatically eliminate the algebraic loop using techniques described in:
  - “Minimize algebraic loop”
  - “Minimize algebraic loop occurrences”
  - “Eliminating Algebraic Loops”
- Manually insert one or more Unit Delay blocks as needed to break the algebraic loop.

# Model

---

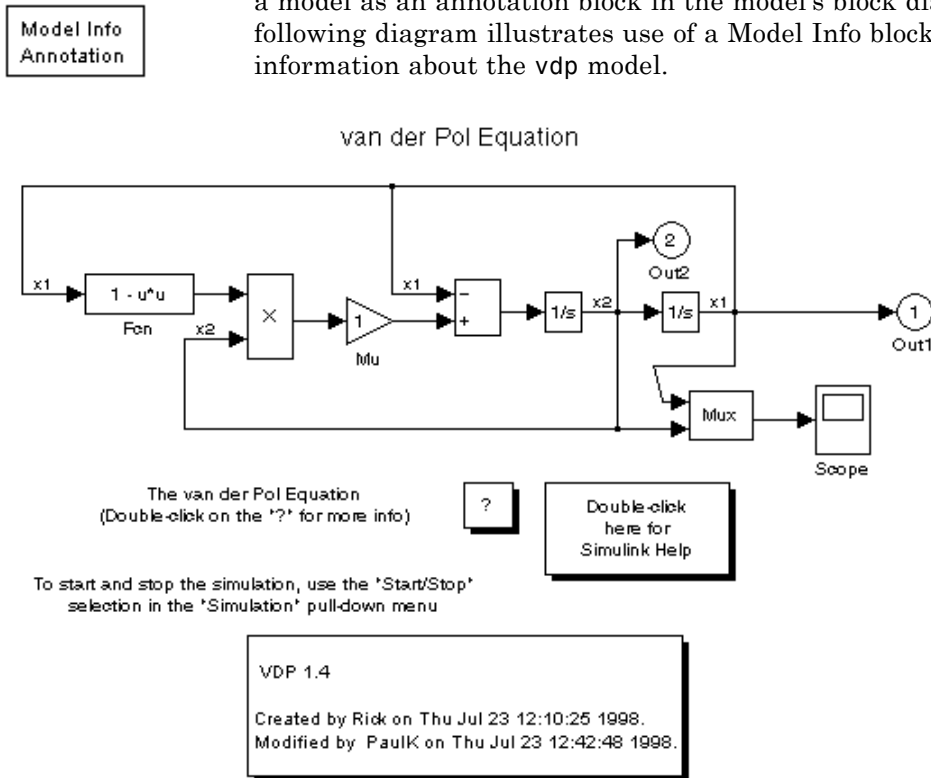
## Characteristics

Direct Feedthrough	<p>If “Single output/update function” is enabled (the default), a Model block is a direct feedthrough block regardless of the structure of the referenced model.</p> <p>If “Single output/update function” is disabled, a Model block may or may not be a direct feedthrough block, depending on the structure of the referenced model.</p>
Scalar Expansion	Depends on model referenced by this block.
Multidimensionalized	Yes

**Purpose** Display revision control information in 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.



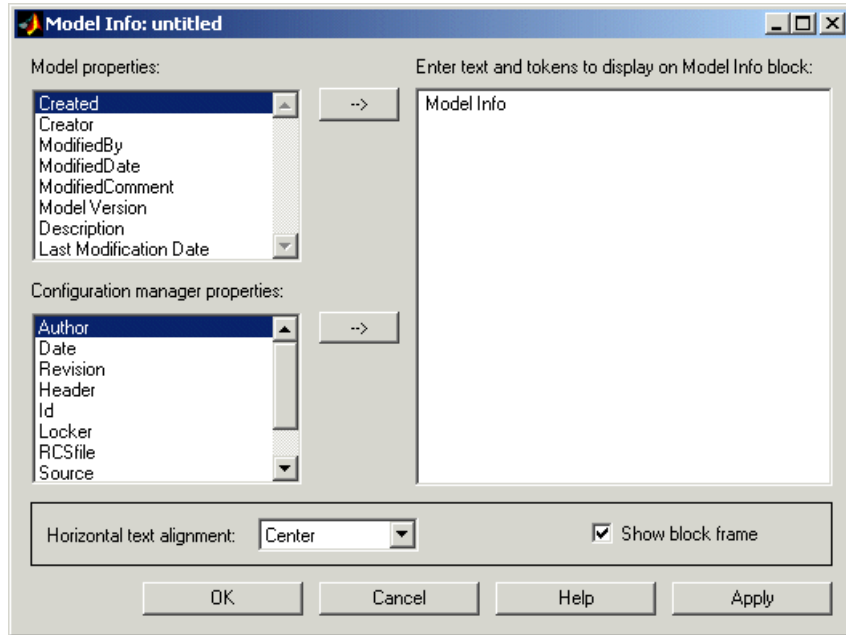
A Model Info block can show revision control information embedded in the model itself and/or information maintained by an external revision control or configuration management system. A Model Info block's dialog allows you to specify the content and format of the text displayed by the block.

# Model Info

## Data Type Support

Not applicable.

## 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 “Specifying the Source Control System on UNIX Platforms” in the online MATLAB 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.

---

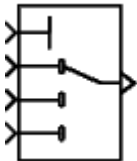
# Multiport Switch

---

**Purpose** Choose between multiple block inputs

**Library** Signal Routing

## Description



The Multiport Switch block chooses among a number of inputs. The first input is the *control input*, while the rest of the inputs are *data inputs*. The number of data inputs must be greater than one.

The value of the control input determines which data input is passed through to the output port. See “How to Rotate a Block” in the Simulink User’s Guide for a description of the port order for various block orientations.

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 inputs** 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 signal can be of any data type supported by Simulink software, including fixed-point and enumerated types, except Boolean. If the control signal is numeric, it cannot be complex. If it is enumerated, the block uses the value of the underlying integer to select a data port. If the underlying integer does not correspond to a data port, an error occurs.

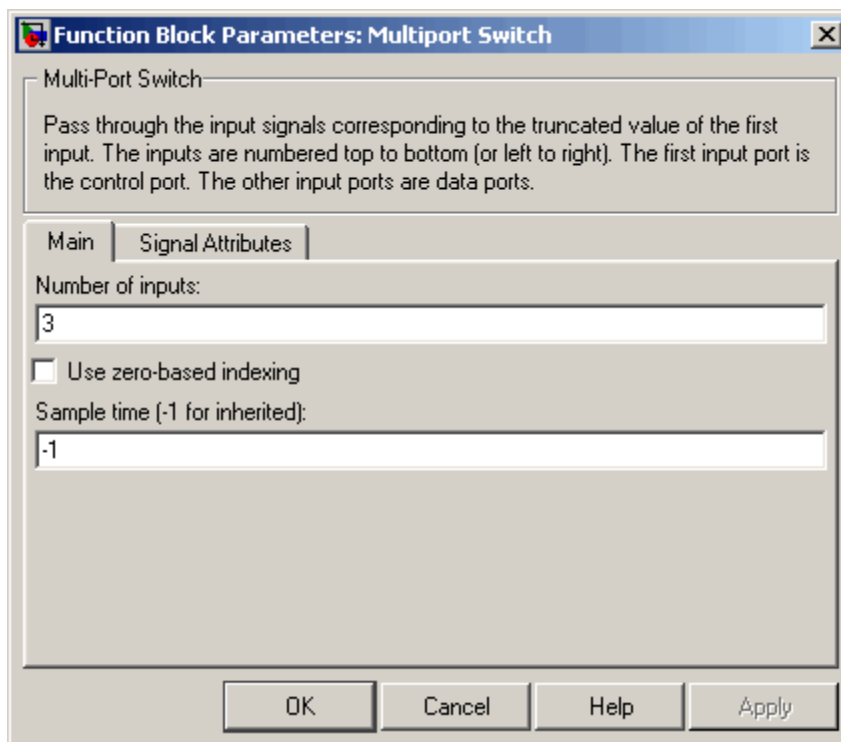
The data signals can be of any data type supported by Simulink software. If any data signal is of an enumerated type, all others must be of the same enumerated type.

For a discussion on the data types supported by Simulink software, see “Data Types Supported by Simulink” in the Simulink documentation.

# Multiport Switch

## Parameters and Dialog Box

The **Main** pane of the Multiport Switch block dialog box appears as follows:



### Number of inputs

Specify the number of data inputs to the block. The number of data inputs must be greater than one.

### Use zero-based indexing

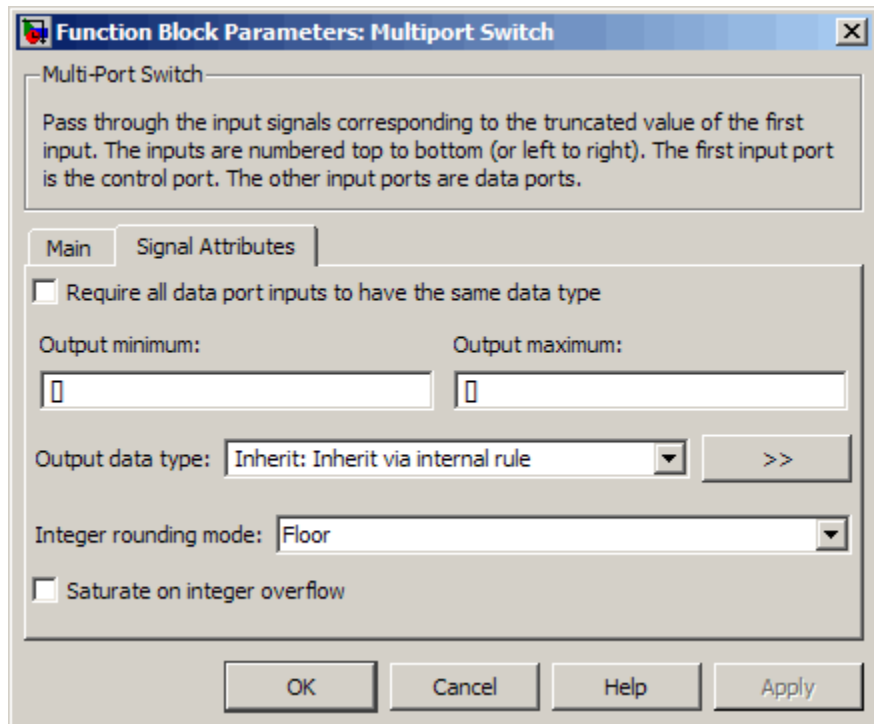
If selected, the block uses zero-based indexing. Otherwise, the block uses one-based indexing.



## Sample time (-1 for inherited)

Specify the time interval between samples. To inherit the sample time, set this parameter to -1. See “How to Specify the Sample Time” in the Simulink User’s Guide for more information.

The **Signal Attributes** pane of the Multiport Switch block dialog box appears as follows:



## Require all data port inputs to have the same data type

Select to require all data port inputs to have the same data type.

# Multiport Switch

---

## Output minimum

Specify the minimum value that the block should output. The default value, [], is equivalent to `-Inf`. Simulink software uses this value to perform:

- Simulation range checking (see “Checking Signal Ranges”)
- Automatic scaling of fixed-point data types

## Output maximum


Specify the maximum value that the block should output. The default value, [], is equivalent to `Inf`. Simulink software uses this value to perform:

- Simulation range checking (see “Checking Signal Ranges”)
- Automatic scaling of fixed-point data types

## Output data type

Specify the output data type. You can set it to:

- A rule that inherits a data type, for example, `Inherit: Inherit via back propagation`
- The name of a built-in data type, for example, `single`
- The name of a data type object, for example, a `Simulink.NumericType` object
- An expression that evaluates to a data type, for example, `fixdt(1,16,0)`

Click the **Show data type assistant** button  to display the **Data Type Assistant**, which helps you set the **Output data type** parameter.

See “Specifying Block Output Data Types” in the *Simulink User’s Guide* for more information.

## Lock output scaling against changes by the autoscaling tool

Select to lock scaling of outputs. This parameter is visible only if you enter an expression for the **Output data type** parameter.

## Integer rounding mode

Select the rounding mode for fixed-point operations. For more information, see “Rounding” in the *Simulink Fixed Point User’s Guide*.

## Saturate on integer overflow

Select to have overflows saturate.

When you select this check box, saturation applies to every internal operation on the block, not just the output or result. In general, the code generation process can detect when overflow is not possible, in which case, no saturation code is generated.

## Bus Support

The Multiport Switch block is a bus-capable block. The data inputs can be virtual or nonvirtual bus signals subject to the following restrictions:

- All the buses must be equivalent (same hierarchy with identical names and attributes for all elements).
- All signals in a nonvirtual bus input to a Multiport Switch block must have the same sample time, even if the elements of the associated bus object specify inherited sample times.

You can use a Rate Transition block to change the sample time of an individual signal, or of all signals in a bus. See *Using Buses and Bus-Capable Blocks* for more information.

## Characteristics

Bus-capable	Yes, with restrictions as noted above
Direct Feedthrough	Yes
Sample Time	Specified in the <b>Sample time</b> parameter
Scalar Expansion	Yes
Dimensionalized	Yes

# Multiport Switch

---

Multidimensionalized	Yes
Zero Crossing	No

**Purpose** Combine several input signals into 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 must be of the same data type and numeric type. The elements of the vector output signal take their order from the top to bottom, or left to right, input port signals. See “How to Rotate a Block” for a description of the port order for various block orientations. To avoid adding clutter to a model, Simulink software hides the name of a Demux block when you copy it from the Simulink library to a model. See “Mux Signals” for information about creating and decomposing vectors.

---

**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 acts like a Bus Creator block and outputs a bus signal rather than a vector. The MathWorks discourages using mux blocks to create bus signals, and may not support this practice in future releases. See “Avoiding Mux/Bus Mixtures” 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 software 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, respectively. If an input signal width does not match the expected width, Simulink software 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 software 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`.

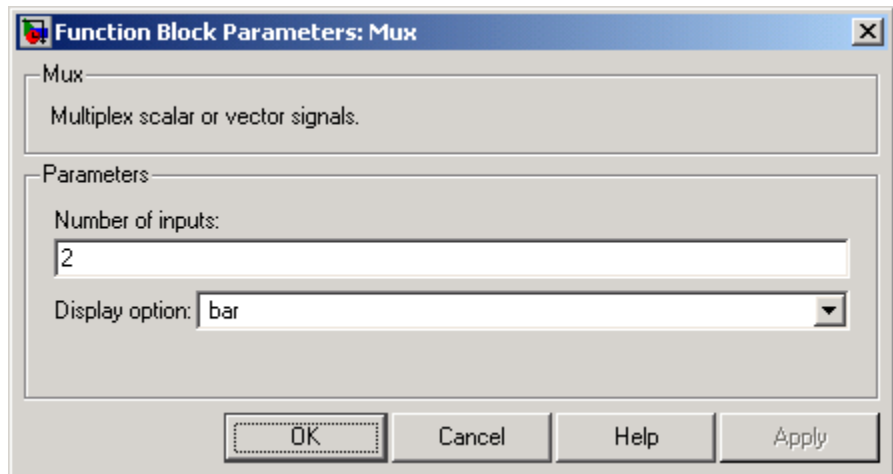
The MathWorks encourages using Vector Concatenate blocks rather than Mux blocks to combine vectors. The primary exception is the creation of a vector of function calls, which requires a Mux block. In future releases, Mux blocks may have no unique capabilities and may be deprecated.

If you want to create a composite signal, in which the constituent signals retain their identities and can have different data types, use a Bus Creator block rather than a Mux block. Although you can use a Mux block to create a composite signal, The MathWorks discourages this practice. See “Avoiding Mux/Bus Mixtures” for more information.

## Data Type Support

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

For a discussion on the data types supported by Simulink software, see “Data Types Supported by Simulink” in the Simulink documentation.

**Parameters  
and  
Dialog  
Box**

## **Number of inputs**

Specify number and size of inputs.

### **Settings**

**Default:** 2

You can enter a comma-separated list of signal names for this parameter field.

### **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.



**Display option**

Specify the appearance of the block in the model.

**Settings**

**Default:** bar

bar

Displays the block in a solid foreground color

none

Mux appears inside the block

signals

Displays signal names next to each port

**Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

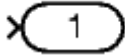
# Output

---

**Purpose** Create output port for subsystem or external output

**Library** Ports & Subsystems, Sinks

**Description** Output blocks are the links from a system to a destination outside the system.



Simulink software assigns Outputport block port numbers according to these rules:

- It automatically numbers the Outputport blocks within a top-level system or subsystem sequentially, starting with 1.
- If you add an Outputport block, it is assigned the next available number.
- If you delete an Outputport block, other port numbers are automatically renumbered to ensure that the Outputport blocks are in sequence and that no numbers are omitted.

## Output Blocks in a Subsystem

Output blocks in a subsystem represent outputs from the subsystem. A signal arriving at an Outputport block in a subsystem flows out of the associated output port on that Subsystem block. The Outputport 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 Outputport 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 Outputport 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 Outputport block is included in the grouped blocks, Simulink software automatically renumbers the ports on the blocks.

The Outputport block name appears in the Subsystem icon as a port label. To suppress display of the label, select the Outputport block and choose **Hide Name** from the **Format** menu.

## Output Blocks in Conditionally Executed Subsystems

When an Output block is in an enabled subsystem, its initial output value can be either explicitly specified, or inherited from its input signal.

### Specifying Initial Conditions

To explicitly specify an initial output value:

- 1 Select **Dialog** in the **Source of initial output value** drop-down list.
- 2 Specify the **Initial output** parameter.

If you select **Dialog**, you can also specify what happens to the output when the subsystem is disabled, using the **Output when disabled** drop-down menu. Select either:

- **reset** – The output value is reset to the **Initial output** value when the subsystem is disabled.
- **held** – The output value remains at its most recent value when the subsystem is disabled.

---

**Note** If you are connecting the output of the conditionally executed subsystem to a Merge block, set **Output when disabled** to **held** to ensure consistent simulation results.

If you are using simplified initialization mode, you must select **held** when connecting a conditionally executed subsystem to a Merge block. For more information, see “Underspecified initialization detection”.

---

### Inheriting Initial Conditions

The initial output value of the output block can be inherited from the following sources:

- Output port of another conditionally executed subsystem
- Merge block (with Initial output specified)

- Function-Call Model Reference block
- Constant block (simplified initialization mode only)
- IC block (simplified initialization mode only)

The procedure you use to inherit the initial conditions of the Output block differs depending on whether you are using classic initialization mode or simplified initialization mode.

### To inherit initial conditions in classic initialization mode:

- 1 Select Dialog in the **Source of initial output value** drop-down list.
- 2 Set the **Initial output** parameter to [ ] (empty matrix).
- 3 Click **OK**.

---

**Note** For all other driving blocks, specify an explicit initial output value.

---

### To inherit initial conditions in simplified initialization mode:

- 1 Select Input signal in the **Source of initial output value** drop-down list.
- 2 Click **OK**.

The **Initial output** and **Output when disabled** parameters are disabled, and the values are both inherited from the input signal.

For more information on classic and simplified initialization mode, see “Underspecified initialization detection”.

## Output Blocks in a Top-Level System

Output 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”)

### Connecting Buses to Root Level Outports

A root level Outport of a model can accept a virtual bus only if all elements of the bus have the same data type. The Outport block automatically unifies the bus to a vector having the same number of elements as the bus, and outputs that vector.

If you want a root level Outport of a model to accept a bus signal that contains mixed types, you must select the Outport’s **Specify properties via bus object** parameter and set the Outport’s **Bus object for validating input bus** parameter to the name of a bus object that defines the type of bus that the Outport produces. If the bus signal is virtual, it will be converted to nonvirtual, as described in “Automatic Bus Conversion”. See “Using Bus Objects” more information.

An Output in a conditionally executed subsystem that is connected to a bus that contains mixed data types cannot be configured to reset and have initial values specified.

## Data Type Support

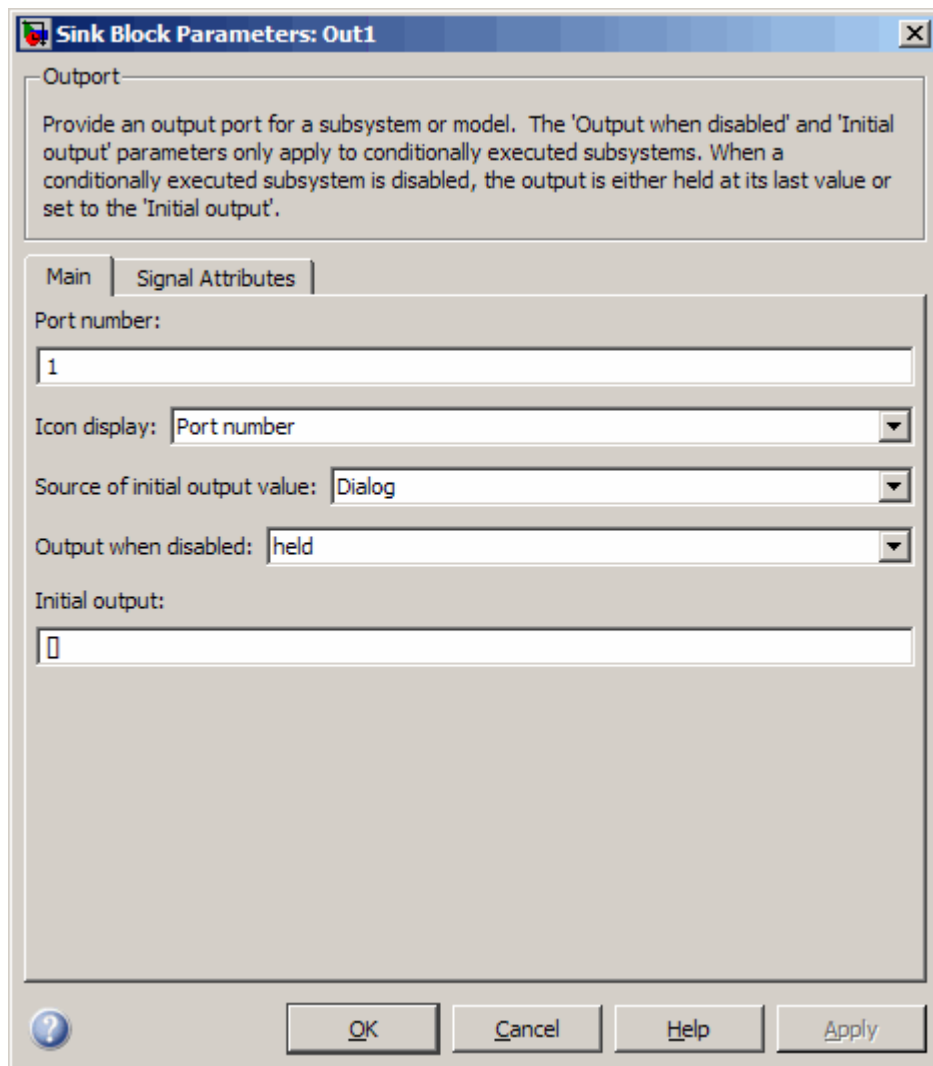
The Output block accepts complex or real signals of any data type supported by Simulink software. An Output block can also accept fixed-point and enumerated data types if the block is not a root-level output port. The complexity and data type of the block's output are the same as those of its input. For a discussion on the data types supported by Simulink software, see "Data Types Supported by Simulink" in the Simulink documentation.

The elements of a signal array connected to an Output 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 software 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 software halts the simulation and signals an error.

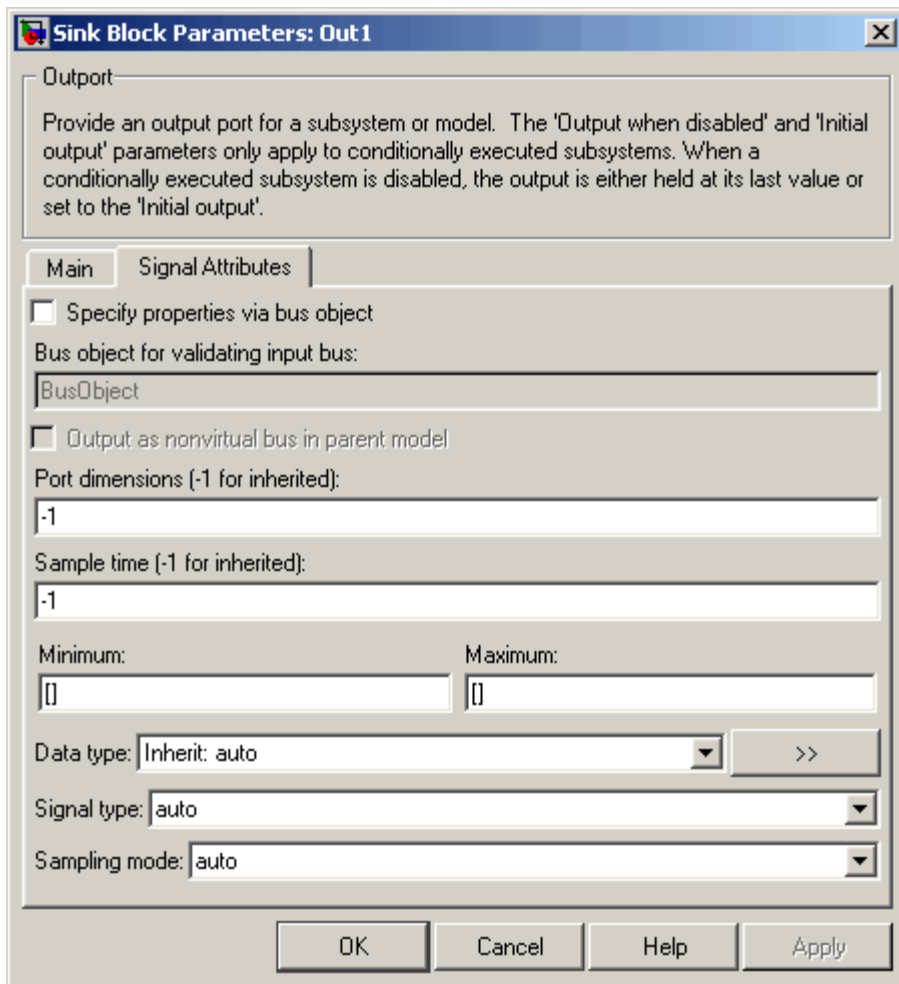
## Parameters and Dialog Box

The **Main** pane of the Output block dialog box appears as follows:



# Output

The **Signal Attributes** pane of the Output block dialog appears as follows:





## **Show data type assistant**

Display the **Data Type Assistant**.

### **Settings**

The **Data Type Assistant** helps you set the **Output data type** parameter.

See “Specifying Block Output Data Types” in *Simulink User’s Guide* for more information.

### **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

## **Port number**

Specify the port number of the block.

## **Settings**

**Default:** 1

This parameter controls the order in which the port that corresponds to the block appears on the parent subsystem or model block.

## **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

## **Icon display**

Specify the information to be displayed on the icon of this input port.

### **Settings**

**Default:** Port number

Signal name

Display the name of the signal connected to this port (or signals if the input is a bus).

Port number

Display port number of this port.

Port number and signal name

Display both the port number and the names of the signals connected to this port.

### **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

## Source of initial output value

Select the source of the initial output value of the Outport block.

### Settings

**Default:** Dialog

#### Dialog

The initial output value is specified by the **Initial output** parameter on the dialog.

#### Input signal

The initial output value is inherited from the input signal.

### Tips

- If you are using classic initialization mode, you *must* select Dialog. Selecting Input signal will cause an error.
- If you are using classic initialization mode and want to inherit the initial output value, set this parameter to Dialog, and then specify [ ] (empty matrix) for the **Initial output** value. For more information, see Inheriting Initial Conditions on page 711.

### Dependencies

This parameter applies only if the Outport resides in an Enabled Subsystem.

Selecting Dialog enables the following parameters:

- **Output when disabled**
- **Initial output**

### Command-Line Information

See “Block-Specific Parameters” on page 8-96 for the command-line information.

## Output when disabled

Specify what happens to the block output when the subsystem is disabled.

### Settings

**Default:** held

held

Output is held when the subsystem is disabled.

reset

Output is reset when the subsystem is disabled.

### Tips

- If you are connecting the output of a conditionally executed subsystem to a Merge block, set **Output when disabled** to held to ensure consistent simulation results.
- If you are using simplified initialization mode, you must select held when connecting a conditionally executed subsystem to a Merge block.

### Dependencies

- This parameter is enabled by selecting Dialog in **Source of initial output value**.
- This parameter applies only if the Output resides in an Enabled Subsystem.

### Command-Line Information

See “Block-Specific Parameters” on page 8-96 for the command-line information.

## Initial output

For conditionally executed subsystems, specify the block output before the subsystem executes and while it is disabled.

### Settings

**Default:** []

Simulink software does not allow the initial output of this block to be `inf` or `NaN`.

### Tips

- If you are using classic initialization mode, specify [] (empty matrix) to inherit the initial output value from the input signal. For more information, see *Inheriting Initial Conditions* on page 711.
- You can also specify [] if you are using classic initialization mode, and your model does not depend on the initial output of the conditionally executed subsystem.
- If you are using simplified initialization mode, you cannot specify [], you must specify an explicit value. If you do not want to specify an initial output value for this block, set **Source of initial output value** to `Input signal`.

### Dependencies

- This parameter is enabled by selecting `Dialog` in **Source of initial output value**.
- This parameter applies only if the Outport resides in an Enabled Subsystem.

### Command-Line Information

See “Block-Specific Parameters” on page 8-96 for the command-line information.

## Specify properties via bus object

Use a bus object to define the structure of the bus that is input or output by this block.

### Settings

**Default:** Off

On

Use a bus object to define the structure of the bus that is input or output by this block.

Off

Do not use a bus object to define the structure of the bus that is input or output by this block.

### Tips

Selecting this parameter is required if the bus is nonvirtual (including a nonvirtual bus that was converted from a virtual bus as described in “Automatic Bus Conversion”) and is optional otherwise.

### Dependencies

This parameter enables **Bus object for validating input bus**.

This parameter enables **Output as nonvirtual bus in parent model**.

### Command-Line Information

See “Block-Specific Parameters” on page 8-96 for the command-line information.

## **Bus object for validating input bus**

Specify the name of the bus object that defines the structure that a bus must have to be connected to this port.

### **Settings**

**Default:** BusObject

A bus object is an instance of class `Simulink.Bus` that is defined in the base workspace.

### **Tips**

At the beginning of a simulation or when you update the model's diagram, Simulink software checks whether the bus connected to this port has the specified structure. If not, Simulink software displays an error message.

### **Dependencies**

This parameter is enabled by **Specify properties via bus object**.

### **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.



## Output as nonvirtual bus in parent model

Select this parameter if you want the bus emerging in the parent model to be nonvirtual, in which case C code generated from the model uses a C structure to define the structure of the bus signal output by this block.

### Settings

**Default:** Off

On

Select this parameter if you want the bus emerging in the parent model to be nonvirtual, in which case C code generated from the model uses a C structure to define the structure of the bus signal output by this block.

Off

Do not select this parameter if you want the bus emerging in the parent model to be nonvirtual, in which case C code generated from the model uses a C structure to define the structure of the bus signal output by this block.

### Tips

- The bus that is input to the Outputport can be virtual or nonvirtual, regardless of the setting of **Output as nonvirtual bus in parent model**.
- All signals in a nonvirtual bus must have the same sample time, even if the elements of the associated bus object specify inherited sample times. Any bus operation that would result in a nonvirtual bus that violates this requirement generates an error. Therefore, if you select this option all signals in the bus must have the same sample time. You can use a Rate Transition block to change the sample time of an individual signal, or of all signals in a bus, to allow the signal or bus to be included in a nonvirtual bus.

### Dependencies

This parameter is enabled by **Specify properties via bus object**.

## **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

## Port dimensions (-1 for inherited)

Specify the dimensions that a signal must have in order to be connected to this Output block.

### Settings

**Default:** -1

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.

### Dependencies

This parameter is enabled by clearing **Specify properties via bus object**.

### Command-Line Information

See “Block-Specific Parameters” on page 8-96 for the command-line information.

## **Sample time (-1 for inherited)**

Enter the discrete interval between sample time hits or specify another appropriate sample time such as continuous or inherited.

### **Settings**

**Default:** -1

By default, the block inherits its sample time based upon the context of the block within the model. To set a different sample time, enter a valid sample time based upon the table in “Types of Sample Time”.

See also “How to Specify the Sample Time” in the online documentation for more information.

### **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

## **Lock output scaling against changes by the autoscaling tool**

Select to lock scaling of outputs.

### **Settings**

**Default:** Off

On

Lock scaling of outputs.

Off

Do not lock scaling of outputs.

### **Dependencies**

This parameter is enabled when you enter an expression for the **Output data type** or **Data type** parameter.

### **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

## Signal type

Specify the numeric type of the signal output by this block.

### Settings

**Default:** auto

auto

Output the numeric type of the signal that is connected to its input.

real

Output a real-valued signal. The signal connected to this block must be real. If it is not, Simulink software displays an error if you try to update the diagram or simulate the model that contains this block.

complex

Output a complex signal. The signal connected to this block must be complex. If it is not, Simulink software displays an error if you try to update the diagram or simulate the model that contains this block.

### Command-Line Information

See “Block-Specific Parameters” on page 8-96 for the command-line information.

## **Sampling mode**

Specify the sampling mode (Sample based or Frame based) that the input signal must match.

### **Settings**

**Default:** auto

auto

Accept any sampling mode.

Sample based

The output signal is sample-based.

Frame based

The output signal is frame-based.

### **Tips**

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

### **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

## **Minimum**

Specify the minimum value that the block should output.

## **Settings**

**Default:** []

The default value, [], is equivalent to `-Inf`. Simulink software uses this value to perform:

- Simulation range checking (see “Checking Signal Ranges”)
- Automatic scaling of fixed-point data types

## **Tip**

This number must be a double scalar value.

## **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.



## **Maximum**

Specify the maximum value that the block should output.

### **Settings**

**Default:** []

The default value, [], is equivalent to  $-\text{Inf}$ . Simulink software uses this value to perform:

- Simulation range checking (see “Checking Signal Ranges”)
- Automatic scaling of fixed-point data types

### **Tip**

This number must be a double scalar value.

### **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

## **Data type**

Specify the output data type of the external input.

### **Settings**

**Default:** Inherit: auto

Inherit: auto

A rule that inherits a data type

double

Data type is double.

single

Data type is single.

int8

Data type is int8.

uint8

Data type is uint8.

int16

Data type is int16.

uint16

Data type is uint16.

int32

Data type is int32.

uint32

Data type is uint32.

boolean

Data type is boolean.

fixdt(1,16,0)

Data type is fixed point fixdt(1,16,0).

fixdt(1,16,2<sup>0</sup>,0)

Data type is fixed point fixdt(1,16,2<sup>0</sup>,0).

Enum: <class name>  
Data type is enumerated.

<data type expression>  
The name of a data type object, for example  
Simulink.NumericType

### **Tips**

This parameter can also be an expression that evaluates to a data type, for example, `float('single')`

### **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

## Mode

Select the category of data to specify

## Settings

**Default:** Inherit (Constant, Data Type Conversion, Discrete Time Integrator, Gain, Inport, Output, Product, Saturation, Sum, Switch),  
**Built in** (Logical Operator, Relational Operator)

### Inherit

Inheritance rules for data types. Selecting **Inherit** enables a second menu/text box to the right. Below are the possible values, which can vary by block:

- Inherit from 'Constant value' (Constant block default)
- Inherit via internal rule (Discrete-Time Integrator, Gain, Product, Sum, Switch block default)
- Inherit via back propagation (Data Type Conversion block default)
- auto (Inport, Output block default)
- Logical (see Configuration Parameters: Optimization)
- Same as first input
- Same as input (Saturation block default)
- Same as accumulator

### Built in

Built-in data types. Selecting **Built in** enables a second menu/text box to the right. Below are the possible values, which can vary by block:

- double (Constant, Data Type Conversion, Discrete-Time Integrator, Gain, Inport, Output, Product, Saturation, Sum, Switch block default)
- single

- int8
- uint8
- int16
- uint16
- int32
- uint32
- boolean (Logical Operator, Relational Operator block default)

#### Fixed point

Fixed-point data types.

#### Enumerated

Enumerated data types. This option is available on some blocks. Selecting Enumerated enables a second menu/text box to the right. Below are the possible values, which can vary by block:

- <class name>

#### Expression

Expressions that evaluate to data types. Selecting Expression enables a second menu/text box to the right. Below are the possible values, which can vary by block:

- <data type expression>

#### Dependency

This parameter is enabled by the **Show data type assistant** button.

#### Command-Line Information

See “Block-Specific Parameters” on page 8-96 for the command-line information.

#### See Also

See “Using the Data Type Assistant” in the *Simulink User’s Guide*.

## **Signedness**

Specify whether you want the fixed-point data to be signed or unsigned.

### **Settings**

**Default:** Signed

Signed

Specify the fixed-point data to be signed.

Unsigned

Specify the fixed-point data to be unsigned.

### **Dependencies**

This parameter is enabled by selecting **Mode** > Fixed point.

### **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

### **See Also**

See “Specifying a Fixed-Point Data Type” in the *Simulink User’s Guide* for more information.

## **Word length**

Specify the bit size of the word that will hold the quantized integer.

### **Settings**

**Default:** 16

**Minimum:** 0

**Maximum:** 32

Large word sizes represent large values with greater precision than small word sizes.

### **Dependencies**

This parameter is enabled by selecting **Mode** > Fixed point.

### **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

### **See Also**

See “Specifying a Fixed-Point Data Type” in the *Simulink User’s Guide* for more information.

## Scaling

Specify the method for scaling your fixed-point data to avoid overflow conditions and minimize quantization errors.

### Settings

**Default:** Best precision (Constant), Binary point (Data Type Conversion, Discrete-Time Integrator, Gain, Inport, Outport, Product, Saturation, Sum, Switch), Integer (Logical Operator, Relational Operator)

Binary point

Specify binary point location.

Slope and bias

Enter slope and bias.

Best precision

Specify best-precision values. This option appears for some blocks.

Integer

Specify integer. This setting has the same result as specifying a binary point location and setting fraction length to 0. This option appears for some blocks.

### Dependencies

This parameter is enabled by selecting **Mode** > Fixed point.

Selecting Binary point enables:

- **Fraction length**
- **Calculate Best-Precision Scaling**

Selecting Slope and bias enables:

- **Slope**
- **Bias**
- **Calculate Best-Precision Scaling**



**Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

**See Also**

See “Specifying a Fixed-Point Data Type” in the *Simulink User’s Guide* for more information.

## **Fraction length**

Specify fraction length for fixed-point data type.

### **Settings**

**Default:** 0

Binary points can be positive or negative integers.

### **Dependencies**

This parameter is enabled by selecting **Scaling** > Binary point.

### **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

### **See Also**

See “Specifying a Fixed-Point Data Type” in the *Simulink User’s Guide* for more information.

## **Slope**

Specify slope for the fixed-point data type.

### **Settings**

**Default:**  $2^0$

Specify any positive real number.

### **Dependencies**

This parameter is enabled by selecting **Scaling** > Slope and bias.

### **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

### **See Also**

See “Specifying a Fixed-Point Data Type” in the *Simulink User’s Guide* for more information.

## **Bias**

Specify bias for the fixed-point data type.

## **Settings**

**Default:** 0

Specify any real number.

## **Dependencies**

This parameter is enabled by selecting **Scaling** > Slope and bias.

## **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

## **See Also**

See “Specifying a Fixed-Point Data Type” in the *Simulink User’s Guide* for more information.

## **Characteristics**

Sample Time	Inherited from driving block
Dimensionalized	Yes
Multidimensionalized	Yes

**Purpose** Rearrange dimensions of multidimensional array dimensions

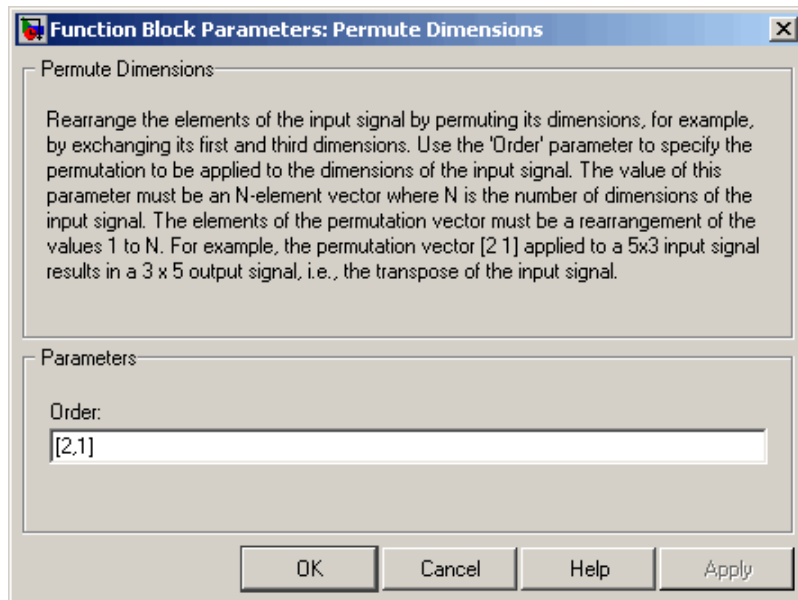
**Library** Math Operations

**Description** The block reorders the elements of the input signal so that they are in the order that you specify in the **Order** parameter.



**Data Type Support** Accepts signals of any data type supported by Simulink software, including fixed-point and enumerated data types. Output must be the same data type as the input.

## Parameters and Dialog Box



# Permute Dimensions

---

## Order

Specify the permutation order to apply to the dimensions of the input signal. This parameter is a vector of elements, where the number of elements in the vector is the number of dimensions of the input signal.

## Characteristics

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

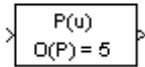
## See Also

Math Function (transpose), permute (in the MATLAB reference documentation)

**Purpose** Perform evaluation of polynomial coefficients on input values

**Library** Math Operations

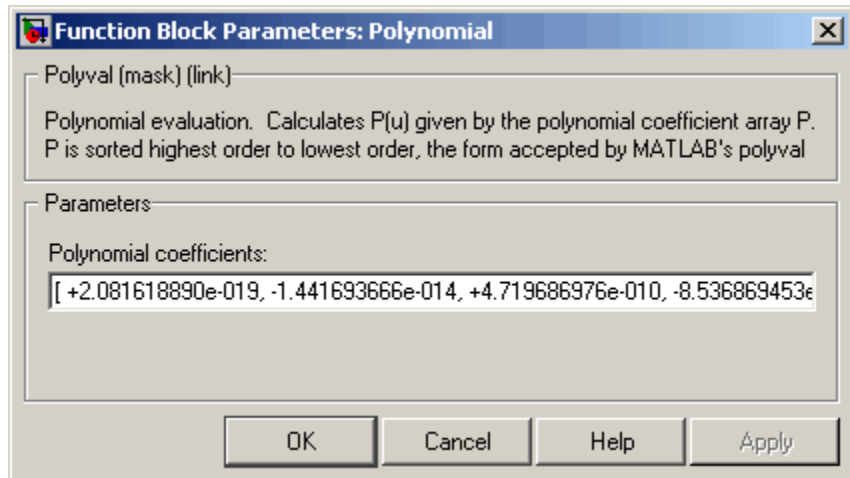
**Description** The Polynomial block uses a coefficients parameter to evaluate a real polynomial for the input value.



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.

# Polynomial

---

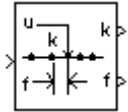
<b>Characteristics</b>	Direct Feedthrough	Yes
	Sample Time	Inherited from driving block
	Scalar Expansion	No
	Dimensionalized	Yes
	Zero Crossing	No



**Purpose** Compute index and fraction for Interpolation Using Prelookup block

**Library** Lookup Tables

## Description



The Prelookup block is intended for use with the Interpolation Using Prelookup block. The Prelookup block calculates the index and interval fraction that specifies how its input value relates to the breakpoint data set. You feed the resulting index and fraction values into an Interpolation 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. However, the Prelookup and Interpolation Using Prelookup blocks offer greater flexibility that can provide more efficient simulation and code generation.

To use this block, you must define a set of breakpoint values. In normal use, this breakpoint data set corresponds to one dimension of the **Table data** parameter in an Interpolation 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 forms an interval containing the input
- The resulting fractional value that is a number  $0 \leq f < 1$ , representing the input value's normalized position on the breakpoint interval between the index and the next index value for in-range input

For example, if the breakpoint data set is

[ 0 5 10 20 50 100 ]

and the input value  $u$  is 55, the index is 4 and the fractional value is 0.1, denoted respectively as  $k$  and  $f$  on the block. The index value is zero-based.

# Prelookup

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**Note** The interval fraction can be negative or greater than 1 for out-of-range input. See the documentation for the **Process out of range input** block parameter for more information.

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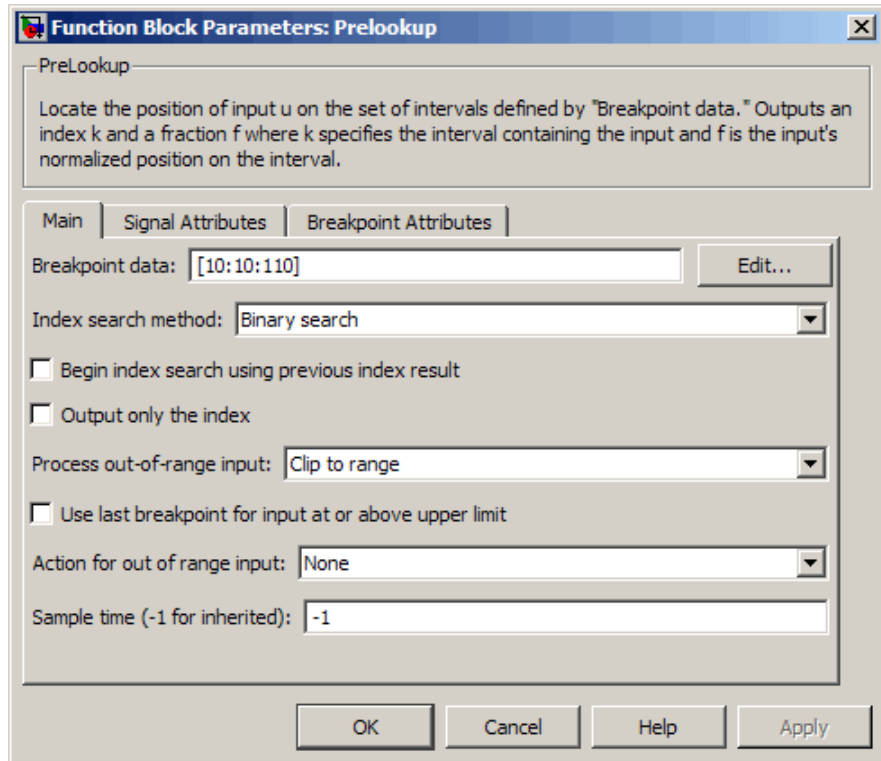
## Data Type Support

The Prelookup block accepts real signals of any numeric data type supported by Simulink software, except `Boolean`. The Prelookup block supports fixed-point data types for signals and breakpoint data.

For a discussion on the data types supported by Simulink software, see “Data Types Supported by Simulink” in the Simulink documentation.

## Parameters and Dialog Box

The **Main** pane of the Prelookup block dialog box appears as follows:



### Breakpoint data

The set of numbers to search. Specify a strictly monotonically increasing vector that contains two or more elements.

Click the **Edit** button to open the Lookup Table Editor (see “Lookup Table Editor” in the Simulink documentation).

### Index search method

Binary search, Evenly spaced points, or Linear search. Use Binary search or Linear search in combination with **Begin**

**index search using previous index result** for more efficient performance when the input values do not change much from one time step to the next. For large breakpoint data 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. Use **Evenly spaced points** if the elements of the **Breakpoint data** parameter are spaced apart evenly.

### **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 at the previous time step. For inputs that change slowly with respect to the interval size, you can realize a large performance gain.

### **Output only the index**

Select this option if you want the block to output only the resulting index value.

Typical applications include:

- Feeding a Direct Lookup Table (n-D) block, with no interpolation on the interval
- Feeding selection ports of a sub-table selection for an Interpolation Using Prelookup block
- Performing nonlinear quantizations

### **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-last breakpoint and 1 for the interval fraction.

Suppose the range is [1 2 3] and you select this option. If the input is 0.5, the index is 0 and the interval fraction is 0; if the input is 3.5, the index is 1 and the interval fraction is 1.

- **Linear extrapolation**

If the input is less than the first breakpoint, return the index of the first breakpoint (i.e., 0) 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-last breakpoint and an interval fraction that represents the linear distance from the next-to-last breakpoint to the input.

Suppose the range is [1 2 3] and you select this option. If the input is 0.5, the index is 0 and the interval fraction is -0.5; if the input is 3.5, the index is 1 and the interval fraction is 1.5.

The Prelookup block supports **Linear extrapolation** only if all of these conditions apply:

- The block input, breakpoint data, and fraction output specify floating-point data types.
- The data type of its index specifies a built-in integer.

**Use last breakpoint for input at or above upper limit**

Specifies how to index inputs that are greater than or equal to the last breakpoint. If enabled when the block input equals the last breakpoint, the block returns the index of the last element in the breakpoint data set and 0 for the interval fraction. If disabled in this situation, the block returns the index of the next-to-last breakpoint and 1 for the interval fraction. Note that the index value is zero-based.

This parameter is visible only if **Output only the index** is cleared and **Process out-of-range input** is **Clip to range**. However, if **Output only the index** is selected and **Process out-of-range input** is **Clip to range**, the block behaves as if this parameter is enabled even though it is invisible.

---

**Note** If you enable the **Use last breakpoint for input at or above upper limit** parameter for a Prelookup block, you must also enable the **Valid index input may reach last index** parameter for the Interpolation Using Prelookup block to which it connects. This action allows the blocks to use the same indexing convention when accessing the last elements of their **Breakpoint data** and **Table data** parameters.

---

### Action for out of range input

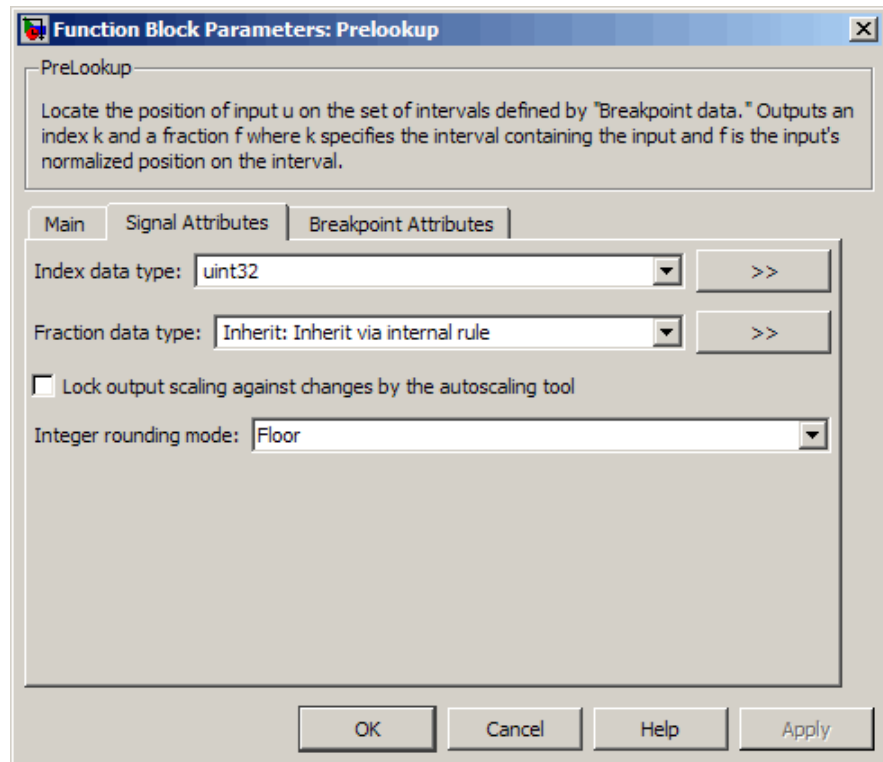
Specifies whether to produce a warning or error message if the input is out of range. The options are

- 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

### Sample time

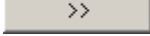
Specifies the time interval between samples. To inherit the sample time, set this parameter to -1. See “How to Specify the Sample Time” in the Simulink User’s Guide for more information.

The **Signal Attributes** pane of the Prelookup block dialog box appears as follows:



### Index data type


Specify how the data type of the index is designated. You can choose a built-in integer data type from the list, or you can specify an integer data type using a fixed-point representation. The data type that you specify must be capable of indexing all elements in the **Breakpoint data** parameter.

Click the **Show data type assistant** button  to display the **Data Type Assistant**, which helps you set the **Index data type** parameter.

See “Using the Data Type Assistant” in the *Simulink User’s Guide* for more information.

## Fraction data type

Specify how the data type of the interval fraction is designated. You can choose a built-in data type from the list, specify that the data type is inherited through an internal rule, or specify a fixed-point data type using either the [Slope Bias] or the binary-point-only scaling representation. If using the [Slope Bias] representation, the scaling must be trivial — i.e., the slope is 1 and the bias is 0. If using the binary-point-only representation, the fixed power-of-two exponent must be less than or equal to zero.

Click the **Show data type assistant** button  to display the **Data Type Assistant**, which helps you set the **Fraction data type** parameter.

See “Using the Data Type Assistant” in the *Simulink User’s Guide* for more information.

## Lock output scaling against changes by the autoscaling tool

Select to lock scaling of outputs.

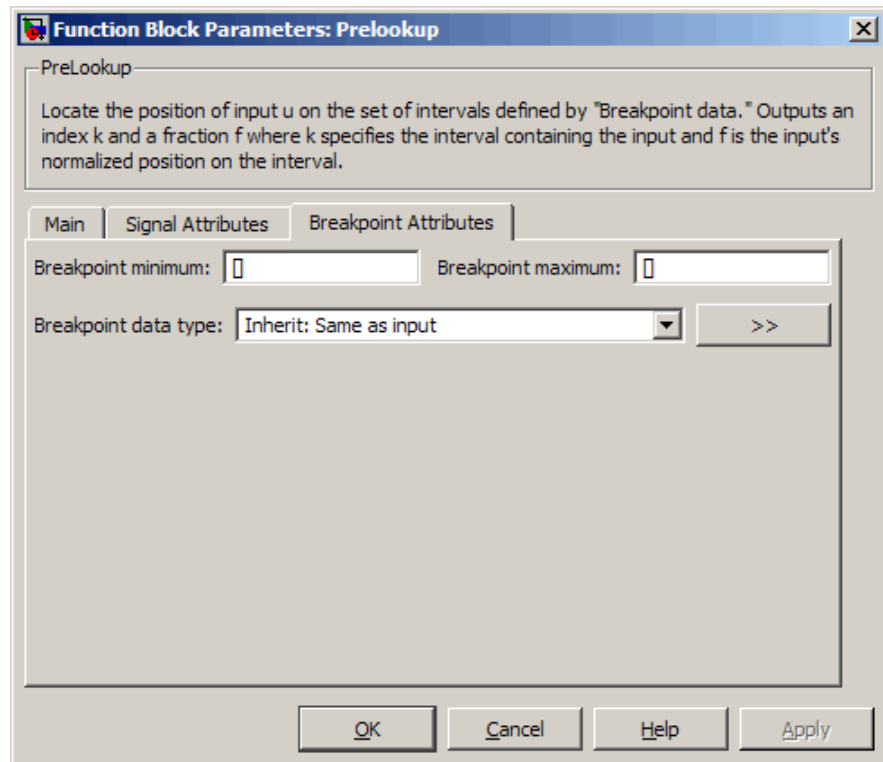
## Integer rounding mode

Select the rounding mode for fixed-point operations. For more information, see “Rounding” in the *Simulink Fixed Point User’s Guide*.

Block parameters such as **Breakpoint 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.

The **Breakpoint Attributes** pane of the Prelookup block dialog box appears as follows:





### **Breakpoint minimum**

Specify the minimum value that the breakpoint data can have. The default value, [ ], is equivalent to  $-\text{Inf}$ .

### **Breakpoint maximum**

Specify the maximum value that the breakpoint data can have. The default value, [ ], is equivalent to  $\text{Inf}$ .

### **Breakpoint data type**


Specify the breakpoint data type. You can set it to:

- A rule that inherits a data type, for example, **Inherit: Same as input**

# Prelookup

---

- The name of a built-in data type, for example, `single`
- The name of a data type object, for example, a `Simulink.NumericType` object
- An expression that evaluates to a data type, for example, `fixdt(1,16,0)`

Click the **Show data type assistant** button  to display the **Data Type Assistant**, which helps you set the **Breakpoint data type** parameter.

See “Using the Data Type Assistant” in the *Simulink User’s Guide* for more information.

---

**Tip** Specify a breakpoint data type different from the input data type for these cases:

- Lower memory requirement for storing breakpoint data that uses a smaller type than the input signal
  - Sharing of prescaled breakpoint data between two Prelookup blocks with different input data types
  - Sharing of custom storage breakpoint data in Real-Time Workshop generated code for blocks with different input data types
- 

## Characteristics

Direct Feedthrough	Yes
Sample Time	Specified in the <b>Sample time</b> parameter
Scalar Expansion	Yes

Dimensionalized	Yes
Zero Crossing	No

**See Also**

Interpolation Using Prelookup

# Probe

---

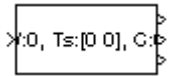
## Purpose

Output 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.

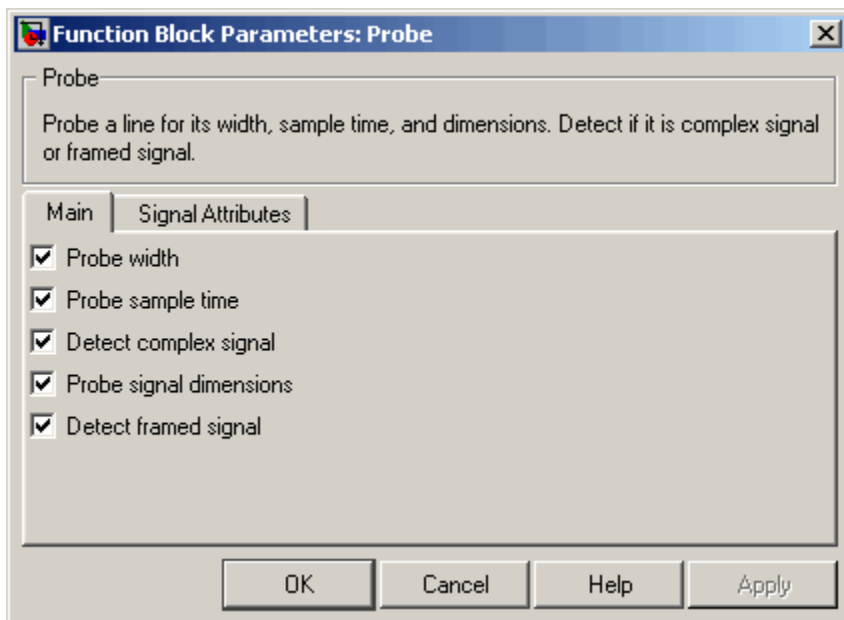
## Data Type Support

The Probe block accepts and outputs any data type supported by Simulink software, including fixed-point and enumerated data types.

For a discussion on the data types supported by Simulink software, 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 “How to Specify the Sample Time” for more information.

### Detect 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.

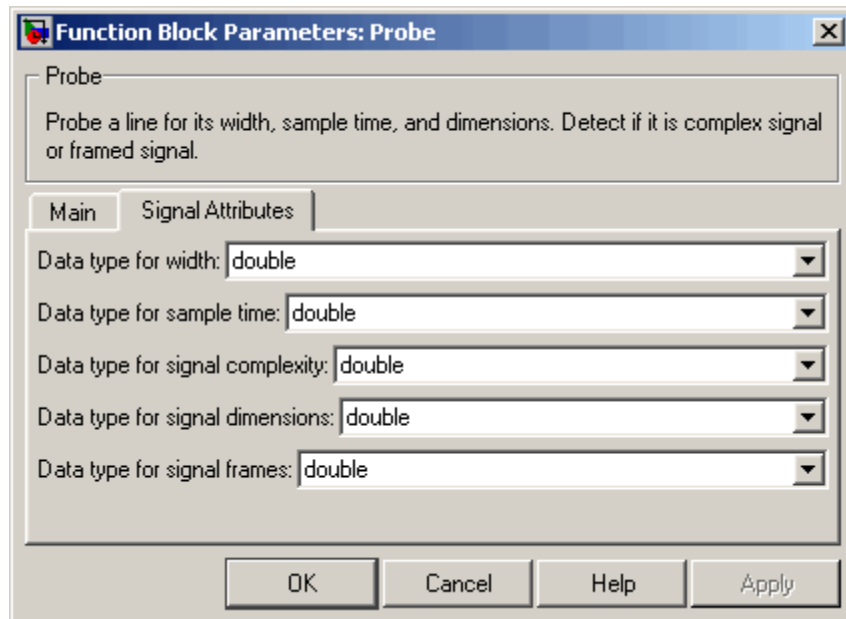
# Probe

---

## Detect framed signal

Select to output 1 if the probed signal is framed; otherwise, 0.

The **Signal Attributes** pane of the Probe block dialog appears as follows:



---

**Note** The Probe block ignores the **Data type override** setting of the Fixed-Point Tool.

---

## 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**

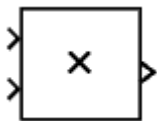
Direct Feedthrough	Yes
Sample Time	Inherited from driving block
Scalar Expansion	Yes
Dimensionalized	Yes
Multidimensionalized	Yes
Zero Crossing	No

# Product

**Purpose** Multiply and divide scalars and nonscalars or multiply and invert matrices

**Library** Math Operations

## Description **Default Product Block Use**



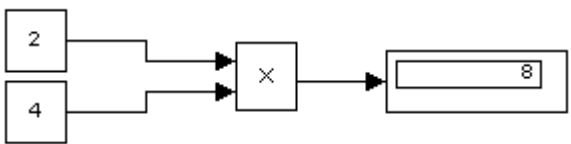
When used with default parameter values, the Product block outputs the result of multiplying its two inputs, which can be two scalars, a scalar and a nonscalar, or two nonscalars that have the same dimensions. The default parameter values that specify this behavior are:

- **Multiplication:** `Element-wise(.*)`
- **Number of Inputs:** 2

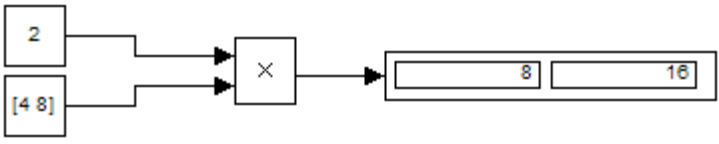
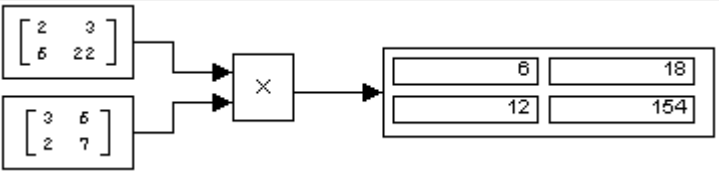
Setting non-default values for either of these parameters can change a Product block to be functionally equivalent to a Divide block or a Product of Elements block. See the documentation of those two blocks for more information.

If all you need is to multiply two inputs to create an output, you can use the Product block with default parameter values. If you need additional capabilities, see “Product Block Capabilities” on page 2-765.

The following table shows the output of the Product block for some typical inputs using default block parameter values.

Inputs and Behavior	Example
<p><b>Scalar X Scalar</b></p> <p>Output the product of the two inputs.</p>	



Inputs and Behavior	Example
<p><b>Scalar X Nonscalar</b></p> <p>Output a nonscalar having the same dimensions as the input nonscalar. Each element of the output nonscalar is the product of the input scalar and the corresponding element of the input nonscalar.</p>	 <p>The diagram shows a block with a multiplication symbol (×) receiving two inputs: a scalar '2' and a nonscalar '[4 8]'. The output is a nonscalar with two elements, '8' and '16', which are the products of the scalar and the input elements respectively.</p>
<p><b>Nonscalar X Nonscalar</b></p> <p>Output a nonscalar having the same dimensions as the inputs. Each element of the output is the product of corresponding elements of the inputs.</p>	 <p>The diagram shows a block with a multiplication symbol (×) receiving two 2x2 matrix inputs: <math>\begin{bmatrix} 2 &amp; 3 \\ 5 &amp; 22 \end{bmatrix}</math> and <math>\begin{bmatrix} 3 &amp; 5 \\ 2 &amp; 7 \end{bmatrix}</math>. The output is a 2x2 matrix with elements '6', '18', '12', and '154', which are the products of corresponding elements from the two input matrices.</p>

### Product Block Capabilities

The Product block, the Divide block, and the Product of Elements block are actually the same underlying block with different default values for the **Number of Inputs** parameter. All three blocks can therefore provide the same capabilities. The Product block (or the Divide block or Product of Elements block if appropriately configured) can:

- Numerically multiply and divide any number of scalar, vector, or matrix inputs
- Perform matrix multiplication and division on any number of matrix inputs

The Product block performs scalar or matrix multiplication, depending on the value of the block's **Multiplication** parameter. The block accepts one or more inputs, depending on the block's **Number of**

**inputs** parameter. The **Number of inputs** parameter also specifies the operation to be performed on each input.

The Product block can input any combination of scalars, vectors, and matrices for which the operation to be performed has a mathematically defined result. The block performs the specified operations on the inputs, then outputs the result.

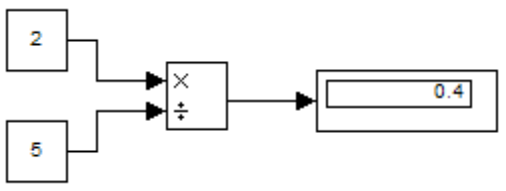
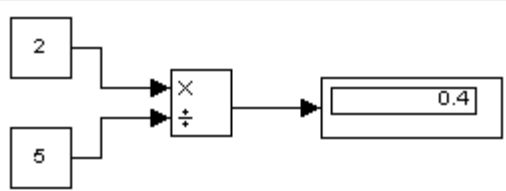
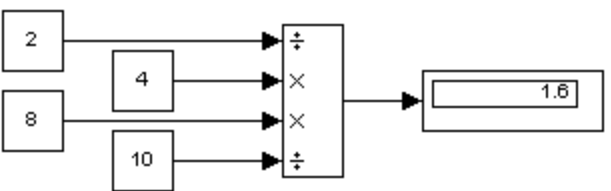
The Product block has two modes: *Element-wise mode*, which processes nonscalar inputs element by element, and *Matrix mode*, which processes nonscalar inputs as matrices. The next two sections describe these two modes.

## Element-wise Mode

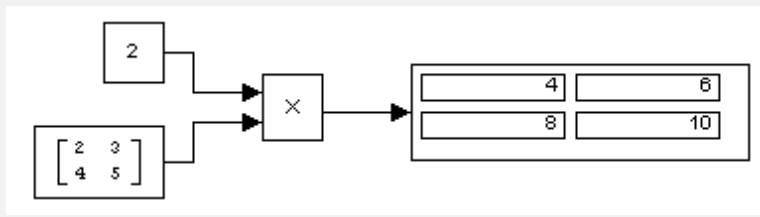
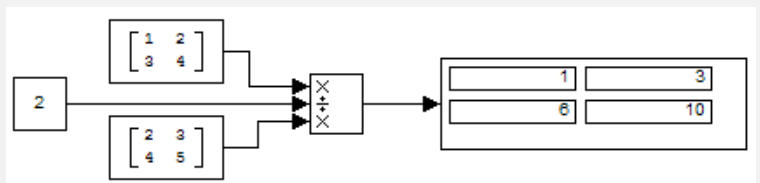
When the value of the **Multiplication** parameter is `element-wise(.*)`, the Product block is in *Element-wise mode*, in which it operates on the individual numeric elements of any nonscalar inputs. The MATLAB equivalent is the `.*` operator. In element-wise mode, the Product block can perform a variety of multiplication, division, and arithmetic inversion operations.

The value of the **Number of inputs** parameter controls both how many inputs exist and whether each is multiplied or divided to form the output. When the Product block in Element-wise mode has only one input, it is functionally equivalent to a Product of Elements block. When the block has multiple inputs, any nonscalar inputs must have identical dimensions, and the block outputs a nonscalar with those dimensions. To calculate the output, the block first expands any scalar input to a nonscalar that has the same dimensions as the nonscalar inputs.

This table shows the output of the Product block for some typical inputs, using the indicated values for the **Number of inputs** parameter.

Parameter Values	Examples
<p>Number of inputs: 2</p>	 <p>The diagram shows two input boxes with the numbers 2 and 5. Arrows from both boxes point to a central box containing a multiplication symbol (X) above a division symbol (÷). An arrow from this central box points to a rectangular output box containing the number 0.4.</p>
<p>Number of inputs: */</p>	 <p>The diagram shows two input boxes with the numbers 2 and 5. Arrows from both boxes point to a central box containing a multiplication symbol (X) above a division symbol (÷). An arrow from this central box points to a rectangular output box containing the number 0.4.</p>
<p>Number of inputs: /**/</p>	 <p>The diagram shows four input boxes with the numbers 2, 4, 8, and 10. Arrows from these boxes point to a vertical stack of four operators: a division symbol (÷) at the top, followed by two multiplication symbols (X), and a division symbol (÷) at the bottom. An arrow from the bottom of this stack points to a rectangular output box containing the number 1.8.</p>

# Product

Parameter Values	Examples
Number of inputs: **	
Number of inputs: */*	

## Matrix Mode

When the value of the **Multiplication** parameter is `matrix(*)`, the Product block is in *Matrix mode*, in which it processes nonscalar inputs as matrices. The MATLAB equivalent is the `*` operator. In Matrix mode, the Product block can invert a single square matrix, or multiply and divide any number of matrices that have dimensions for which the result is mathematically defined.

The value of the **Number of inputs** parameter controls both how many inputs exist and whether each input matrix is multiplied or divided to form the output. The syntax of **Number of inputs** is the same as in Element-wise mode. The difference between the modes is in the type of multiplication and division that occur.

## Data Type Support

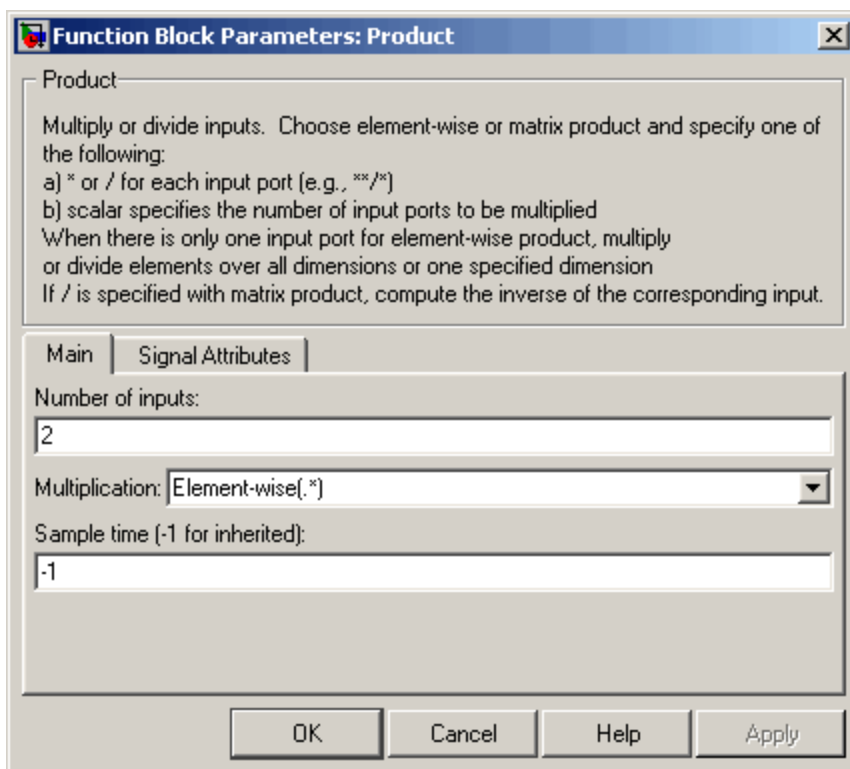
The Product block accepts real or complex signals of any numeric data type supported by Simulink software including fixed-point data types. For a discussion of the data types supported by Simulink software, see “Data Types Supported by Simulink”.

The Product block does not support numeric division for complex signals with `boolean` or `fixed-point` data types. For other types, the block accepts complex signals as divisors only when the input and output signals all specify the same built-in data type. In this case, however, the block ignores its specified rounding mode.

The Product block accepts multidimensional signals when operating in `Element-wise` mode, but not when operating in `Matrix` mode. See “Signal Dimensions”, “Element-wise Mode” on page 2-766, and “Matrix Mode” on page 2-768 for more information.

## Parameters and Dialog Box

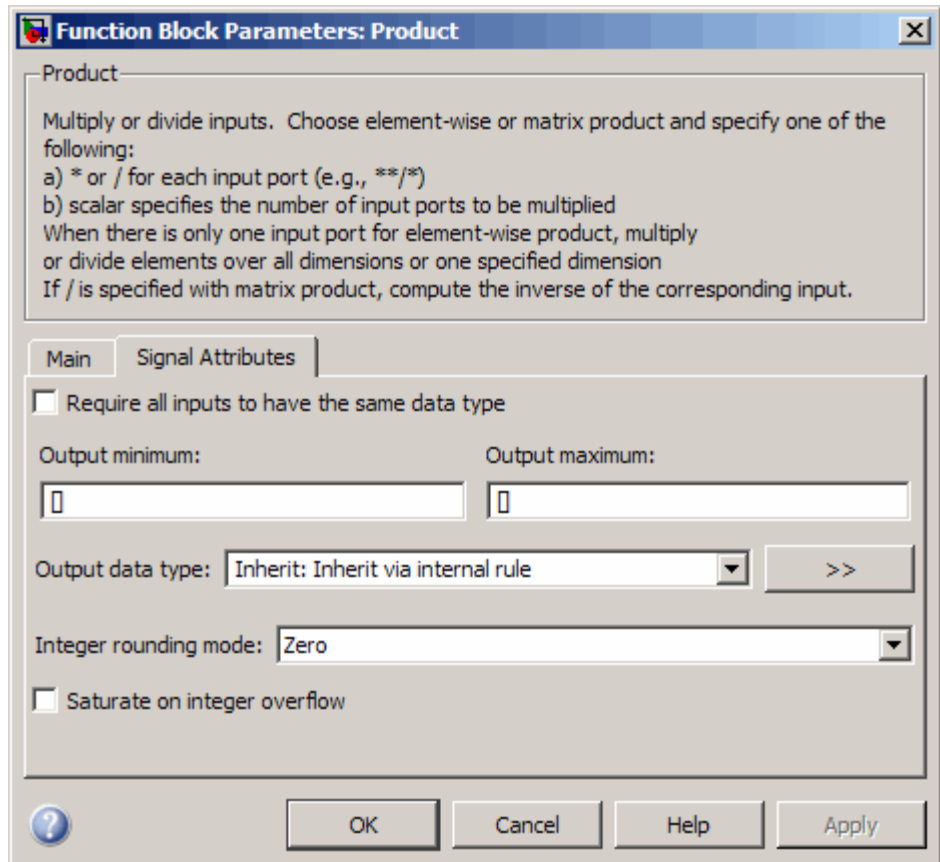
The **Main** pane of the Product block dialog box appears as follows:



# Product

## Signal Attributes Pane

The **Signal Attributes** pane of the Product block dialog box appears as follows:



## **Show data type assistant**

Display the **Data Type Assistant**.

### **Settings**

The **Data Type Assistant** helps you set the **Output data type** parameter.

See “Specifying Block Output Data Types” in *Simulink User’s Guide* for more information.

### **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

## Number of inputs

Control two properties of the Product block:

- The number of input ports on the block
- Whether each input is multiplied or divided into the output

## Settings

**Default:**2

- **1 or \* or /**

Has one input. In Element-wise mode, the input is processed as described for the Product of Elements block. In Matrix mode, if the parameter value is 1 or \* the block outputs the input value. If the value is / the input must be a square matrix (including a scalar as a degenerate case) and the block outputs the matrix inverse. See “Element-wise Mode” on page 2-766 and “Matrix Mode” on page 2-768 for more information.

- **An integer value > 1**

Has number of inputs given by the integer value. The inputs are multiplied together in Element-wise mode or Matrix mode, as specified by the **Multiplication** parameter. See “Element-wise Mode” on page 2-766 and “Matrix Mode” on page 2-768 for more information.

- **An unquoted string of two or more \* and / characters**

Has the number of inputs given by the length of the string. Each input that corresponds to a \* character is multiplied into the output. Each input that corresponds to a / character is divided into the output. The operations occur in Element-wise mode or Matrix mode, as specified by the **Multiplication** parameter. See “Element-wise Mode” on page 2-766 and “Matrix Mode” on page 2-768 for more information.



## **Dependencies**

Setting **Number of Inputs** to \* and selecting **Element-wise (.\*)** for **Multiplication** enable the following parameter:

- **Multiply over**

## **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

## Multiplication

Specify whether the Product block operates in Element-wise mode or Matrix mode.

### Settings

**Default:** Element-wise(.\*)

Element-wise(.\*)

Operate in Element-wise mode.

Matrix(\*)

Operate in Matrix mode.

### Dependencies

Selecting Element-wise(.\*) and setting **Number of Inputs** to \* enable the following parameter:

- **Multiply over**

### Command-Line Information

See “Block-Specific Parameters” on page 8-96 for the command-line information.

## **Multiply over**

Affect multiplication on matrix input.

### **Settings**

**Default:** All dimensions

All dimensions

Output a scalar that is product of all elements of the matrix, or the product of their inverses, depending on the value of **Number of inputs**.

Specified dimension

Output a vector, the composition of which depends on the value of the **Dimension** parameter.

### **Dependencies**

This parameter is enabled by selecting `Element-wise(.*)` for **Multiplication** and setting **Number of Inputs** to `*` or `1` or `/`. Setting the parameter to `Specified Dimension` enables the **Dimension** parameter.

### **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

# Product

---

## Dimension

Affect multiplication on matrix input.

## Settings

**Default:** 1

**Minimum:** 1

**Maximum:** 2

1

Output a vector that contains an element for each column of the input matrix.

2

Output a vector that contains an element for each row of the input matrix.

## Tips

Each element of the output vector contains the product of all elements in the corresponding column or row of the input matrix, or the product of the inverses of those elements, depending on the value of **Number of inputs**:

- 1 or \*

Multiply the values of the column or row elements

- /

Multiply the inverses of the column or row elements

## Dependencies

This parameter is enabled by selecting **Specified Dimension** for **Multiply over**.

## Command-Line Information

See “Block-Specific Parameters” on page 8-96 for the command-line information.

## **Sample time (-1 for inherited)**

Enter the discrete interval between sample time hits or specify another appropriate sample time such as continuous or inherited.

### **Settings**

**Default:** -1

By default, the block inherits its sample time based upon the context of the block within the model. To set a different sample time, enter a valid sample time based upon the table in “Types of Sample Time”.

See also “How to Specify the Sample Time” in the online documentation for more information.

### **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

## **Require all inputs to have the same data type**

Require that all inputs have the same data type.

### **Settings**

**Default:** Off

On

Require that all inputs have the same data type.

Off

Do not require that all inputs have the same data type.

### **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

## **Lock output scaling against changes by the autoscaling tool**

Select to lock scaling of outputs.

### **Settings**

**Default:** Off

On

Lock scaling of outputs.

Off

Do not lock scaling of outputs.

### **Dependencies**

This parameter is enabled when you enter an expression for the **Output data type** or **Data type** parameter.

### **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

## Integer rounding mode

Select the rounding mode for fixed-point operations.

### Settings

**Default:** Zero

#### Ceiling

Round both positive and negative numbers toward positive infinity.

#### Convergent

Round number to the nearest representable value. In the case of a tie, round to the nearest even stored value.

#### Floor

Round both positive and negative numbers toward negative infinity.

#### Nearest

Round number to the nearest representable value. In the case of a tie, round toward positive infinity.

#### Round

Round number to the nearest representable value. In the case of a tie, round positive numbers toward positive infinity and round negative numbers toward negative infinity.

#### Simplest

This option provides for an optimization of the rounding code for several blocks.

#### Zero

Round number toward zero.

### Command-Line Information

See “Block-Specific Parameters” on page 8-96 for the command-line information.

### See Also

For more information, see “Rounding” in the *Simulink Fixed Point User’s Guide*.



## Saturate on integer overflow

Specify whether overflows saturate.

### Settings

**Default:** Off

On  
Overflows saturate.

Off  
Overflows do not saturate.

### Tips

- When you select this check box, saturation applies to every internal operation on the block, not just the output or result.
- In general, the code generation process can detect when overflow is not possible, in which case, no saturation code is generated.

### Command-Line Information

See “Block-Specific Parameters” on page 8-96 for the command-line information.

## **Output minimum**

Specify the minimum value that the block should output.

### **Settings**

**Default:** []

The default value, [], is equivalent to `-Inf`.

Simulink software uses this value to perform:

- Parameter range checking (see “Checking Parameter Values”) for some blocks
- Simulation range checking (see “Checking Signal Ranges”)
- Automatic scaling of fixed-point data types

### **Tip**

This number must be a double scalar value.

### **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

## **Output maximum**

Specify the maximum value that the block should output.

### **Settings**

**Default:** []

The default value, [], is equivalent to Inf.

Simulink software uses this value to perform:

- Parameter range checking (see “Checking Parameter Values”) for some blocks
- Simulation range checking (see “Checking Signal Ranges”)
- Automatic scaling of fixed-point data types

### **Tip**

This number must be a double scalar value.

### **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

## Output data type

Specify the output data type.

### Settings

**Default:** Inherit: Inherit via internal rule (Discrete-Time Integrator, Gain, Product, Sum, Switch block), Inherit: Inherit from 'Constant value' (Constant block default), Inherit: Inherit via back propagation (Data Type Conversion block), Inherit: Same as input (Saturation block)

Inherit: Inherit via internal rule

This option appears for some blocks. Simulink software chooses a combination of output scaling and data type that requires the smallest amount of memory consistent with accommodating the calculated 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 software chooses the output data type without regard to hardware constraints. Otherwise, Simulink software 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 `sfixed24`. 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 software displays an error message in the Simulation Diagnostics Viewer.

Inherit: Inherit from 'Constant value'

Use data type of **Constant value** parameter. This option appears for some blocks.

Inherit: Inherit via back propagation

A rule that inherits a data type

Inherit: Same as input

Use data type of sole input signal. This option appears for some blocks.

Inherit: Same as first input

Use data type of first input signal. This option appears for some blocks.

Inherit: Same as accumulator

Output data type same as accumulator data type. This option appears for some blocks.

double

Output data type is double.

single

Output data type is single.

int8

Output data type is int8.

uint8

Output data type is uint8.

int16

Output data type is int16.

uint16

Output data type is uint16.

int32

Output data type is int32.

uint32

Output data type is uint32.

fixdt(1,16,0)

Output data type is fixed point fixdt(1,16,0).

fixdt(1,16,2<sup>0</sup>,0)

Output data type is fixed point fixdt(1,16,2<sup>0</sup>,0).

<data type expression>

The name of a data type object, for example  
Simulink.NumericType

### **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

### **See Also**

See “Specifying Block Output Data Types” in the *Simulink User’s Guide* for more information.

## Mode

Select the category of data to specify

### Settings

**Default:** Inherit (Constant, Data Type Conversion, Discrete Time Integrator, Gain, Inport, Outport, Product, Saturation, Sum, Switch),  
**Built in** (Logical Operator, Relational Operator)

#### Inherit

Inheritance rules for data types. Selecting **Inherit** enables a second menu/text box to the right. Below are the possible values, which can vary by block:

- Inherit from 'Constant value' (Constant block default)
- Inherit via internal rule (Discrete-Time Integrator, Gain, Product, Sum, Switch block default)
- Inherit via back propagation (Data Type Conversion block default)
- auto (Inport, Outport block default)
- Logical (see Configuration Parameters: Optimization)
- Same as first input
- Same as input (Saturation block default)
- Same as accumulator

#### Built in

Built-in data types. Selecting **Built in** enables a second menu/text box to the right. Below are the possible values, which can vary by block:

- double (Constant, Data Type Conversion, Discrete-Time Integrator, Gain, Inport, Outport, Product, Saturation, Sum, Switch block default)
- single

- int8
- uint8
- int16
- uint16
- int32
- uint32
- boolean (Logical Operator, Relational Operator block default)

## Fixed point

Fixed-point data types.

## Enumerated

Enumerated data types. This option is available on some blocks. Selecting Enumerated enables a second menu/text box to the right. Below are the possible values, which can vary by block:

- <class name>

## Expression

Expressions that evaluate to data types. Selecting Expression enables a second menu/text box to the right. Below are the possible values, which can vary by block:

- <data type expression>

## Dependency

This parameter is enabled by the **Show data type assistant** button.

## Command-Line Information

See “Block-Specific Parameters” on page 8-96 for the command-line information.

## See Also

See “Using the Data Type Assistant” in the *Simulink User’s Guide*.



## **Signedness**

Specify whether you want the fixed-point data to be signed or unsigned.

### **Settings**

**Default:** Signed

#### Signed

Specify the fixed-point data to be signed.

#### Unsigned

Specify the fixed-point data to be unsigned.

### **Dependencies**

This parameter is enabled by selecting **Mode** > Fixed point.

### **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

### **See Also**

See “Specifying a Fixed-Point Data Type” in the *Simulink User’s Guide* for more information.

## **Word length**

Specify the bit size of the word that will hold the quantized integer.

### **Settings**

**Default:** 16

**Minimum:** 0

**Maximum:** 32

Large word sizes represent large values with greater precision than small word sizes.

### **Dependencies**

This parameter is enabled by selecting **Mode** > Fixed point.

### **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

### **See Also**

See “Specifying a Fixed-Point Data Type” in the *Simulink User’s Guide* for more information.

## Scaling

Specify the method for scaling your fixed-point data to avoid overflow conditions and minimize quantization errors.

### Settings

**Default:** Best precision (Constant), Binary point (Data Type Conversion, Discrete-Time Integrator, Gain, Inport, Outport, Product, Saturation, Sum, Switch), Integer (Logical Operator, Relational Operator)

#### Binary point

Specify binary point location.

#### Slope and bias

Enter slope and bias.

#### Best precision

Specify best-precision values. This option appears for some blocks.

#### Integer

Specify integer. This setting has the same result as specifying a binary point location and setting fraction length to 0. This option appears for some blocks.

## Dependencies

This parameter is enabled by selecting **Mode** > Fixed point.

Selecting Binary point enables:

- **Fraction length**
- **Calculate Best-Precision Scaling**

Selecting Slope and bias enables:

- **Slope**
- **Bias**
- **Calculate Best-Precision Scaling**

**Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

**See Also**

See “Specifying a Fixed-Point Data Type” in the *Simulink User’s Guide* for more information.

## **Fraction length**

Specify fraction length for fixed-point data type.

### **Settings**

**Default:** 0

Binary points can be positive or negative integers.

### **Dependencies**

This parameter is enabled by selecting **Scaling** > Binary point.

### **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

### **See Also**

See “Specifying a Fixed-Point Data Type” in the *Simulink User’s Guide* for more information.

## **Slope**

Specify slope for the fixed-point data type.

### **Settings**

**Default:** 2<sup>0</sup>

Specify any positive real number.

### **Dependencies**

This parameter is enabled by selecting **Scaling** > Slope and bias.

### **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

### **See Also**

See “Specifying a Fixed-Point Data Type” in the *Simulink User’s Guide* for more information.

## Bias

Specify bias for the fixed-point data type.

## Settings

**Default:** 0

Specify any real number.

## Dependencies

This parameter is enabled by selecting **Scaling** > Slope and bias.

## Command-Line Information

See “Block-Specific Parameters” on page 8-96 for the command-line information.

## See Also

See “Specifying a Fixed-Point Data Type” in the *Simulink User’s Guide* for more information.

## Characteristics

Direct Feedthrough	Yes
Sample Time	Specified in the <b>Sample time</b> parameter
Scalar Expansion	Yes
Dimensionalized	Yes
Multidimensionalized	Yes, only when the <b>Multiplication</b> parameter specifies <code>Element-wise(.*)</code>
Zero Crossing	No

## See Also

- Divide
- Dot Product
- Product of Elements

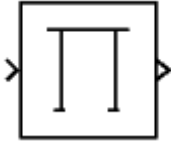
# Product of Elements

---

**Purpose** Copy or invert one scalar input, or collapse one nonscalar input

**Library** Math Operations

**Description** The Product of Elements block inputs one scalar, vector, or matrix. You can use the block to:



- Copy a scalar input unchanged
- Invert a scalar input (divide 1 by it)
- Collapse a vector or matrix to a scalar by multiplying together all elements or their inverses
- Collapse a matrix to a vector by multiplying together the elements or element inverses of each row or column

The Product of Elements block is functionally a Product block that has two block parameter values preset:

- **Multiplication:** `Element-wise(.*)`
- **Number of Inputs:** `*`

Setting non-default values for either of those parameters can change a Product of Element block to be functionally equivalent to a Product block or a Divide block. See the documentation of those two blocks for more information.



## Parameters and Dialog Box

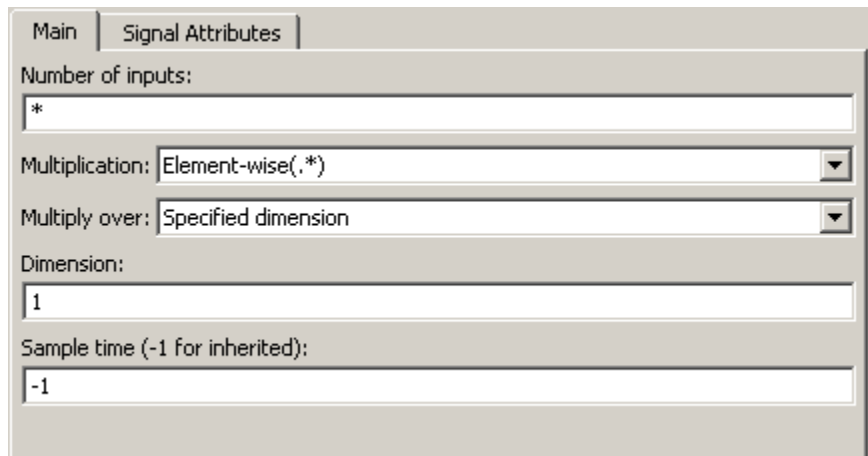
The Product of Elements block has the same parameters and dialog box as the Product block, plus the additional parameter **Multiply Over**, which has the default value All Dimensions:



The dialog box has two tabs: 'Main' and 'Signal Attributes'. The 'Main' tab is selected. It contains the following fields:

- Number of inputs: \*
- Multiplication: Element-wise(.\*)
- Multiply over: All dimensions
- Sample time (-1 for inherited): -1

If you set **Multiply Over** to Specified Dimension, the **Dimension** parameter appears below it.



The dialog box has two tabs: 'Main' and 'Signal Attributes'. The 'Main' tab is selected. It contains the following fields:

- Number of inputs: \*
- Multiplication: Element-wise(.\*)
- Multiply over: Specified dimension
- Dimension: 1
- Sample time (-1 for inherited): -1

To just copy, invert, or collapse one input to create an output, you can use the Product of Elements block with default values for all parameters

# Product of Elements

---

except **Number of elements**, **Multiply over**, and **Dimension**, whose values you might need to change. For additional capabilities, see the Product block documentation, which also describes the capabilities of the Product of Elements block's "Signal Attributes Pane" on page 2-770.

## Number of elements

This parameter is the same as in the Product block, but it must be set to \* (the default) or 1 or / to achieve the effect of a Product of Elements block.

If **Number of elements** is \* or 1 the block:

- Copies a scalar input unchanged
- Collapses a vector input to a scalar by multiplying all of its elements together
- Collapses a matrix input to a scalar or vector by multiplying its elements together as specified by the **Multiply over** parameter.

If **Number of elements** is / the block icon changes to



and the block:

- Outputs the arithmetic inverse of a scalar input
- Collapses a vector input to a scalar by multiplying the inverses of all of its elements together
- Collapses a matrix input to a scalar or vector by multiplying the inverses of its elements together as specified by the **Multiply over** parameter.

## Multiply over

This parameter appears only when **Multiplication** is **Element-wise (.\*)** and **Number of Inputs** is \* or 1 or /. The parameter affects only a matrix input, and has no effect on a scalar or vector input. The possible values are:

**All dimensions** — The block outputs a scalar that is product of all elements of the matrix, or the product of their inverses, depending on the value of **Number of elements**.

**Specified dimension** — The block outputs a vector, the composition of which depends on the value of the **Dimension** parameter.

## Dimension

This parameter appears only when the **Multiply over** parameter appears and is set to **Specified Dimension**. The parameter affects only a matrix input, and must be set to 1 for a scalar or vector input. The possible values are:

1 — Output a vector that contains an element for each column of the input matrix.

2 — Output a vector that contains an element for each row of the input matrix.

Each element of the output vector contains the product of all elements in the corresponding column or row of the input matrix, or the product of the inverses of those elements, depending on the value of **Number of elements**:

- **1 or \***

Multiply the values of the column or row elements

- **/**

Multiply the inverses of the column or row elements

## Examples

This table shows the output of the Product of Elements block for some typical inputs using default block parameter values, except as shown in the table.

# Product of Elements

Parameter Values	Examples
<b>Multiplication:</b> Element-wise(.*) <b>Number of elements:</b> *	
<b>Multiplication:</b> Element-wise(/) <b>Number of elements:</b> /	
<b>Multiplication:</b> Element-wise(.*) <b>Number of elements:</b> *	
<b>Multiplication:</b> Element-wise(.*) <b>Number of elements:</b> * <b>Multiply Over:</b> All Dimensions	
<b>Multiplication:</b> Element-wise(.*) <b>Number of elements:</b> * <b>Multiply Over:</b> Specified Dimension <b>Dimension:</b> 1	
<b>Multiplication:</b> Element-wise(.*) <b>Number of elements:</b> / <b>Multiply Over:</b> Specified Dimension <b>Dimension:</b> 2	

## Purpose

Generate square wave pulses at regular intervals

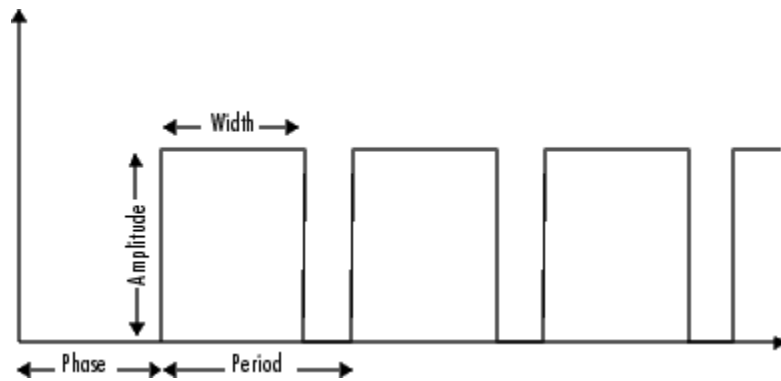
## Library

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.

Use the **Pulse type** parameter 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 specify. If you select

# Pulse Generator

---

time-based, Simulink software computes the block's outputs only at times when the output actually changes. This choice can result in fewer computations for computing 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 has a variable sample time. Simulink software uses brown as the sample time color of such blocks (see "Displaying Sample Time Colors" for more information).

Simulink software cannot use a fixed-step 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 software computes a fixed sample time for the time-based pulse generators. Then the time-based pulse generators simulate as sample-based.

---

**Tip** 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 **Solver** pane of 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 want the pulse to repeat every two seconds. In this case, you would specify 4 as the value of the block's **Period** parameter.

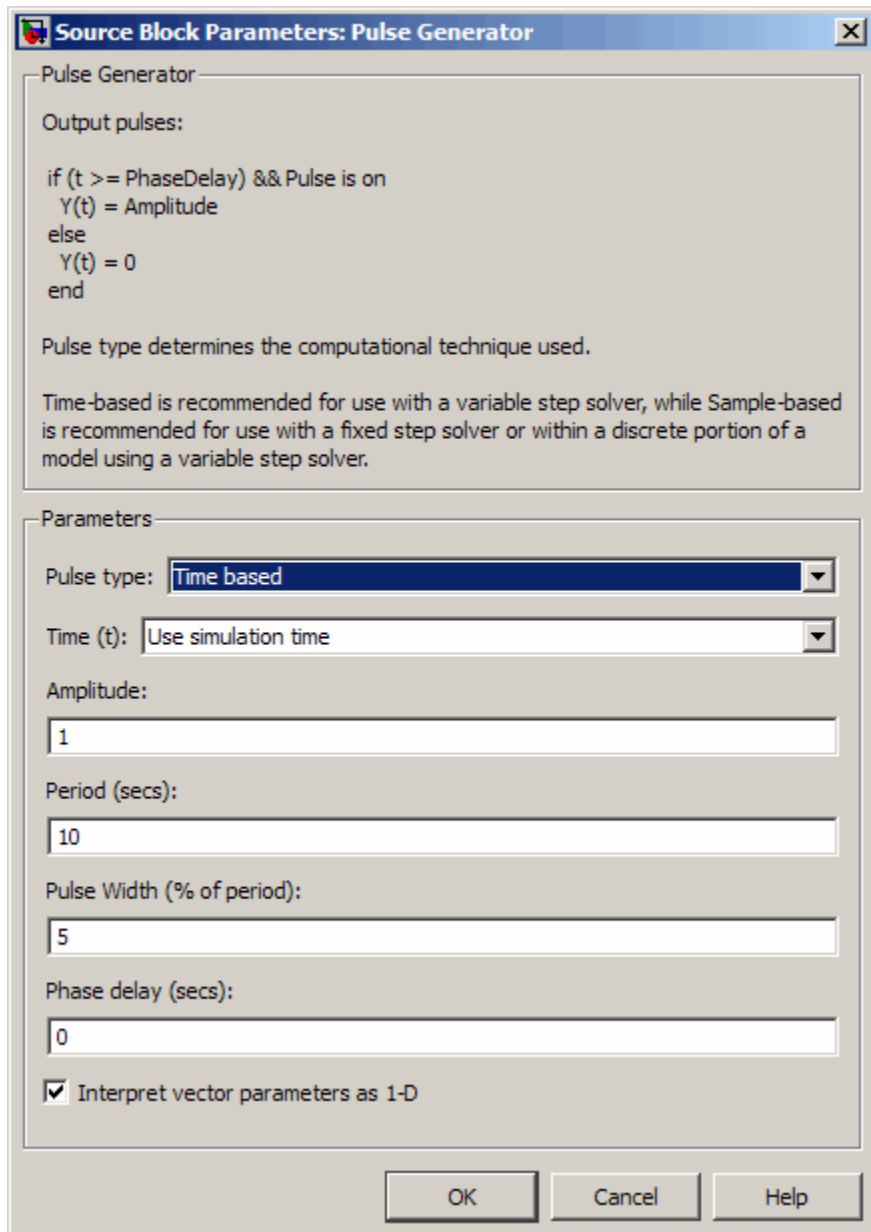
## Data Type Support

The Pulse Generator block outputs real signals of any numeric data type supported by Simulink software, including fixed-point data types. The data type of the output signal is the same as that of the **Amplitude** parameter.

For a discussion on the data types supported by Simulink software, see “Data Types Supported by Simulink” in the Simulink documentation.

# Pulse Generator

## Parameters and Dialog Box



The dialog box is titled "Source Block Parameters: Pulse Generator". It contains the following sections:

**Pulse Generator**

Output pulses:

```
if (t >= PhaseDelay) && Pulse is on
  Y(t) = Amplitude
else
  Y(t) = 0
end
```

Pulse type determines the computational technique used.

Time-based is recommended for use with a variable step solver, while Sample-based is recommended for use with a fixed step solver or within a discrete portion of a model using a variable step solver.

**Parameters**

Pulse type: **Time based** (dropdown menu)

Time (t): **Use simulation time** (dropdown menu)

Amplitude: **1** (text input)

Period (secs): **10** (text input)

Pulse Width (% of period): **5** (text input)

Phase delay (secs): **0** (text input)

Interpret vector parameters as 1-D

Buttons: **OK**, **Cancel**, **Help**



Opening this dialog box causes a running simulation to pause. See “Changing Source Block Parameters During Simulation” in the online Simulink documentation for details.

## Pulse type

The pulse type for this block: time-based or sample-based. The default is time-based.

## Time

Specifies whether to use simulation time or an external signal as the source of values for the output pulse’s time variable. If you specify an external source, the block displays an input port for connecting the source. The output pulse differs as follows:

- If you select **Use simulation time**, the block generates an output pulse where the time variable equals the simulation time.
- If you select **Use external signal**, the block generates an output pulse where the time variable equals the value from the input port, which can differ from the simulation time.

---

**Note** If you select **Use external signal** and click **OK**, an **Apply** button appears the next time that you open the block dialog box. This **Apply** button disappears if you select **Use simulation time** and click **OK**.

---

## 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 10 seconds.

# Pulse Generator

---

## 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 5 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 "How to Specify the Sample Time" in the Simulink User's Guide for more information.

## Interpret vector parameters as 1-D

If you select this check box 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 Simulink User's Guide.

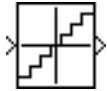
## Characteristics

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

**Purpose** Discretize input at specified interval

**Library** Discontinuities

**Description**



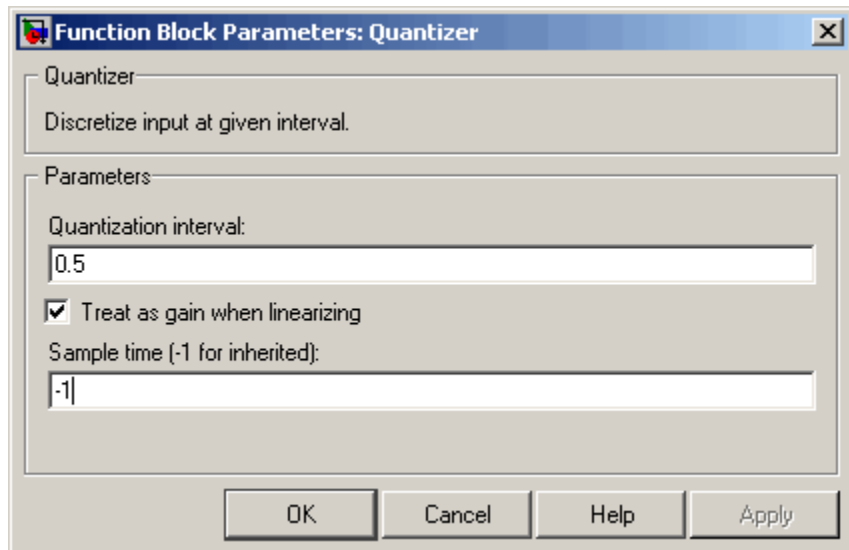
The Quantizer block passes its input signal through a stair-step function so that many neighboring points on the input axis are mapped to one point on the output axis. The effect is to quantize a smooth signal into a stair-step output. The output is computed using the round-to-nearest method, which produces an output that is symmetric about zero.

$$y = q * \text{round}(u/q)$$

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**



# Quantizer

---

## Quantization interval

The interval around which the output is quantized. Permissible output values for the Quantizer block are  $n \cdot q$ , where  $n$  is an integer and  $q$  the **Quantization interval**. The default is 0.5.

## Treat as gain when linearizing

Simulink software 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 Output block. See “How to Specify the 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

**Purpose** Generate constantly increasing or decreasing signal

**Library** Sources

### Description

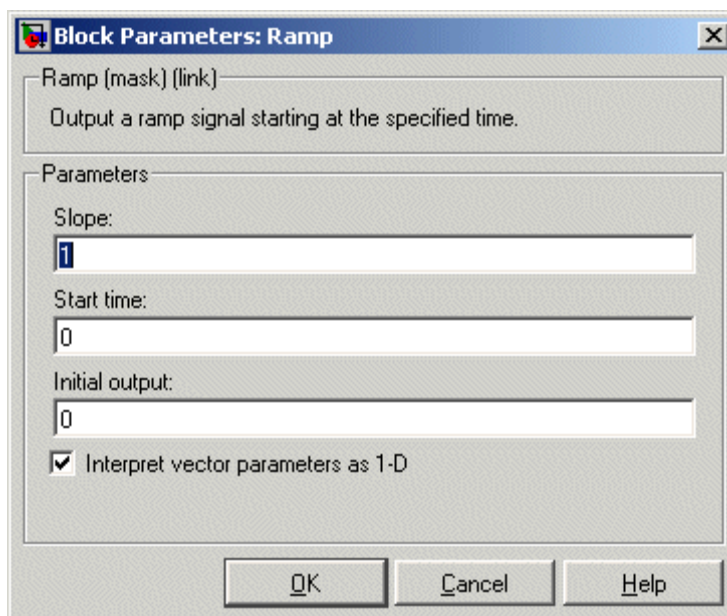


The Ramp block generates a signal that starts at a specified time and value and changes by a specified rate. The block's **Slope**, **Start time**, and **Initial output** parameters determine the characteristics of the output signal. All must have the same dimensions after scalar expansion.

### 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 During Simulation” in the online Simulink documentation for details.

# Ramp

---

## 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

## 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 **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.

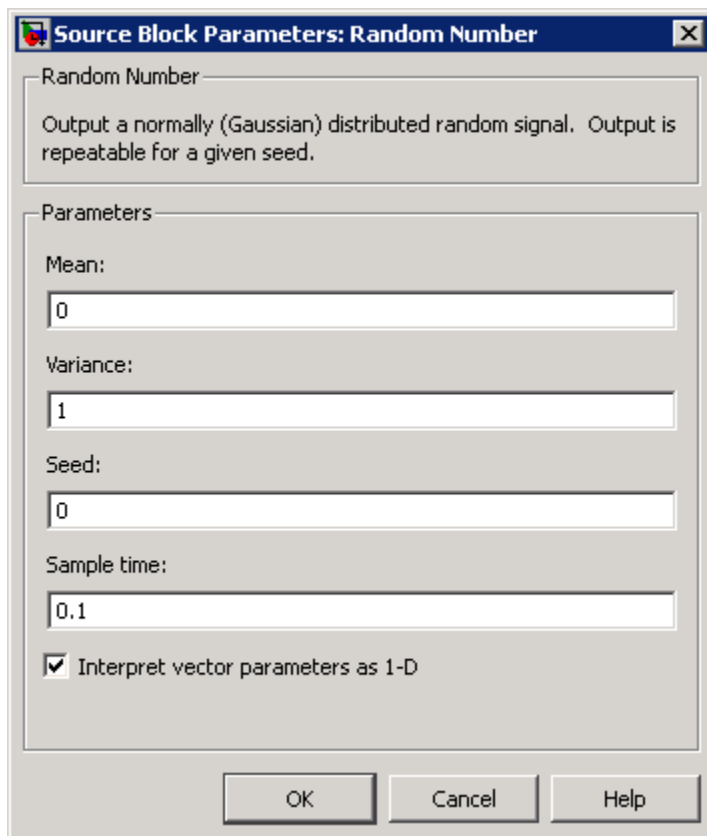
## Data Type Support

The Random Number block accepts and outputs signals of type double.

# Random Number

---

## Parameters and Dialog Box



Opening this dialog box causes a running simulation to pause. See “Changing Source Block Parameters During Simulation” 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.



## 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 0.1, which matches the default sample time of the Band-Limited White Noise block. See “How to Specify the 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 the Output Dimensions of Source Blocks” in the “Working with Signals” chapter of the Using Simulink documentation.

## Characteristics

Sample Time	Specified in the <b>Sample time</b> parameter
Scalar Expansion	Yes, of parameters
Dimensionalized	Yes
Multidimensionalized	Yes
Zero Crossing	No

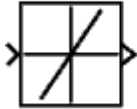
# Rate Limiter

---

**Purpose** Limit rate of change of 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:

$$y(i) = u(i)$$

When the block is running in continuous mode (for example, **Sample time mode** is inherited and **Sample time** of the driving block is zero), the **Initial condition** is ignored. The block output at  $t = 0$  is equal to the initial input:

$$y(0) = u(0)$$

When the block is running in discrete mode (for example, **Sample time mode** is inherited and **Sample time** of the driving block is nonzero), the **Initial condition** is preserved:

$$y(-1) = I_c$$

where  $I_c$  is the initial condition. The block output at  $t = 0$  is calculated as if  $rate$  is outside the bounds of  $R$  and  $F$ . For  $t = 0$ ,  $rate$  is calculated as follows:

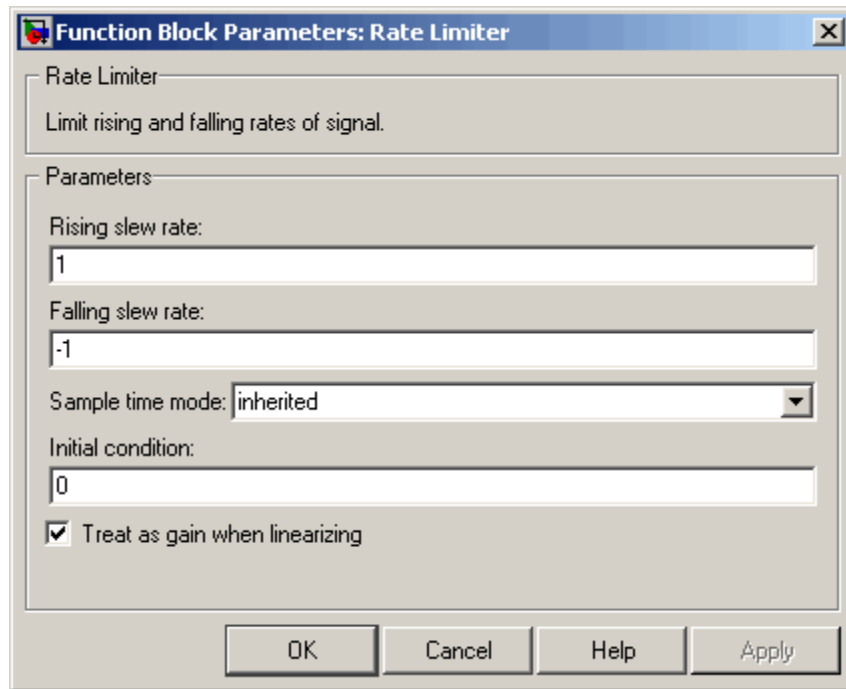
$$rate = \frac{u(0) - y(-1)}{sample\ time}$$

## Data Type Support

The Rate Limiter block accepts and outputs signals of any numeric data type supported by Simulink software, 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 software does not allow you to set the initial condition of this block to  $\infty$  or NaN.

## Treat as gain when linearizing

Linearization commands in Simulink software 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 <b>Sample time mode</b> parameter)
Scalar Expansion	Yes, of input and parameters
Dimensionalized	Yes
Zero Crossing	No

## See Also

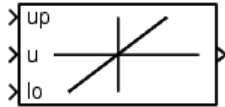
Rate Limiter Dynamic

# Rate Limiter Dynamic

**Purpose** Limit rising and falling rates of 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.

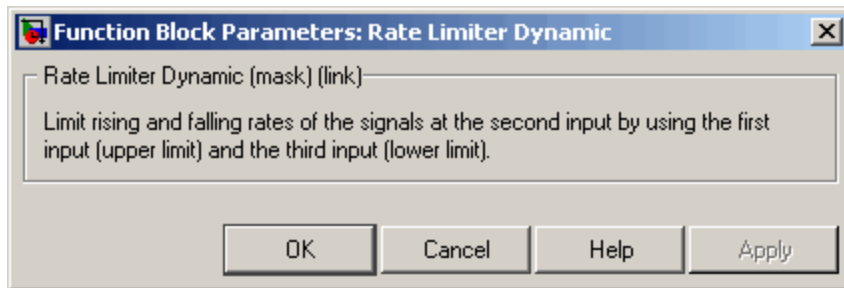
---

**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 numeric data type supported by Simulink software, including fixed-point data types.

## Parameters and Dialog Box



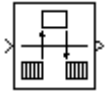
<b>Characteristics</b>	Direct Feedthrough	Yes
	Scalar Expansion	Yes

**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 a block operating at a different rate. Use the block parameters to trade data integrity and deterministic transfer for faster response or lower memory requirements. To learn about data integrity and deterministic data transfer, see “Data Transfer Problems” in the Real-Time Workshop User’s Guide.

**Options**

Transition Handling Options	Block Parameter Settings
<ul style="list-style-type: none"> <li>• Data integrity</li> <li>• Deterministic data transfer</li> <li>• Maximum latency</li> </ul>	Select: <ul style="list-style-type: none"> <li>• <b>Ensure data integrity during data transfer</b></li> <li>• <b>Ensure deterministic data transfer</b></li> </ul>
<ul style="list-style-type: none"> <li>• Data integrity</li> <li>• Nondeterministic data transfer</li> <li>• Minimum latency</li> <li>• Higher memory requirements</li> </ul>	Select: <ul style="list-style-type: none"> <li>• <b>Ensure data integrity during data transfer</b></li> </ul> Clear: <ul style="list-style-type: none"> <li>• <b>Ensure deterministic data transfer</b></li> </ul>
<ul style="list-style-type: none"> <li>• Potential loss of data integrity</li> <li>• Nondeterministic data transfer</li> <li>• Minimum latency</li> <li>• Lower memory requirements</li> </ul>	Clear: <ul style="list-style-type: none"> <li>• <b>Ensure data integrity during data transfer</b></li> <li>• <b>Ensure deterministic data transfer</b></li> </ul>

# Rate Transition

---

**Dependencies** The behavior of the Rate Transition block depends on:

- Sample times of the ports to which the block connects (see “Effects of Synchronous Sample Times” on page 2-821 and “Effects of Asynchronous Sample Times” on page 2-823)
- Priorities of the tasks for the source and destination sample times (see “Sample time properties” in the Simulink documentation)
- Whether the model specifies a fixed- or variable-step solver (see “Solvers” in the Simulink documentation)

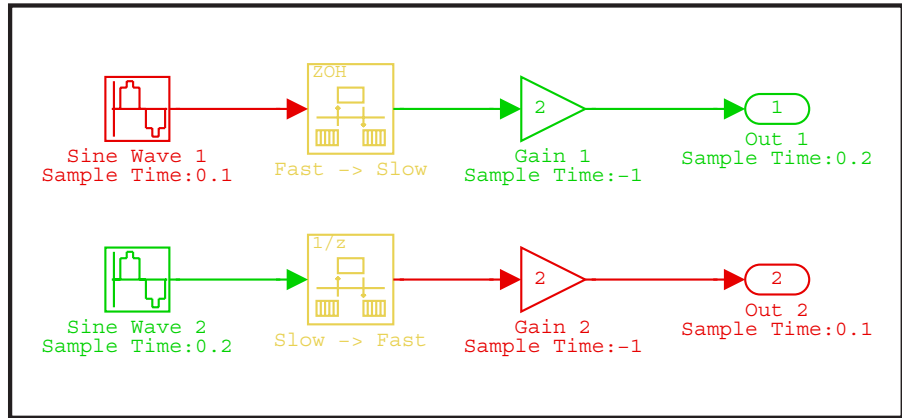
## Block Labels

When you update your diagram, a label appears on the Rate Transition block to indicate simulation behavior.

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 block behavior label shows the method that ensures safe transfer of data between tasks operating at different rates. You can use the sample-time colors feature (see “Displaying Sample Time Colors” in the Simulink User’s Guide) to display the relative rates that the block bridges. Consider, for example, the following diagram.



Sample-time colors and the block behavior label show 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 Real-Time Workshop User’s Guide for more information.

## Effects of Synchronous Sample Times

The following table summarizes how each label appears if the sample times of the input and output ports (inTs and outTs) are periodic, or synchronous.

# Rate Transition

Block Settings		Block Label		
Rate Transition	Conditions for Rate Transition Block	With Data Integrity and Determinism	With Only Data Integrity	Without Data Integrity or Determinism
inTs = outTs (Equal)	inTsOffset < outTsOffset	None (error)	Buf	Copy or NoOp (see note that follows the table)
	inTsOffset = outTsOffset	Copy or NoOp (see note that follows the table)	Copy or NoOp (see note that follows the table)	
	inTsOffset > outTsOffset	None (error)	Db_buf	
inTs < outTs (Fast to slow)	inTs = outTs / N inTsOffset, outTsOffset = 0	Z0H	Buf	
	inTs = outTs / N inTsOffset ≤ outTsOffset	None (error)		
	inTs = outTs / N inTsOffset > outTsOffset	None (error)	Db_buf	
	inTs ≠ outTs / N	None (error)		
inTs > outTs (Slow to fast)	inTs = outTs * N inTsOffset, outTsOffset = 0	1/z	Db_buf	
	inTs = outTs * N inTsOffset ≤ outTsOffset	None (error)		
	inTs = outTs * N inTsOffset > outTsOffset	None (error)		
	inTs = outTs * N inTsOffset > outTsOffset	None (error)		
	inTs ≠ outTs * N	None (error)		

**KEY**

Block Settings		Block Label		
Rate Transition	Conditions for Rate Transition Block	With Data Integrity and Determinism	With Only Data Integrity	Without Data Integrity or Determinism

- inTs, outTs: Sample times of input and output ports, respectively
- inTsOffset, outTsOffset: Sample time offsets of input and output ports, respectively
- N: Integer value > 1

**Note** If you select **Block reduction** in the Optimization pane of the Configuration Parameters dialog box, Copy reduces to NoOp. No code generation occurs for a Rate Transition block with a NoOp label. To prevent a block from being reduced when block reduction is on, add a test point to the block output (see “Working with Test Points” in the Simulink documentation).

## Effects of Asynchronous Sample Times

The following table summarizes how each label appears if the sample time of the input or output port (inTs or outTs) is not periodic, or asynchronous.

Block Settings	Block Label		
	With Data Integrity and Determinism	With Only Data Integrity	Without Data Integrity or Determinism
inTs = outTs	Copy	Copy	Copy
inTs ≠ outTs	None (error)	Db_buf	

**KEY**

# Rate Transition

---

Block Settings	Block Label		
	With Data Integrity and Determinism	With Only Data Integrity	Without Data Integrity or Determinism

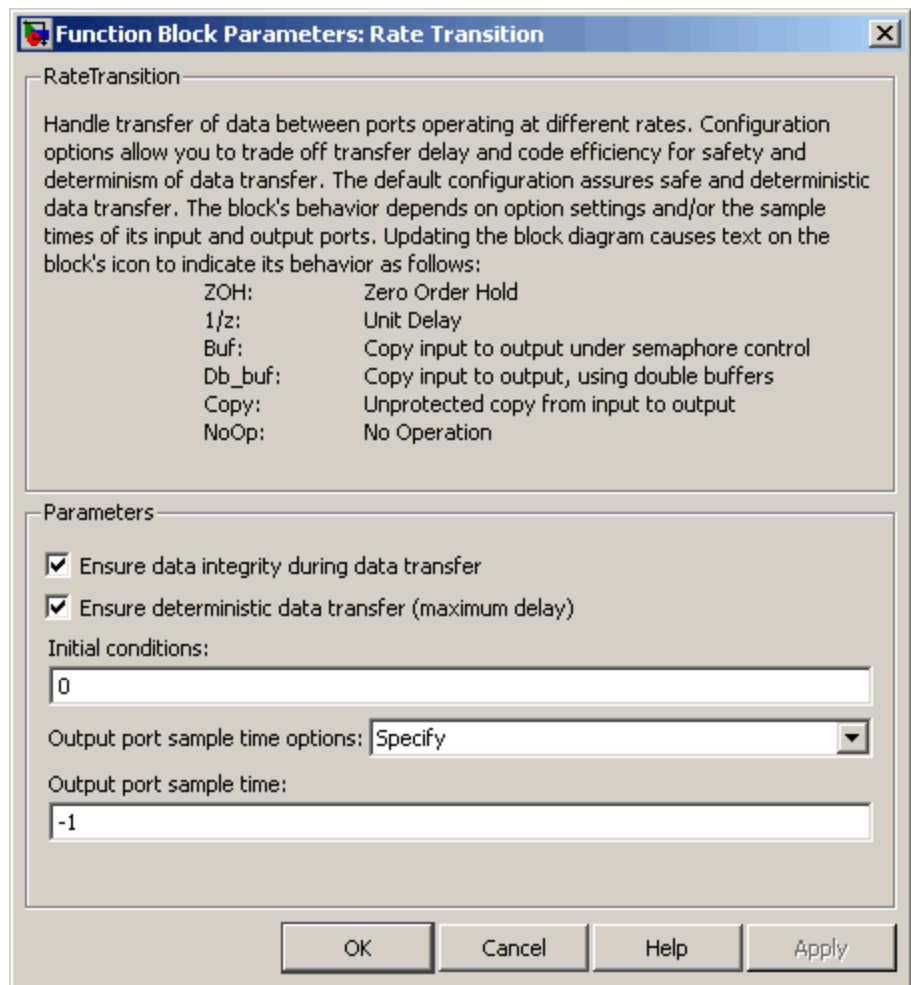
- inTs, outTs: Sample times of input and output ports, respectively

## Data Type Support

The Rate Transition block accepts signals of any data type supported by Simulink software, including fixed-point and enumerated data types.

For a discussion on the data types supported by Simulink software, see “Data Types Supported by Simulink” in the Simulink User’s Guide.

## Parameters and Dialog Box



### Ensure data integrity during data transfer

Selecting this check box results in generated code that ensures data integrity when the block transfers data. If you select this check box and the transfer is nondeterministic (see **Ensure deterministic data transfer** 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, which can lead to loss of data during nondeterministic data transfers. Select this check box if you want the generated code to operate with maximum responsiveness (i.e., nondeterministically) and data integrity. See “Rate Transition Block Options” in the Real-Time Workshop User’s Guide for more information.

### **Ensure deterministic data transfer (maximum delay)**

Selecting this check box results in generated code that transfers data at the sample rate of the slower block, i.e., deterministically. If you do not select this check box, data transfers occur as soon as new data is available from the source block and the receiving block is ready to receive the data. You avoid transfer delays, thus ensuring that the system operates with maximum responsiveness. However, transfers can occur unpredictably, which is undesirable in some applications. See “Rate Transition Block Options” in the Real-Time Workshop User’s Guide for more information.

### **Initial conditions**

This parameter applies only to slow-to-fast transitions. It specifies the initial output of the Rate Transition block at the beginning of a transition when there is no output from the slow block connected to the input of the Rate Transition block. Simulink software does not allow the initial output of this block to be `inf` or `NaN`.

### **Output port sample time options**

Specifies a mode for setting the output port sample time. The options are:

- **Specify** — Allows you to use the **Output port sample time** parameter to specify the output rate to which the Rate Transition block converts its input rate.
- **Inherit** — Specifies that the Rate Transition block inherits an output rate from the block to which its output port is connected.

- **Multiple of input port sample time** — Allows you to use the **Sample time multiple (>0)** parameter to specify the Rate Transition block's output rate as a multiple of its input rate.

## Output port sample time

This parameter is visible only if the **Output port sample time options** parameter is set to **Specify**. Enter a value that specifies the output rate to which the block converts its input rate. 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 “How to Specify the Sample Time” in the Simulink User's Guide for information on how to specify the output rate.

## Sample time multiple (>0)

This parameter is visible only if the **Output port sample time options** parameter specifies **Multiple of input port sample time**. Enter a positive value that specifies the output rate as a multiple of the input port sample time. The default value (1) specifies that the output rate is the same as the input rate. A value of 0.5 specifies that the output rate is half of the input rate, while a value of 2 specifies that the output rate is twice the input rate.

## Bus Support

The Rate Transition block is a bus-capable block. The input can be a virtual or nonvirtual bus signal, with the restriction that **Initial conditions** must be zero or a nonzero scalar. All signals in a nonvirtual bus input to a Rate Transition block must have the same sample time, even if the elements of the associated bus object specify inherited sample times. You can use a Rate Transition block to change the sample time of an individual signal, or of all signals in a bus. See “Using Buses” and “Bus-Capable Blocks” in the Simulink User's Guide for more information.

# Rate Transition

---

## Characteristics

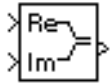
Bus-capable	Yes, with restrictions as noted above
Direct Feedthrough	No, for slow-to-fast transitions that are protected, i.e., for which you select the <b>Ensure data integrity during data transfer</b> check box. Yes, otherwise.
Sample Time	This block supports discrete-to-discrete transitions.
Scalar Expansion	Yes, of input.
Dimensionalized	Yes
Multidimensionalized	Yes
Zero Crossing	No



**Purpose** Convert real and/or imaginary inputs to 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 software, 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.

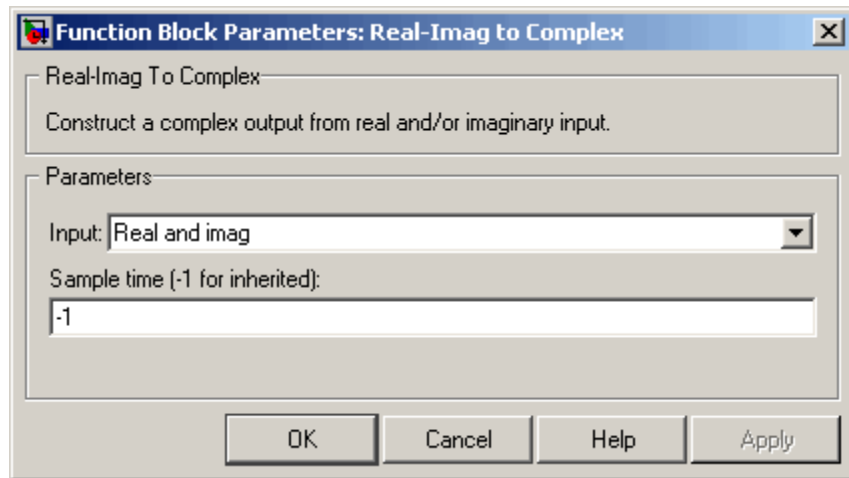
For a discussion on the data types supported by Simulink software, see “Data Types Supported by Simulink” in the Simulink documentation.

## Data Type Support

See the preceding description.

# Real-Imag to Complex

## 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 “How to Specify the Sample Time” in the online documentation for more information.

## Characteristics

Direct Feedthrough	Yes
Sample Time	Inherited from driving block

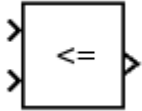
Scalar Expansion	Yes, of the input when the function requires two inputs
Dimensionalized	Yes
Multidimensionalized	Yes
Zero Crossing	No

# Relational Operator

**Purpose** Perform specified relational operation on 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. In each case, the first input corresponds to the top input port and the second input to the bottom input port. (See “How to Rotate a Block” in the Simulink documentation for a description of the port order for various block orientations.)

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** parameter. 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

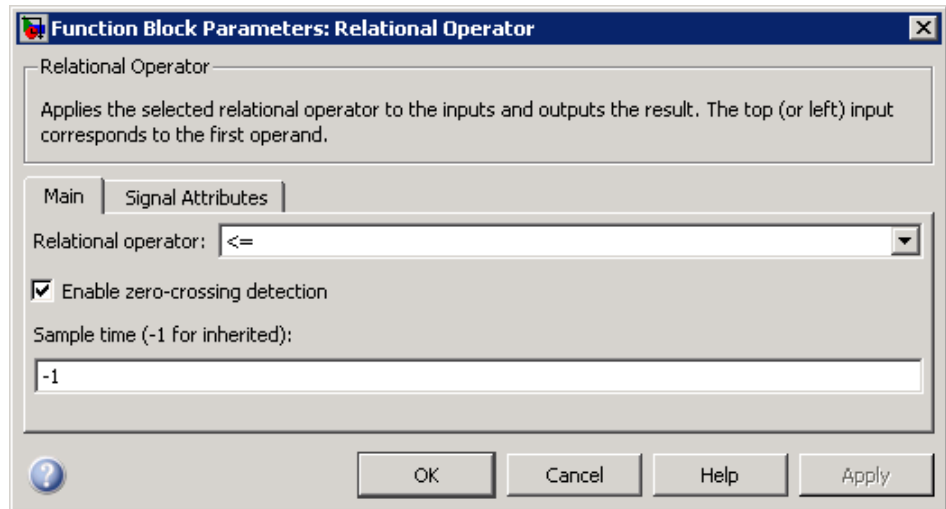
The Relational Operator block accepts real or complex signals of any data type supported by Simulink software, including fixed-point and enumerated data types. One input can be real and the other complex if the operator is == or !=.

For a discussion on the data types supported by Simulink software, see “Data Types Supported by Simulink” in the Simulink documentation.

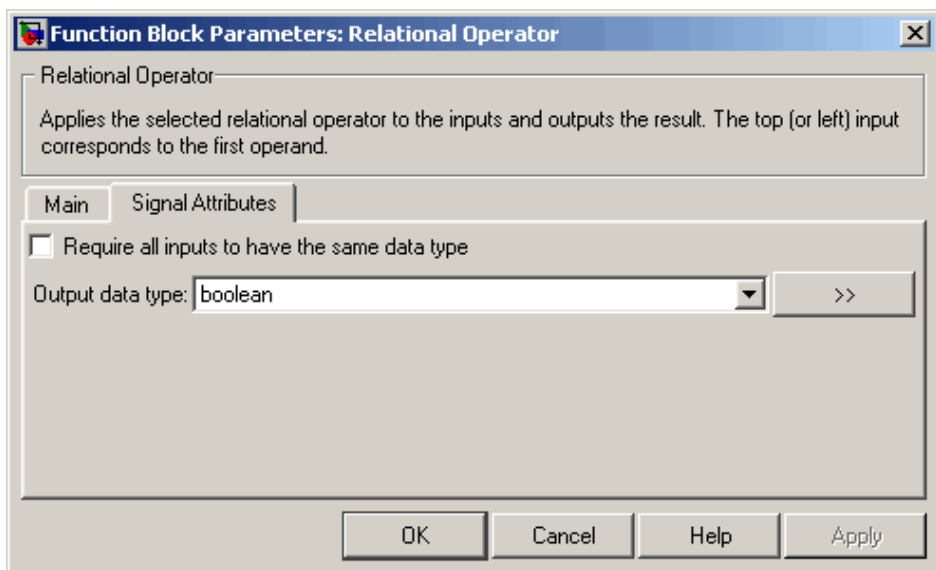
# Relational Operator

## Parameters and Dialog Box

The **Main** pane of the Relational Operator block dialog box appears as follows:



The **Signal Attributes** pane of the Relational Operator block dialog box appears as follows:



# Relational Operator

---

## **Show data type assistant**

Display the **Data Type Assistant**.

## **Settings**

The **Data Type Assistant** helps you set the **Output data type** parameter.

See “Specifying Block Output Data Types” in *Simulink User’s Guide* for more information.

## **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.



## Relational operator

Designate the relational operator used to compare the two inputs.

### Settings

**Default:** <=

<=

TRUE if the first input is less than or equal to the second input

==

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

### Command-Line Information

See “Block-Specific Parameters” on page 8-96 for the command-line information.

# Relational Operator

---

## Enable zero-crossing detection

Select to enable zero-crossing detection.

### Settings

**Default:** On



On

Enable zero-crossing detection.



Off

Do not enable zero-crossing detection.

### Command-Line Information

See “Block-Specific Parameters” on page 8-96 for the command-line information.

### See Also

For more information, see “How Blocks Work with Zero-Crossing Detection” in the “How Simulink Works” chapter of the Simulink documentation.

## **Sample time (-1 for inherited)**

Enter the discrete interval between sample time hits or specify another appropriate sample time such as continuous or inherited.

### **Settings**

**Default:** -1

By default, the block inherits its sample time based upon the context of the block within the model. To set a different sample time, enter a valid sample time based upon the table in “Types of Sample Time”.

See also “How to Specify the Sample Time” in the online documentation for more information.

### **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

# Relational Operator

---

## **Require all inputs to have the same data type**

Require that all inputs have the same data type.

### **Settings**

**Default:** Off



On

Require that all inputs have the same data type.



Off

Do not require that all inputs have the same data type.

### **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

## Output data type

Specify the output data type.

### Settings

**Default:** boolean

boolean

Specifies the output data type as boolean.

Inherit: 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.

---

## Command-Line Information

See “Block-Specific Parameters” on page 8-96 for the command-line information.

# Relational Operator

---

## Mode

Select the category of data to specify

## Settings

**Default:** Inherit (Constant, Data Type Conversion, Discrete Time Integrator, Gain, Inport, Outport, Product, Saturation, Sum, Switch),  
**Built in** (Logical Operator, Relational Operator)

### Inherit

Inheritance rules for data types. Selecting **Inherit** enables a second menu/text box to the right. Below are the possible values, which can vary by block:

- Inherit from 'Constant value' (Constant block default)
- Inherit via internal rule (Discrete-Time Integrator, Gain, Product, Sum, Switch block default)
- Inherit via back propagation (Data Type Conversion block default)
- auto (Inport, Outport block default)
- Logical (see Configuration Parameters: Optimization)
- Same as first input
- Same as input (Saturation block default)
- Same as accumulator

### Built in

Built-in data types. Selecting **Built in** enables a second menu/text box to the right. Below are the possible values, which can vary by block:

- double (Constant, Data Type Conversion, Discrete-Time Integrator, Gain, Inport, Outport, Product, Saturation, Sum, Switch block default)
- single

- int8
- uint8
- int16
- uint16
- int32
- uint32
- boolean (Logical Operator, Relational Operator block default)

## Fixed point

Fixed-point data types.

## Enumerated

Enumerated data types. This option is available on some blocks. Selecting Enumerated enables a second menu/text box to the right. Below are the possible values, which can vary by block:

- <class name>

## Expression

Expressions that evaluate to data types. Selecting Expression enables a second menu/text box to the right. Below are the possible values, which can vary by block:

- <data type expression>

## Dependency

This parameter is enabled by the **Show data type assistant** button.

## Command-Line Information

See “Block-Specific Parameters” on page 8-96 for the command-line information.

## See Also

See “Using the Data Type Assistant” in the *Simulink User’s Guide*.

# Relational Operator

---

## **Signedness**

Specify whether you want the fixed-point data to be signed or unsigned.

## **Settings**

**Default:** Signed

Signed

Specify the fixed-point data to be signed.

Unsigned

Specify the fixed-point data to be unsigned.

## **Dependencies**

This parameter is enabled by selecting **Mode** > Fixed point.

## **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

## **See Also**

See “Specifying a Fixed-Point Data Type” in the *Simulink User’s Guide* for more information.



## Word length

Specify the bit size of the word that will hold the quantized integer.

### Settings

**Default:** 16

**Minimum:** 0

**Maximum:** 32

Large word sizes represent large values with greater precision than small word sizes.

### Dependencies

This parameter is enabled by selecting **Mode** > Fixed point.

### Command-Line Information

See “Block-Specific Parameters” on page 8-96 for the command-line information.

### See Also

See “Specifying a Fixed-Point Data Type” in the *Simulink User’s Guide* for more information.

# Relational Operator

---

## Scaling

Specify the method for scaling your fixed-point data to avoid overflow conditions and minimize quantization errors.

## Settings

**Default:** Best precision (Constant), Binary point (Data Type Conversion, Discrete-Time Integrator, Gain, Inport, Outport, Product, Saturation, Sum, Switch), Integer (Logical Operator, Relational Operator)

Binary point

Specify binary point location.

Slope and bias

Enter slope and bias.

Best precision

Specify best-precision values. This option appears for some blocks.

Integer

Specify integer. This setting has the same result as specifying a binary point location and setting fraction length to 0. This option appears for some blocks.

## Dependencies

This parameter is enabled by selecting **Mode** > Fixed point.

Selecting Binary point enables:

- **Fraction length**
- **Calculate Best-Precision Scaling**

Selecting Slope and bias enables:

- **Slope**
- **Bias**
- **Calculate Best-Precision Scaling**

## Command-Line Information

See “Block-Specific Parameters” on page 8-96 for the command-line information.

## See Also

See “Specifying a Fixed-Point Data Type” in the *Simulink User’s Guide* for more information.

## Characteristics

Direct Feedthrough	Yes
Sample Time	Specified in the <b>Sample time</b> parameter
Scalar Expansion	Yes, of inputs
Dimensionalized	Yes
Multidimensionalized	Yes
Zero-Crossing Detection	Yes, if enabled.

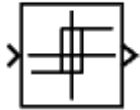
# Relay

---

**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.

---

**Note** When the initial input falls between the **Switch off point** and **Switch on point** values, the initial output is the value when the relay is off.

---

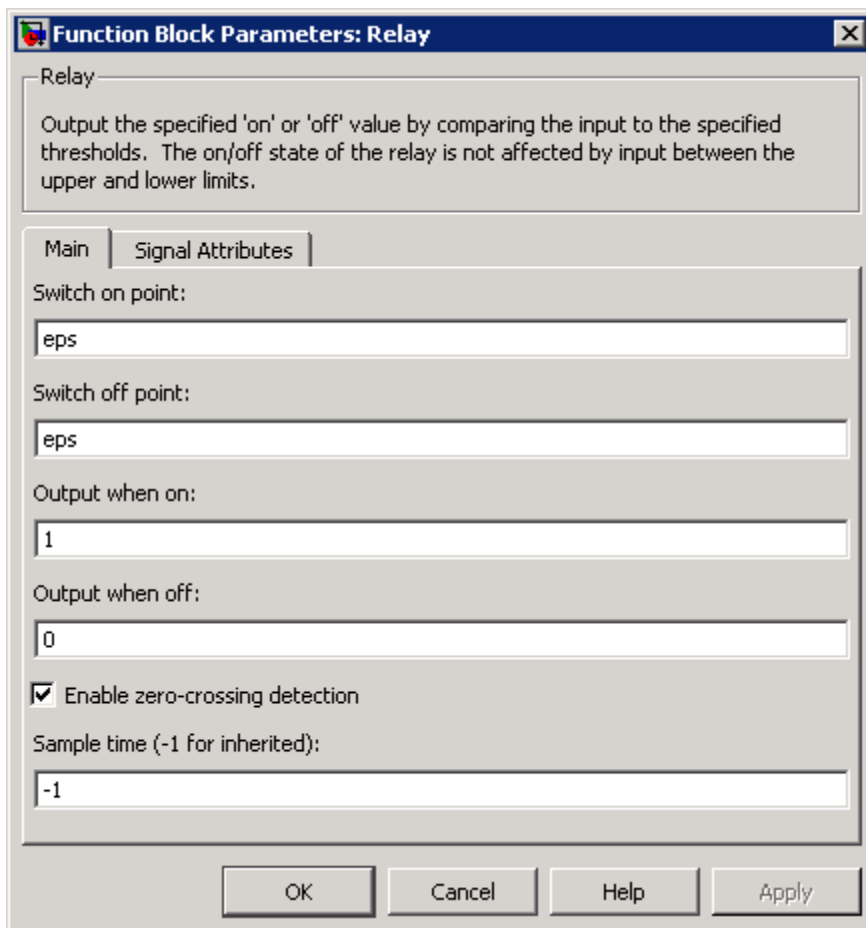
## Data Type Support

The Relay block accepts signals of any data type supported by Simulink software, including fixed-point and enumerated data types.

For a discussion on the data types supported by Simulink software, see “Data Types Supported by Simulink” in the Simulink documentation.

## Parameters and Dialog Box

The **Main** pane of the Relay block dialog box 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.

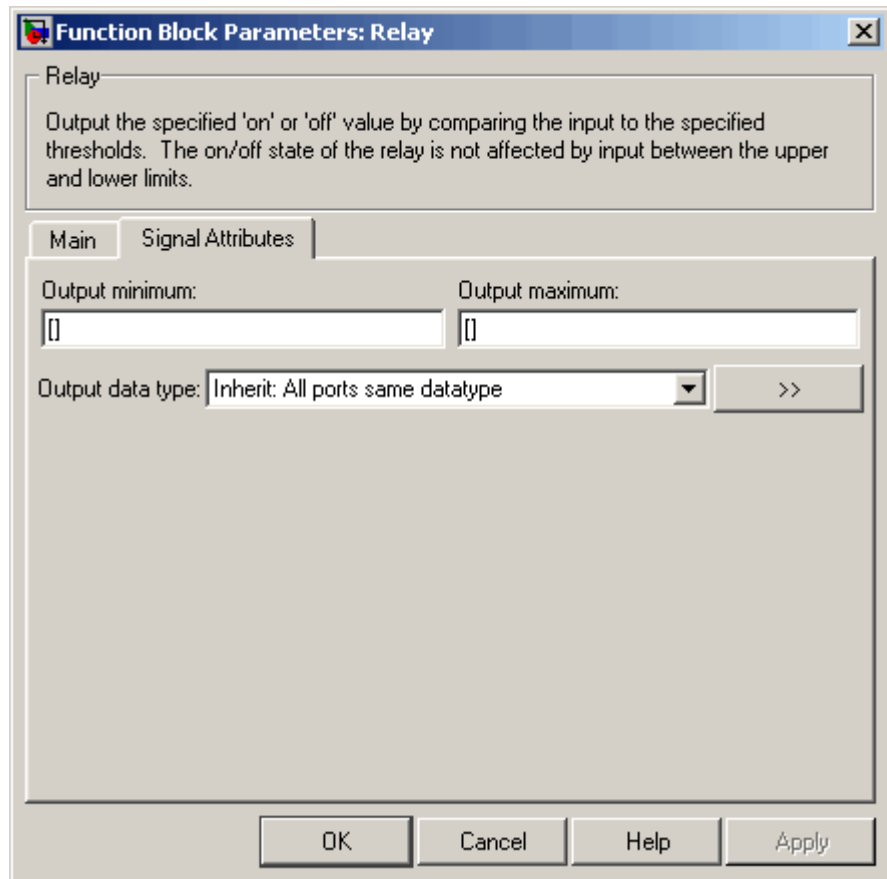
**Enable zero-crossing detection**

Select to enable zero-crossing detection to detect switch-on and switch-off points. For more information, see “How Blocks Work with Zero-Crossing Detection” in the “How Simulink Works” chapter of the Simulink documentation.

**Sample time (-1 for inherited)**

Specify the time interval between samples. To inherit the sample time, set this parameter to -1. See “How to Specify the Sample Time” in the Simulink documentation for more information.

The **Signal Attributes** pane of the Relay block dialog box appears as follows:



### Output minimum

Specify the minimum value that the block should output. The default value, [], is equivalent to  $-\text{Inf}$ . Simulink software uses this value to perform:

- Parameter range checking (see “Checking Parameter Values”)
- Simulation range checking (see “Checking Signal Ranges”)
- Automatic scaling of fixed-point data types

## Output maximum

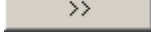
Specify the maximum value that the block should output. The default value, [], is equivalent to `Inf`. Simulink software uses this value to perform:

- Parameter range checking (see “Checking Parameter Values”)
- Simulation range checking (see “Checking Signal Ranges”)
- Automatic scaling of fixed-point data types

## Output data type

Specify the output data type. You can set it to:

- A rule that inherits a data type, for example, `Inherit: Inherit via back propagation`
- The name of a built-in data type, for example, `single`
- The name of a data type object, for example, a `Simulink.NumericType` object
- An expression that evaluates to a data type, for example, `fixdt(1,16,0)`

Click the **Show data type assistant** button  to display the **Data Type Assistant**, which helps you set the **Output data type** parameter.

See “Specifying Block Output Data Types” in *Simulink User’s Guide* for more information.

## Lock output scaling against changes by the autoscaling tool

Select to lock scaling of outputs. This parameter is visible only if you enter an expression for the **Output data type** parameter.

## Characteristics

Direct Feedthrough	Yes
Sample Time	Specified in the <b>Sample time</b> parameter



Scalar Expansion	Yes
Dimensionalized	Yes
Zero-Crossing Detection	Yes, if enabled

# Repeating Sequence

---

**Purpose** Generate arbitrarily shaped periodic signal

**Library** Sources

## Description

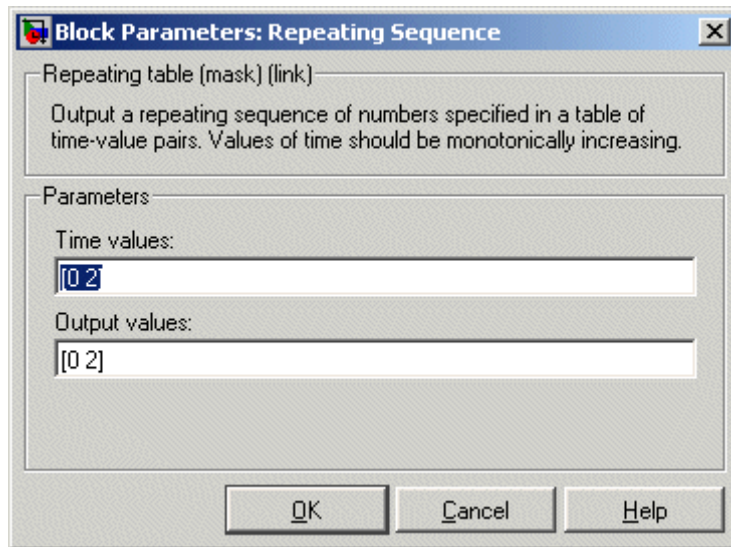


The Repeating Sequence block outputs a periodic scalar signal having a waveform that you specify. You can specify any waveform, using the block dialog's **Time values** and **Output values** parameters. The **Times value** parameter specifies a vector of sample times. The **Output values** parameter 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 During Simulation” 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

# Repeating Sequence

---

## **See Also**

Repeating Sequence Interpolated, Repeating Sequence Stair

# Repeating Sequence Interpolated

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**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 **Lookup Method** parameter to determine the output.

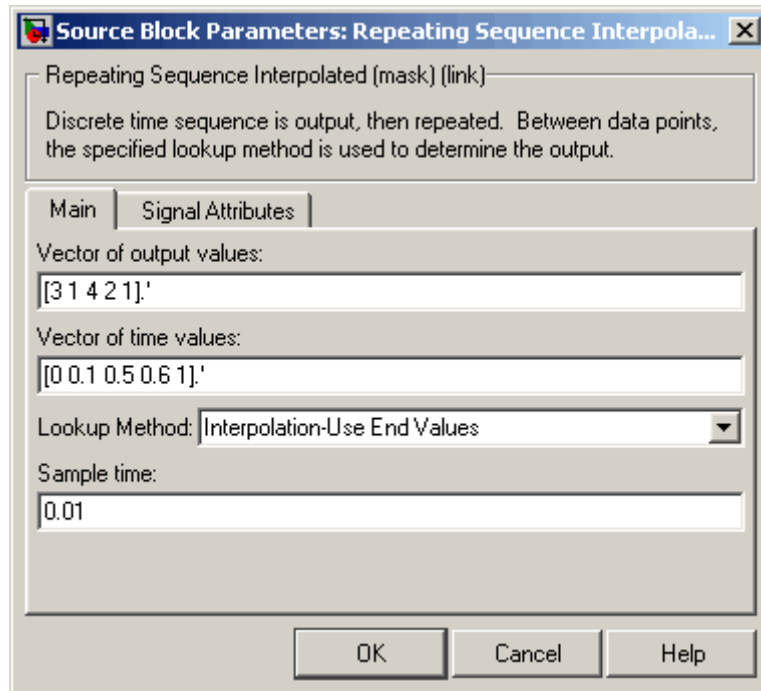
## Data Type Support

The Repeating Sequence Interpolated block accepts signals of any numeric data type supported by Simulink software, including fixed-point data types.

# Repeating Sequence Interpolated

## Parameters and Dialog Box

The **Main** pane of the Repeating Sequence Interpolated block dialog box 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 strictly increasing, and the vector must have the same size as the vector of output values.

### Lookup Method

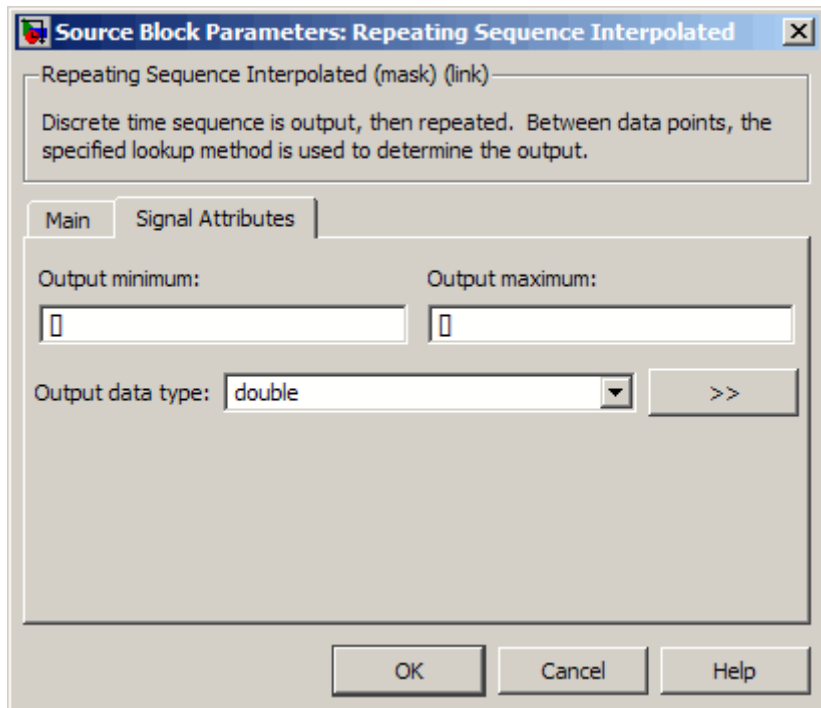
Specify the lookup method to determine the output between data points.

# Repeating Sequence Interpolated

## Sample time

Specify the time interval between samples. To inherit the sample time, set this parameter to -1. See “How to Specify the Sample Time” in the *Simulink User’s Guide* for more information.

The **Signal Attributes** pane of the Repeating Sequence Interpolated block dialog box appears as follows:



## Output minimum

Specify the minimum value that the block should output. The default value, [ ], is equivalent to  $-\text{Inf}$ . Simulink software uses this value to perform:

- Parameter range checking (see “Checking Parameter Values”)

# Repeating Sequence Interpolated

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- Simulation range checking (see “Checking Signal Ranges”)
- Automatic scaling of fixed-point data types

## Output maximum

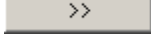
Specify the maximum value that the block should output. The default value, [], is equivalent to `Inf`. Simulink software uses this value to perform:

- Parameter range checking (see “Checking Parameter Values”)
- Simulation range checking (see “Checking Signal Ranges”)
- Automatic scaling of fixed-point data types

## Output data type

Specify the output data type. You can set it to:

- A rule that inherits a data type, for example, `Inherit: Inherit via back propagation`
- The name of a built-in data type, for example, `single`
- The name of a data type object, for example, a `Simulink.NumericType` object
- An expression that evaluates to a data type, for example, `fixdt(1,16,0)`

Click the **Show data type assistant** button  to display the **Data Type Assistant**, which helps you set the **Output data type** parameter.

See “Specifying Block Output Data Types” in *Simulink User’s Guide* for more information.

## Lock output scaling against changes by the autoscaling tool

Select to lock scaling of outputs. This parameter is visible only if you enter an expression for the **Output data type** parameter.



# Repeating Sequence Interpolated

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## Characteristics

Sample Time	Specified in the <b>Sample time</b> parameter
Scalar Expansion	Yes

## See Also

Repeating Sequence, Repeating Sequence Stair

# Repeating Sequence Stair

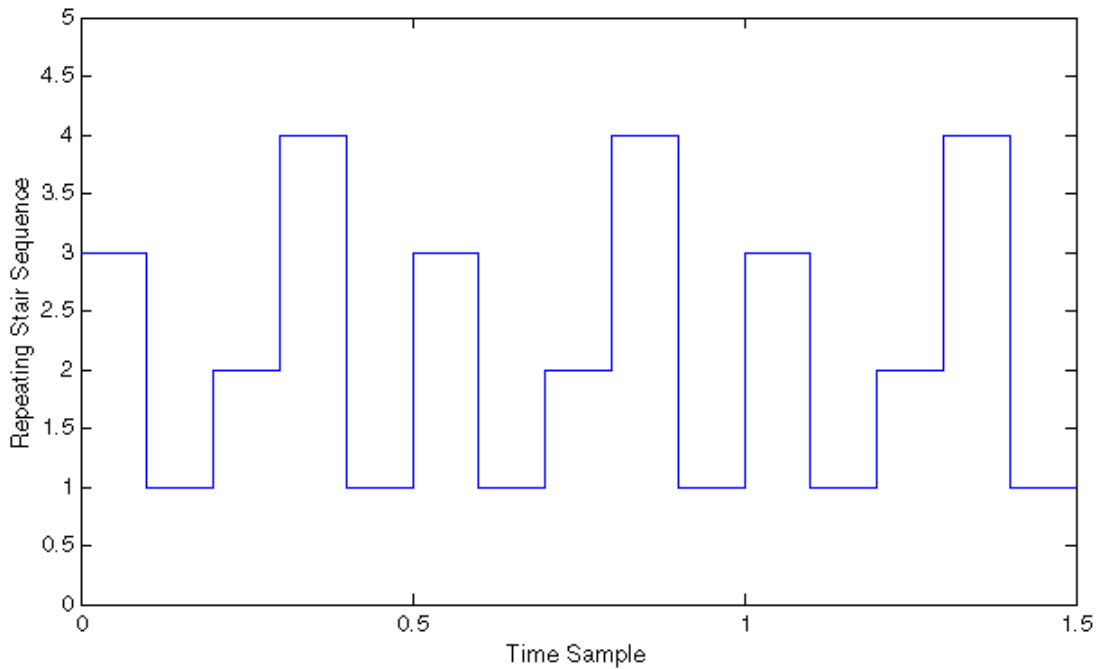
**Purpose** Output and repeat discrete time sequence

**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.

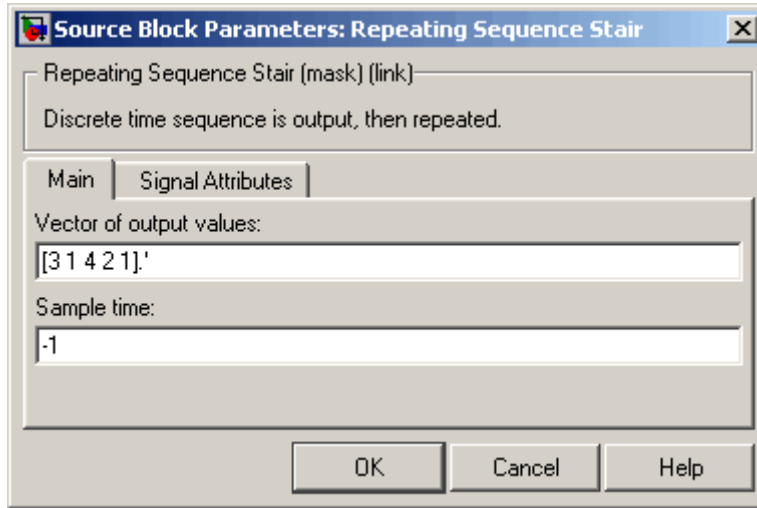


**Data Type Support**

The Repeating Sequence Stair block accepts signals of any data type supported by Simulink software, including fixed-point and enumerated data types.

## Parameters and Dialog Box

The **Main** pane of the Repeating Sequence Stair block dialog box appears as follows:



### Vector of output values

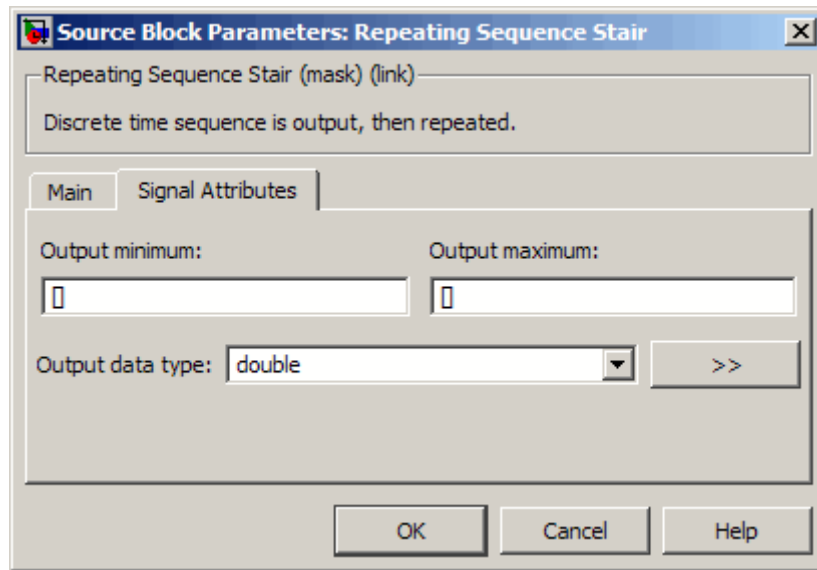
Vector containing values of the repeating stair sequence.

### Sample time

Specify the time interval between samples. To inherit the sample time, set this parameter to -1. See “How to Specify the Sample Time” in the *Simulink User’s Guide* for more information.

The **Signal Attributes** pane of the Repeating Sequence Stair block dialog box appears as follows:

# Repeating Sequence Stair



## Output minimum

Specify the minimum value that the block should output. The default value, [ ], is equivalent to  $-\text{Inf}$ . Simulink software uses this value to perform:

- Parameter range checking (see “Checking Parameter Values”)
- Simulation range checking (see “Checking Signal Ranges”)
- Automatic scaling of fixed-point data types

## Output maximum

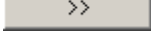
Specify the maximum value that the block should output. The default value, [ ], is equivalent to  $\text{Inf}$ . Simulink software uses this value to perform:

- Parameter range checking (see “Checking Parameter Values”)
- Simulation range checking (see “Checking Signal Ranges”)
- Automatic scaling of fixed-point data types

## Output data type

Specify the output data type. You can set it to:

- A rule that inherits a data type, for example, `Inherit: Inherit via back propagation`
- The name of a built-in data type, for example, `single`
- The name of a data type object, for example, a `Simulink.NumericType` object
- An expression that evaluates to a data type, for example, `fixdt(1,16,0)`

Click the **Show data type assistant** button  to display the **Data Type Assistant**, which helps you set the **Output data type** parameter.

See “Specifying Block Output Data Types” in the *Simulink User’s Guide* for more information.

## Lock output scaling against changes by the autoscaling tool

Select to lock scaling of outputs. This parameter is visible only if you enter an expression for the **Output data type** parameter.

## Characteristics

Sample Time	Specified in the <b>Sample time</b> parameter
Scalar Expansion	No

## See Also

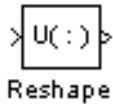
Repeating Sequence, Repeating Sequence Interpolated

# Reshape

**Purpose** Change dimensionality of 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 multidimensional 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, matrix, or multidimensional 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. For multidimensional arrays, the conversion is done along the first dimension.

Output Dimensionality	Description
Row vector	Converts a vector, matrix, or multidimensional 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. For multidimensional arrays, the conversion is done along the first dimension.
Customize	Converts the input signal to an output signal whose dimensions you specify, using the <b>Output dimensions</b> parameter. The value of the <b>Output dimensions</b> parameter can be a one- or multi-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 <b>Output dimensions</b> parameter. For multidimensional arrays, the conversion is done along the first dimension.
Derive from reference input port	Creates a second input port, Ref, on the block. Derives the dimensions of the output signal from the dimensions of the signal input to the Ref input port. Selecting this option disables the <b>Output dimensions</b> parameter. When you select this parameter, the input signals for both inport ports, U and Ref, must have the same sampling mode (sample-based or frame-based).

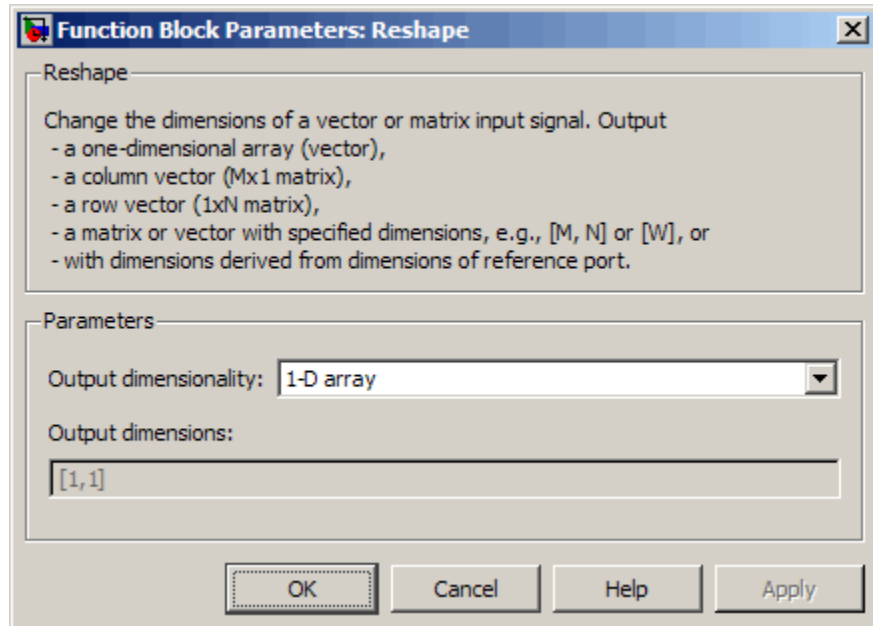
### Data Type Support

The Reshape block accepts and outputs signals of any data type supported by Simulink software, including fixed-point and enumerated data types.

# Reshape

For a discussion on the data types supported by Simulink software, see “Data Types Supported by Simulink” in the Simulink documentation.

## 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
Multidimensionalized	Yes
Zero Crossing	No

# Rounding Function

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**Purpose** Apply rounding function to signal

**Library** Math Operations

**Description** The Rounding Function block applies a rounding function to the input signal to produce the output signal.



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.

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**Tip** Use the Rounding Function block instead of the Fcn block when you want vector or matrix output, because the Fcn block produces only scalar output.

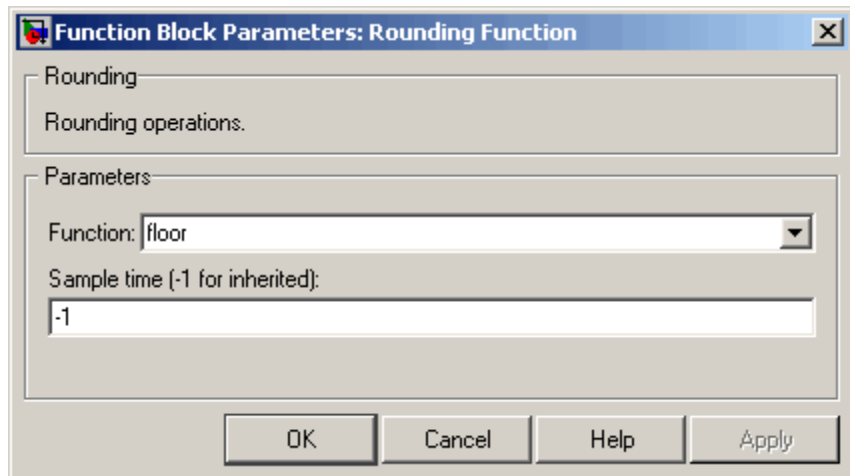
Also, the Rounding Function block provides two more rounding modes. The Fcn block supports `floor` and `ceil`, but does not support `round` and `fix`.

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## 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 “How to Specify the Sample Time” in the online documentation for more information.

# Rounding Function

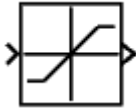
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<b>Characteristics</b>	Direct Feedthrough	Yes
	Sample Time	Inherited from driving block
	Scalar Expansion	N/A
	Dimensionalized	Yes
	Zero Crossing	No

**Purpose** Limit range of 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 block clips the signal 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

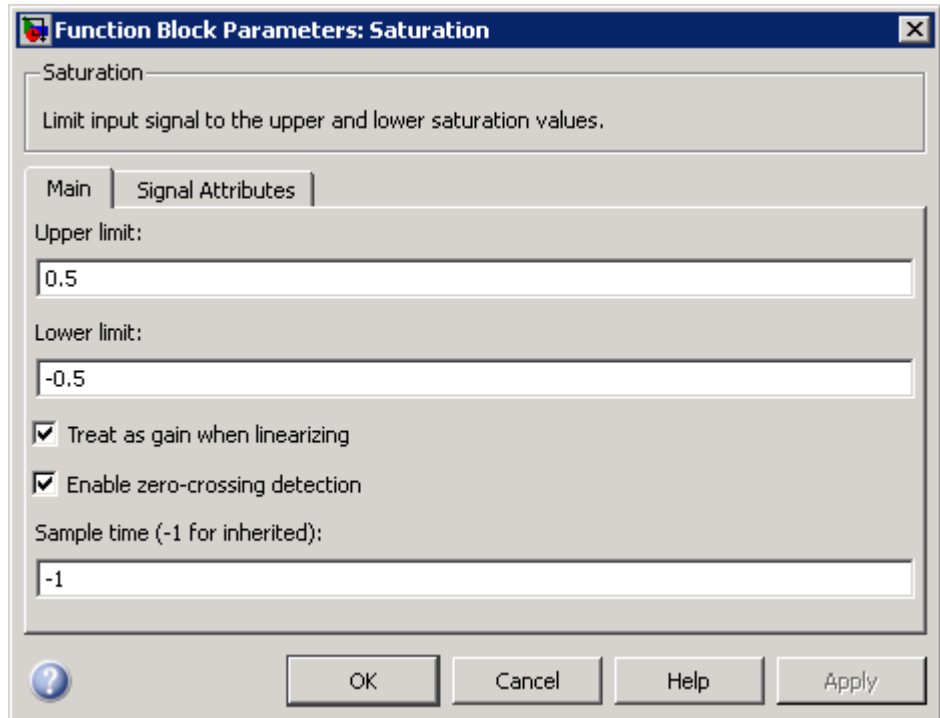
The Saturation block accepts real signals of any numeric data type supported by Simulink software, except `Boolean`. The Saturation block supports fixed-point data types.

For a discussion on the data types supported by Simulink software, see “Data Types Supported by Simulink” in the Simulink documentation.

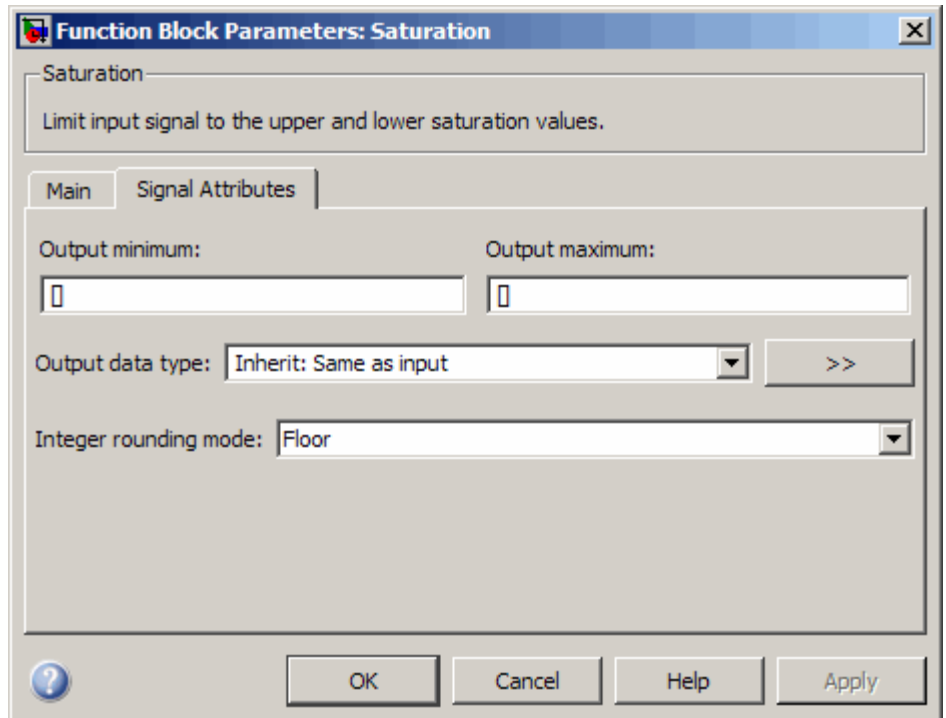
# Saturation

## Parameters and Dialog Box

The **Main** pane of the Saturation block dialog box appears as follows:



The **Signal Attributes** pane of the Saturation block dialog box appears as follows:



## **Show data type assistant**

Display the **Data Type Assistant**.

### **Settings**

The **Data Type Assistant** helps you set the **Output data type** parameter.

See “Specifying Block Output Data Types” in *Simulink User’s Guide* for more information.

### **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.



## Upper limit

Specify the upper bound on the input signal.

### Settings

**Default:** 0.5

**Minimum:** value from the **Output minimum** parameter

**Maximum:** value from the **Output maximum** parameter

### Tip

- 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 output data type offline using round-to-nearest and saturation.

### Command-Line Information

See “Block-Specific Parameters” on page 8-96 for the command-line information.

# Saturation

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## Lower limit

Specify the lower bound on the input signal.

## Settings

**Default:** -0.5

**Minimum:** value from the **Output minimum** parameter

**Maximum:** value from the **Output maximum** parameter

## Tips

- 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 output data type offline using round-to-nearest and saturation.

## Command-Line Information

See “Block-Specific Parameters” on page 8-96 for the command-line information.

## Treat as gain when linearizing

Select this parameter to cause the linearization commands to treat the gain as 1

### Settings

**Default:** On

On

Select to cause the linearization commands to treat the gain as 1.

Off

Clear to cause the linearization commands to treat the gain as 0.

### Tips

Linearization commands in Simulink software treat this block as a gain in state space.

### Command-Line Information

See “Block-Specific Parameters” on page 8-96 for the command-line information.

## **Enable zero-crossing detection**

Select to enable zero-crossing detection.

### **Settings**

**Default:** On

On  
Enable zero-crossing detection.

Off  
Do not enable zero-crossing detection.

### **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

### **See Also**

For more information, see “How Blocks Work with Zero-Crossing Detection” in the “How Simulink Works” chapter of the Simulink documentation.

## **Sample time (-1 for inherited)**

Enter the discrete interval between sample time hits or specify another appropriate sample time such as continuous or inherited.

### **Settings**

**Default:** -1

By default, the block inherits its sample time based upon the context of the block within the model. To set a different sample time, enter a valid sample time based upon the table in “Types of Sample Time”.

See also “How to Specify the Sample Time” in the online documentation for more information.

### **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

## **Lock output scaling against changes by the autoscaling tool**

Select to lock scaling of outputs.

### **Settings**

**Default:** Off

On

Lock scaling of outputs.

Off

Do not lock scaling of outputs.

### **Dependencies**

This parameter is enabled when you enter an expression for the **Output data type** or **Data type** parameter.

### **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

## Integer rounding mode

Select the rounding mode for fixed-point operations.

### Settings

**Default:** Floor

#### Ceiling

Round both positive and negative numbers toward positive infinity.

#### Convergent

Round number to the nearest representable value. In the case of a tie, round to the nearest even stored value.

#### Floor

Round both positive and negative numbers toward negative infinity.

#### Nearest

Round number to the nearest representable value. In the case of a tie, round toward positive infinity.

#### Round

Round number to the nearest representable value. In the case of a tie, round positive numbers toward positive infinity and round negative numbers toward negative infinity.

#### Simplest

This option provides for an optimization of the rounding code for several blocks.

#### Zero

Round number toward zero.

### Command-Line Information

See “Block-Specific Parameters” on page 8-96 for the command-line information.

### See Also

For more information, see “Rounding” in the *Simulink Fixed Point User’s Guide*.

## **Output minimum**

Specify the minimum value that the block should output.

### **Settings**

**Default:** []

The default value, [], is equivalent to `-Inf`.

Simulink software uses this value to perform:

- Parameter range checking (see “Checking Parameter Values”) for some blocks
- Simulation range checking (see “Checking Signal Ranges”)
- Automatic scaling of fixed-point data types

### **Tip**

This number must be a double scalar value.

### **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.



## **Output maximum**

Specify the maximum value that the block should output.

### **Settings**

**Default:** []

The default value, [], is equivalent to Inf.

Simulink software uses this value to perform:

- Parameter range checking (see “Checking Parameter Values”) for some blocks
- Simulation range checking (see “Checking Signal Ranges”)
- Automatic scaling of fixed-point data types

### **Tip**

This number must be a double scalar value.

### **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

## Output data type

Specify the output data type.

### Settings

**Default:** Inherit: Inherit via internal rule (Discrete-Time Integrator, Gain, Product, Sum, Switch block), Inherit: Inherit from 'Constant value' (Constant block default), Inherit: Inherit via back propagation (Data Type Conversion block), Inherit: Same as input (Saturation block)

Inherit: Inherit via internal rule

This option appears for some blocks. Simulink software chooses a combination of output scaling and data type that requires the smallest amount of memory consistent with accommodating the calculated 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 software chooses the output data type without regard to hardware constraints. Otherwise, Simulink software 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 `sfixed24`. 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 software displays an error message in the Simulation Diagnostics Viewer.

Inherit: Inherit from 'Constant value'

Use data type of **Constant value** parameter. This option appears for some blocks.

Inherit: Inherit via back propagation

A rule that inherits a data type

**Inherit: Same as input**  
Use data type of sole input signal. This option appears for some blocks.

**Inherit: Same as first input**  
Use data type of first input signal. This option appears for some blocks.

**Inherit: Same as accumulator**  
Output data type same as accumulator data type. This option appears for some blocks.

**double**  
Output data type is double.

**single**  
Output data type is single.

**int8**  
Output data type is int8.

**uint8**  
Output data type is uint8.

**int16**  
Output data type is int16.

**uint16**  
Output data type is uint16.

**int32**  
Output data type is int32.

**uint32**  
Output data type is uint32.

**fixdt(1,16,0)**  
Output data type is fixed point fixdt(1,16,0).

**fixdt(1,16,2<sup>0</sup>,0)**  
Output data type is fixed point fixdt(1,16,2<sup>0</sup>,0).

# Saturation

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<data type expression>

The name of a data type object, for example  
Simulink.NumericType

## **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

## **See Also**

See “Specifying Block Output Data Types” in the *Simulink User’s Guide* for more information.

## Mode

Select the category of data to specify

### Settings

**Default:** Inherit (Constant, Data Type Conversion, Discrete Time Integrator, Gain, Inport, Outport, Product, Saturation, Sum, Switch),  
**Built in** (Logical Operator, Relational Operator)

#### Inherit

Inheritance rules for data types. Selecting **Inherit** enables a second menu/text box to the right. Below are the possible values, which can vary by block:

- Inherit from 'Constant value' (Constant block default)
- Inherit via internal rule (Discrete-Time Integrator, Gain, Product, Sum, Switch block default)
- Inherit via back propagation (Data Type Conversion block default)
- auto (Inport, Outport block default)
- Logical (see Configuration Parameters: Optimization)
- Same as first input
- Same as input (Saturation block default)
- Same as accumulator

#### Built in

Built-in data types. Selecting **Built in** enables a second menu/text box to the right. Below are the possible values, which can vary by block:

- double (Constant, Data Type Conversion, Discrete-Time Integrator, Gain, Inport, Outport, Product, Saturation, Sum, Switch block default)
- single

# Saturation

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- int8
- uint8
- int16
- uint16
- int32
- uint32
- boolean (Logical Operator, Relational Operator block default)

## Fixed point

Fixed-point data types.

## Enumerated

Enumerated data types. This option is available on some blocks. Selecting Enumerated enables a second menu/text box to the right. Below are the possible values, which can vary by block:

- <class name>

## Expression

Expressions that evaluate to data types. Selecting Expression enables a second menu/text box to the right. Below are the possible values, which can vary by block:

- <data type expression>

## Dependency

This parameter is enabled by the **Show data type assistant** button.

## Command-Line Information

See “Block-Specific Parameters” on page 8-96 for the command-line information.

## See Also

See “Using the Data Type Assistant” in the *Simulink User’s Guide*.

## Signedness

Specify whether you want the fixed-point data to be signed or unsigned.

### Settings

**Default:** Signed

#### Signed

Specify the fixed-point data to be signed.

#### Unsigned

Specify the fixed-point data to be unsigned.

### Dependencies

This parameter is enabled by selecting **Mode** > Fixed point.

### Command-Line Information

See “Block-Specific Parameters” on page 8-96 for the command-line information.

### See Also

See “Specifying a Fixed-Point Data Type” in the *Simulink User’s Guide* for more information.

## **Word length**

Specify the bit size of the word that will hold the quantized integer.

### **Settings**

**Default:** 16

**Minimum:** 0

**Maximum:** 32

Large word sizes represent large values with greater precision than small word sizes.

### **Dependencies**

This parameter is enabled by selecting **Mode** > Fixed point.

### **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

### **See Also**

See “Specifying a Fixed-Point Data Type” in the *Simulink User’s Guide* for more information.



## Scaling

Specify the method for scaling your fixed-point data to avoid overflow conditions and minimize quantization errors.

### Settings

**Default:** Best precision (Constant), Binary point (Data Type Conversion, Discrete-Time Integrator, Gain, Inport, Outport, Product, Saturation, Sum, Switch), Integer (Logical Operator, Relational Operator)

#### Binary point

Specify binary point location.

#### Slope and bias

Enter slope and bias.

#### Best precision

Specify best-precision values. This option appears for some blocks.

#### Integer

Specify integer. This setting has the same result as specifying a binary point location and setting fraction length to 0. This option appears for some blocks.

### Dependencies

This parameter is enabled by selecting **Mode** > Fixed point.

Selecting Binary point enables:

- **Fraction length**
- **Calculate Best-Precision Scaling**

Selecting Slope and bias enables:

- **Slope**
- **Bias**
- **Calculate Best-Precision Scaling**

# Saturation

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## **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

## **See Also**

See “Specifying a Fixed-Point Data Type” in the *Simulink User’s Guide* for more information.

## **Fraction length**

Specify fraction length for fixed-point data type.

### **Settings**

**Default:** 0

Binary points can be positive or negative integers.

### **Dependencies**

This parameter is enabled by selecting **Scaling** > Binary point.

### **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

### **See Also**

See “Specifying a Fixed-Point Data Type” in the *Simulink User’s Guide* for more information.

## **Slope**

Specify slope for the fixed-point data type.

### **Settings**

**Default:** 2<sup>0</sup>

Specify any positive real number.

### **Dependencies**

This parameter is enabled by selecting **Scaling** > Slope and bias.

### **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

### **See Also**

See “Specifying a Fixed-Point Data Type” in the *Simulink User’s Guide* for more information.

## Bias

Specify bias for the fixed-point data type.

## Settings

**Default:** 0

Specify any real number.

## Dependencies

This parameter is enabled by selecting **Scaling** > Slope and bias.

## Command-Line Information

See “Block-Specific Parameters” on page 8-96 for the command-line information.

## See Also

See “Specifying a Fixed-Point Data Type” in the *Simulink User’s Guide* for more information.

## Characteristics

Direct Feedthrough	Yes
Sample Time	Specified in the <b>Sample time</b> parameter
Scalar Expansion	Yes, of parameters and input
Dimensionalized	Yes
Zero Crossing	Yes, if enabled.

## See Also

Saturation Dynamic

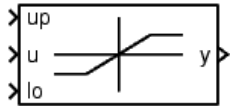
# Saturation Dynamic

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**Purpose** Bound range of 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.

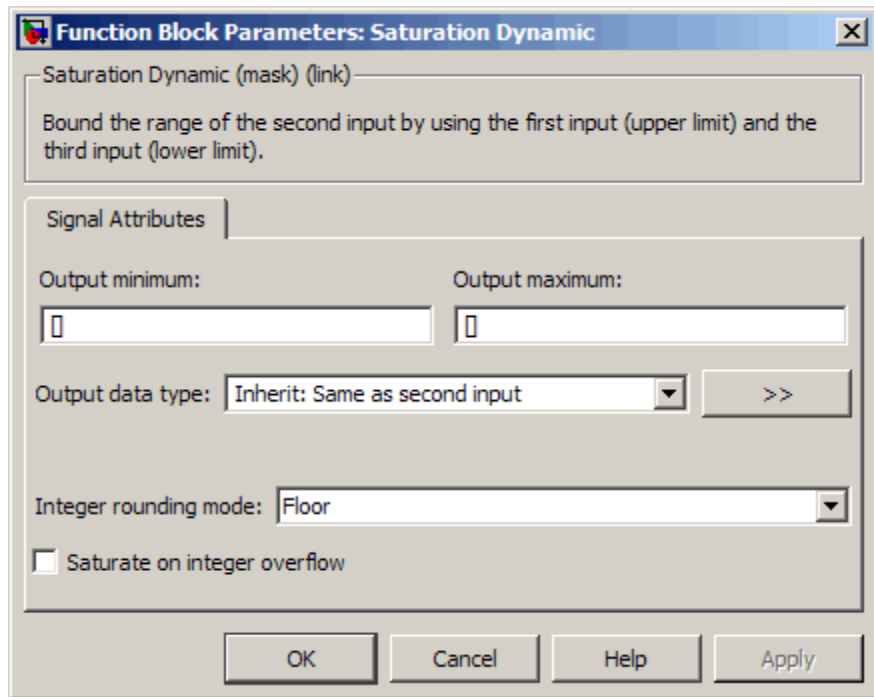
The input for the upper limit is the up port, and the input for the lower limit is the lo port.

## Data Type Support

The Saturation Dynamic block accepts signals of any numeric data type supported by Simulink software, including fixed-point data types.

For a discussion on the data types supported by Simulink software, see “Data Types Supported by Simulink” in the Simulink documentation.

## Parameters and Dialog Box



### Output minimum

Specify the minimum value that the block should output. The default value, [ ], is equivalent to  $-\text{Inf}$ . Simulink software uses this value to perform:

- Simulation range checking (see “Checking Signal Ranges”)
- Automatic scaling of fixed-point data types

### Output maximum

Specify the maximum value that the block should output. The default value, [ ], is equivalent to  $\text{Inf}$ . Simulink software uses this value to perform:

- Simulation range checking (see “Checking Signal Ranges”)

# Saturation Dynamic

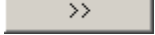
---

- Automatic scaling of fixed-point data types

## Output data type

Specify the output data type. You can set it to:

- A rule that inherits a data type, for example, `Inherit: Same as second input`
- The name of a built-in data type, for example, `single`
- The name of a data type object, for example, a `Simulink.NumericType` object
- An expression that evaluates to a data type, for example, `fixdt(1,16,0)`

Click the **Show data type assistant** button  to display the **Data Type Assistant**, which helps you set the **Output data type** parameter.

See “Specifying Block Output Data Types” in the *Simulink User’s Guide* for more information.

## Lock output scaling against changes by the autoscaling tool

Select to lock scaling of outputs. This parameter is visible only if you enter an expression for the **Output data type** parameter.

## Integer rounding mode

Select the rounding mode for fixed-point operations. For more information, see “Rounding” in the *Simulink Fixed Point User’s Guide*.

## Saturate on integer overflow

Select to have overflows saturate.

When you select this check box, saturation applies to every internal operation on the block, not just the output or result. In general, the code generation process can detect when overflow is not possible, in which case, no saturation code is generated.



<b>Characteristics</b>	Direct Feedthrough	Yes
	Scalar Expansion	Yes

**See Also**      Saturation

# Scope and Floating Scope

---

**Purpose** Display signals generated during 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) and all axes have a common time range with independent  $y$ -axes. The Scope block 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.

The Scope Block described here is not the same as the Scope Viewer. For help on the scope viewer, see “Things to Know When Using Viewers”.

When you start a simulation the Scope windows are not opened, but data is written 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.

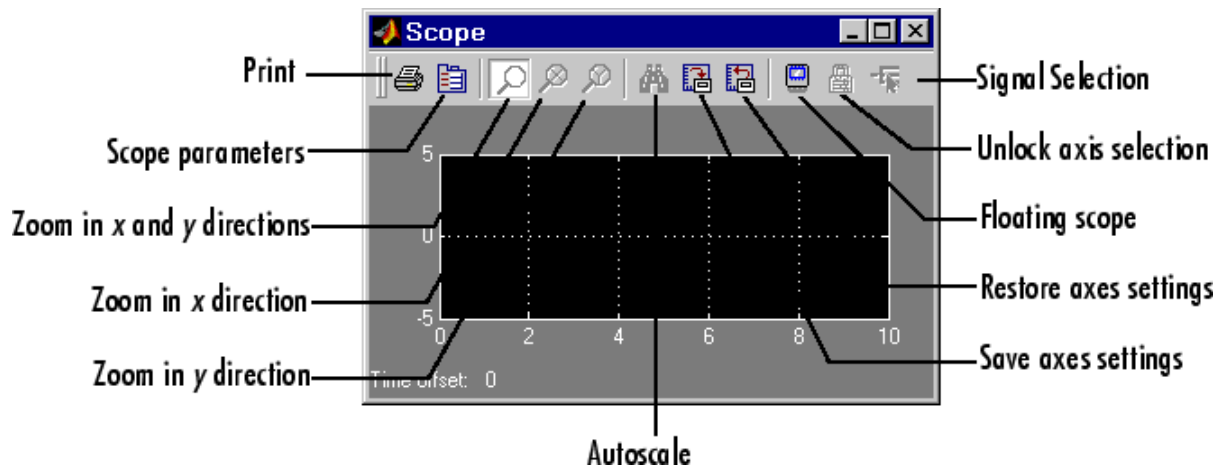
---

**Note** By default, the Scope block only displays major time step values. However, if a variable-step solver is employed and if the Refine parameter is set to a value greater than 1, minor (intermediate) time step values are displayed in direct proportion to the Refine setting.

---

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 and Floating 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.

---

## Color Coding Used When Displaying Multiple Signals

The scope block can display one signal per axes. When displaying a vector or matrix signal on the same axis, the Scope block assigns colors to each signal element, in this order:

- 1 Yellow
- 2 Magenta
- 3 Cyan
- 4 Red
- 5 Green
- 6 Dark Blue

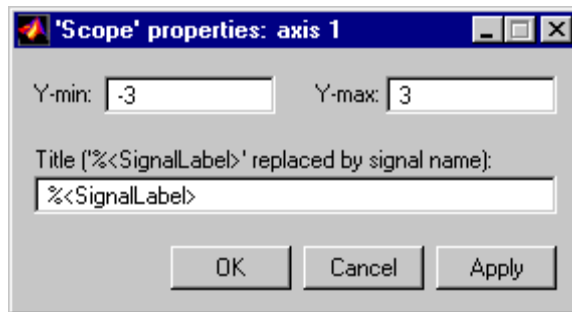
# Scope and Floating Scope

---

The Scope block cycles through the colors if a signal has more than six elements.

## 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).

---

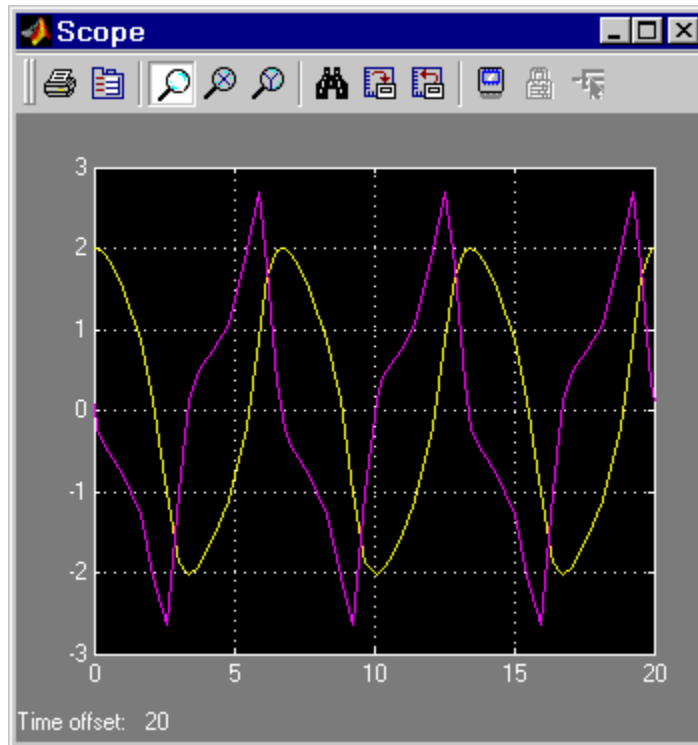
**Note** You cannot add a title to a floating scope.

---

## 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

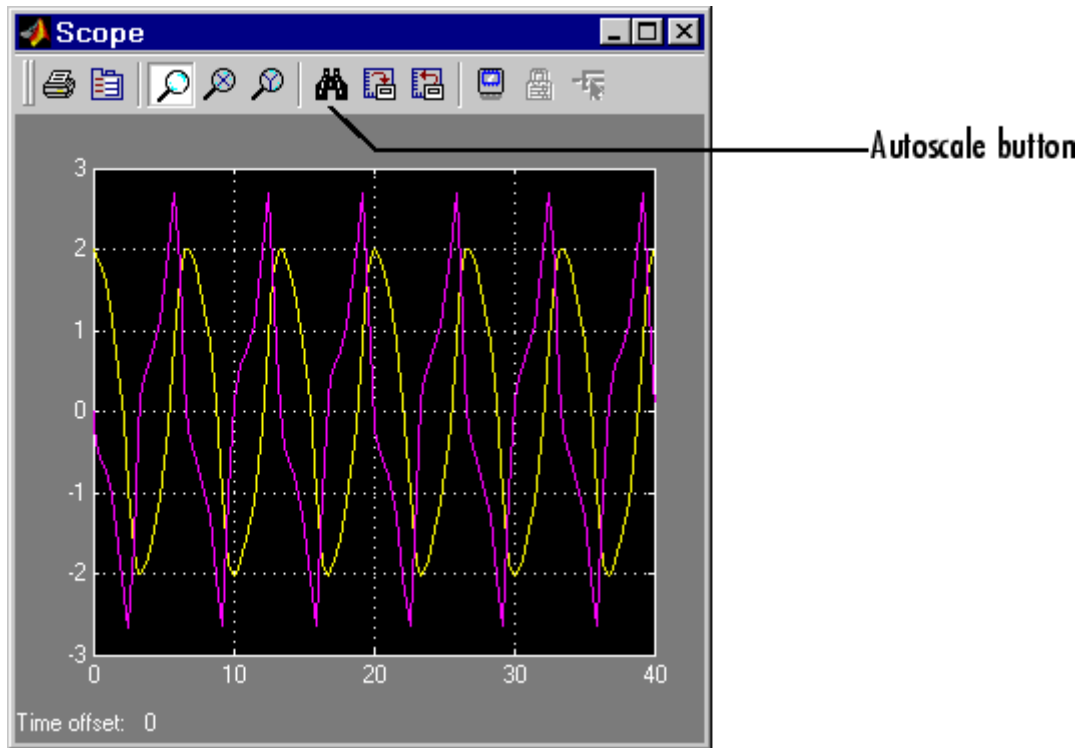
have to add the offset to the fixed time range values on the  $x$ -axis to get the actual time.



## 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 and Floating Scope



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 software 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 software 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.

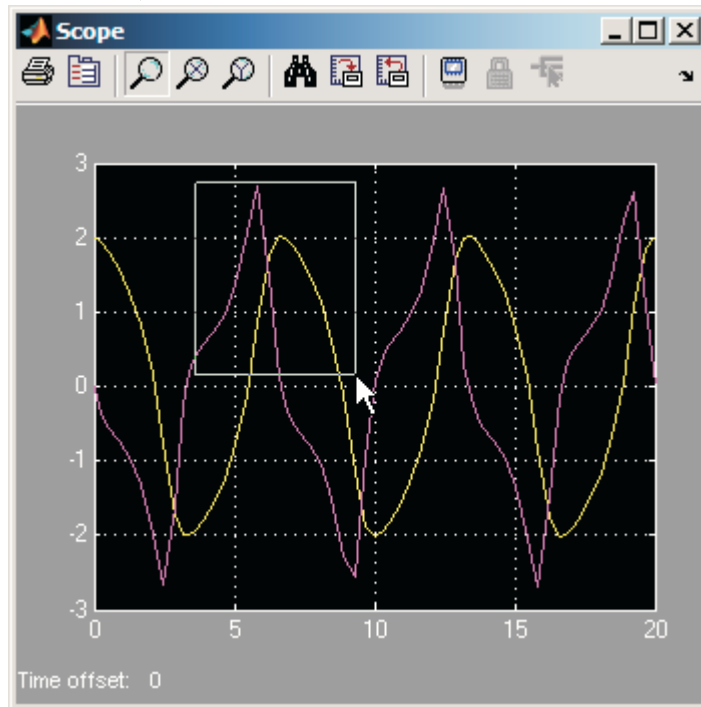
If the scope has multiple  $y$ -axes, and you zoom in on one set of  $x$ - $y$  axes, the  $x$ -limits on all sets of  $x$ - $y$  axes are changed so that they match, because all  $x$ - $y$  axes must share the same time base ( $x$ -axis).

This figure shows a region of the displayed data enclosed within a bounding box.

# Scope and Floating Scope

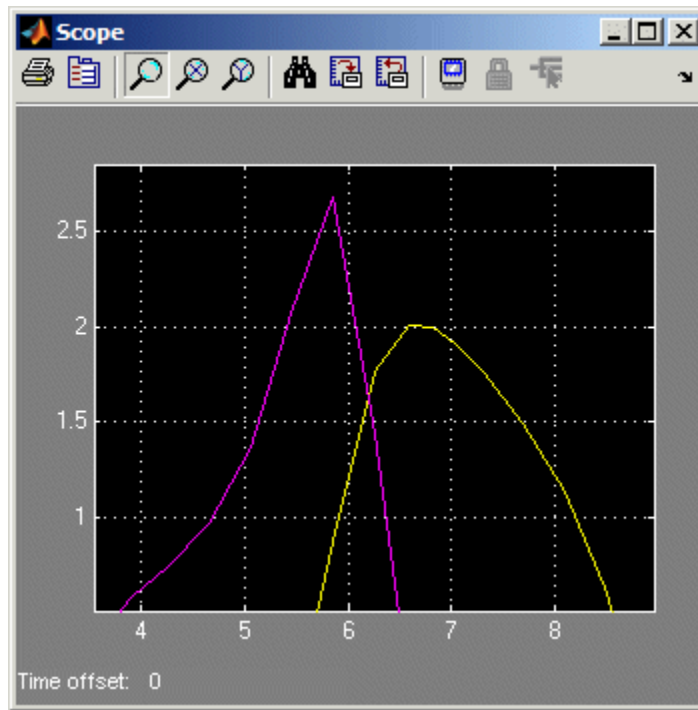
---

Zoom in both directions



This figure shows the zoomed region, which appears after you release the mouse button.

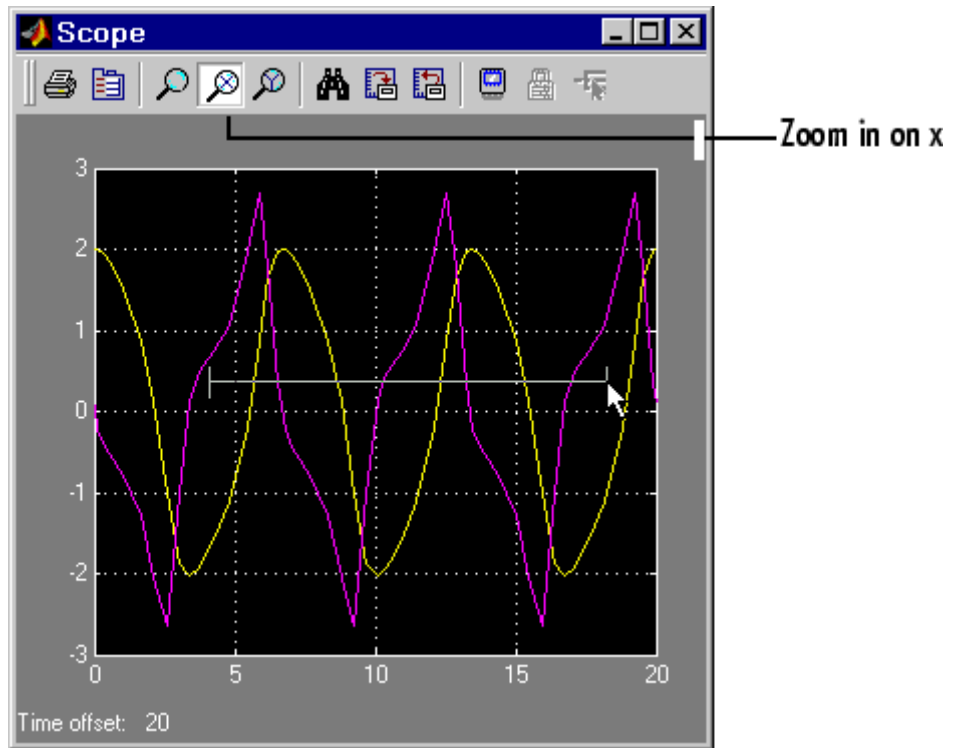




To zoom in on data in just the  $x$  direction, click the middle **Zoom** toolbar button. Define the zoom region by positioning the pointer at one end of the region, pressing and holding down the mouse button, then moving the pointer to the other end of the region. This figure shows the Scope after you define the zoom region, but before you release the mouse button.

# Scope and Floating Scope

---



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.

---

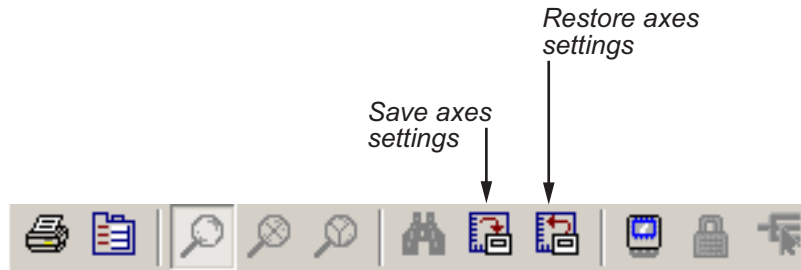
**Note** Simulink software does not buffer the data that it displays on a floating scope. It therefore cannot zoom the contents of a floating scope. To indicate this, Simulink software disables (grays) the **Zoom** button on the toolbar of a floating scope.

---

## Saving and Restoring the Axes Settings

The **Save axes settings** toolbar button enables you to store the current  $x$ - and  $y$ -axes settings so you can apply them to the next simulation.

Use the **Restore axes settings** button to restore the saved settings.



---

**Tip** If you select the Save axes settings button on the toolbar, the block specifies its current  $y$ -limits as the values of the **Y-min** and **Y-max** parameters (see “Y-Axis Limits” on page 2-904). Similarly, the block specifies its current  $x$ -axis limits as the value of the **Time range** parameter (see “General Parameters Pane” on page 2-912).

---

## Scope Parameters

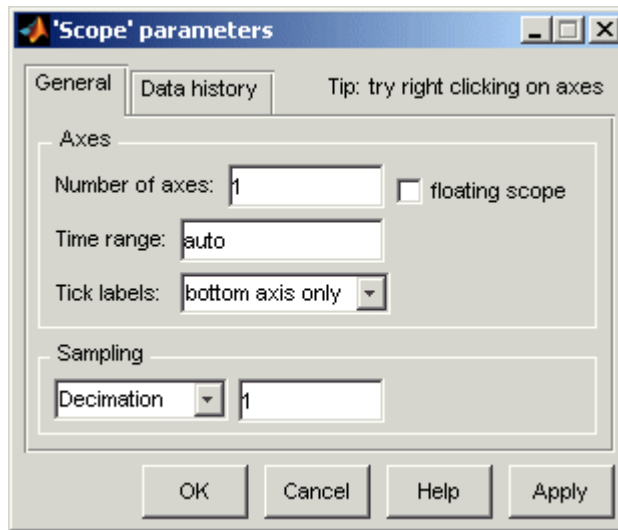
The **Scope Parameters** dialog box lets you change axis limits, set the number of axes, time range, tick labels, sampling parameters, and saving options. To display the dialog, select the **Parameters** button on the toolbar of the Scope block’s display



or double-click the Scope viewer’s display.

# Scope and Floating Scope

---



For information on the **General** pane, see “General Parameters Pane” on page 2-912

For information on the **Data history** pane, see “Data History Parameters Pane” on page 2-917

## General Parameters Pane

You set the axis parameters, time range, tick labels and decimation or sample time 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 ticks. The options are:

<code>all</code>	Label ticks on the outside of all axes
<code>inside</code>	Place tick labels inside all axes (available only on scope viewers)
<code>bottom-axis only</code>	Place tick labels outside the bottom (or only) axes
<code>none</code>	Do not label ticks

## Sampling

Use this control to select either a **Decimation** factor or **Sample time** interval. Once the selection has been made, enter a number in the data field.

## Floating scope

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 **Floating scope**, or by copying the Floating Scope block from the Sinks library into the model window.

To add signals to a floating scope during simulation, you can either click on signals in your block diagram, or use the Signal Selector (for more information on the signal selector, see “The Signal Selector”).

To add signals to a floating scope while the simulation is running by clicking on signals:

- Open the scope

# Scope and Floating Scope

---

- Select the line to display the signals it carries  
It might be necessary to click the **Autoscale data** button on the floating scope's toolbar to display the signal
- You can add multiple lines by holding down the **Shift** key while clicking another line

---

**Note** For you to add signals, the floating scope must have its axes unlocked.

Click the Axes lock icon to lock and unlock the axes.



The axes are highlighted in blue when they are unlocked.

---

To use the Signal Selector to add signals:

- Open the floating scope
- Right-click your mouse in the floating scope and select **Signal Selection** from the pop-up menu
- From the displayed list, select the signals to be added to the floating scope

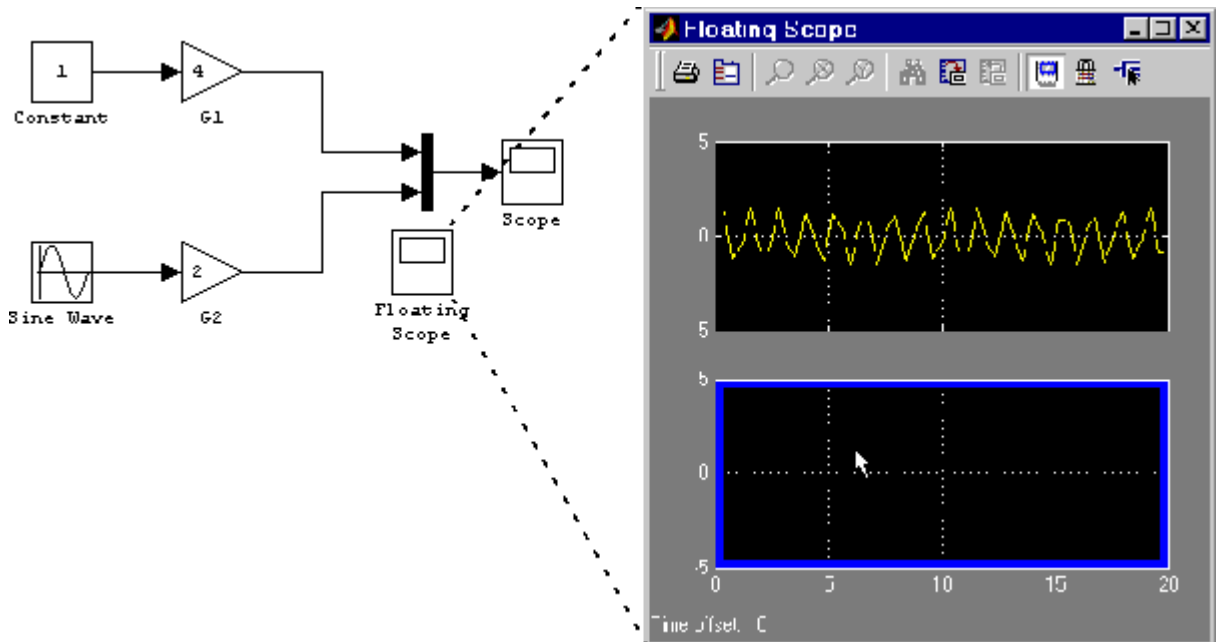
It might be necessary to click the **Autoscale data** button on the floating scope's toolbar to display the signal

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.

# Scope and Floating Scope

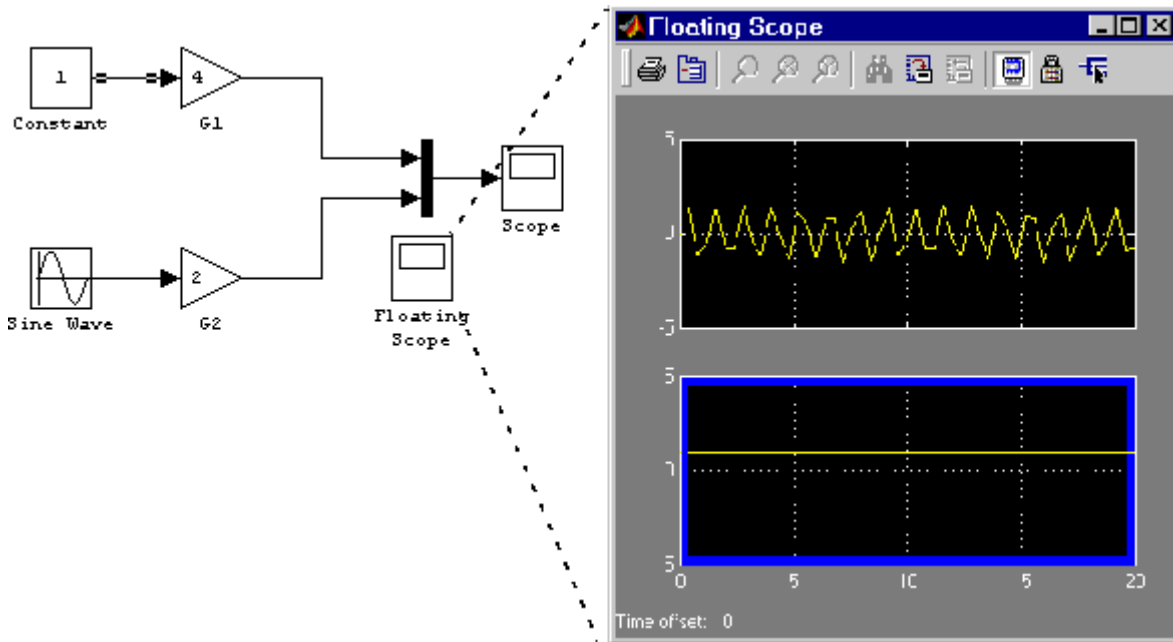
Other floating scopes continue to display the signals that you selected when they were active. In other words, inactive floating scopes are locked, in that their signal displays cannot change.

To specify display of a signal on one of the axes of a multi-axis floating scope, click the axis. Simulink software 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.

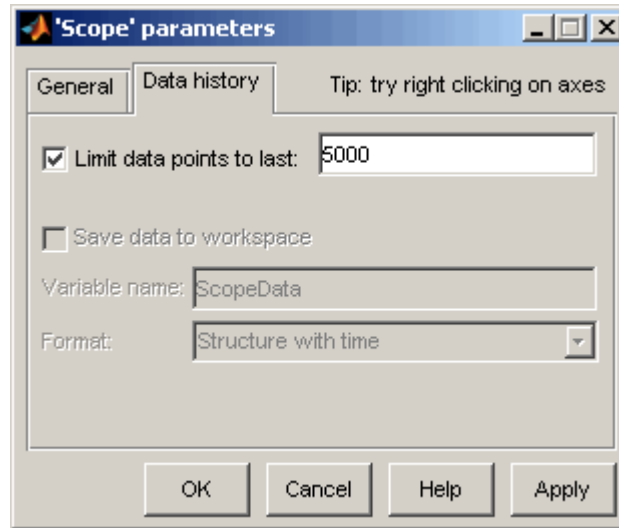
# Scope and Floating Scope



If you plan to use a floating scope during a simulation, you should disable signal storage reuse. See "Signal storage reuse" in "Optimization Pane" for more information.



## Data History Parameters Pane



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**

# Scope and Floating Scope

---

check box. If you select this option, the **Variable name** and **Format** fields become active.

---

**Note** When using a floating scope, **Save data to workspace** is disabled to show that data logging is not supported.

---

## 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.

## 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.

## Creating an Editable Figure from a Scope Block

To create a figure that looks identical to the Scope window but can be annotated using the Plot Editing Tools, use the `simplot` command. Only Scope blocks that save data to the MATLAB workspace from the **Data history** pane are compatible with this command. For example, on the **Data history** pane for the Scope block in `vdp.mdl`, check the **Save data to workspace** option and select Structure with time from

the **Format** list. After running the simulation, a figure can be created with the command

```
simplot(ScopeData)
```

## Data Type Support

The Scope block accepts real signals of any data type supported by Simulink software, including fixed-point and enumerated data types. The Scope block accepts homogeneous vectors.

For a discussion on the data types supported by Simulink software, see “Data Types Supported by Simulink” in the Simulink documentation.

## Characteristics

Sample Time	Inherited from driving block or can be set
States	0
Multidimensionalized	Yes

# Selector

---

**Purpose** Select input elements from vector, matrix, or multidimensional signal

**Library** Signal Routing

## Description



The Selector block generates as output selected or reordered elements of an input vector, matrix, or multidimensional signal.

A Selector block accepts vector, matrix, or multidimensional signals as input. The parameter dialog box and the block's appearance change to reflect the number of dimensions of the input.

Based on the value you enter for the **Number of input dimensions** parameter, a table of indexing settings is displayed. Each row of the table corresponds to one of the input dimensions in **Number of input dimensions**. For each dimension, you define the elements of the signal to work with. Specify a vector signal as a 1-D signal and a matrix signal as a 2-D signal. When you configure the Selector block for multidimensional signal operations, the block icon changes.

For example, assume a 5-D signal with a one-based index mode. The table of the Selector block dialog changes to include one row for each dimension. If you define each dimension with the following entries:

- 1  
**Index Option**, select Select all
- 2  
**Index Option**, select Starting index (dialog)  
**Index**, enter 2  
**Output Size**, enter 5
- 3  
**Index Option**, select Index vector (dialog)  
**Index**, enter [1 3 5]
- 4

**Index Option**, select Starting index (port)

**Output Size**, enter 8

- 5

**Index Option**, select Index vector (port)

The output will be  $Y=U(1:\text{end}, 2:6, [1\ 3\ 5], \text{Idx4}:\text{Idx4}+7, \text{Idx5})$ , where  $\text{Idx4}$  and  $\text{Idx5}$  are the index ports for dimensions 4 and 5.

## Data Type Support

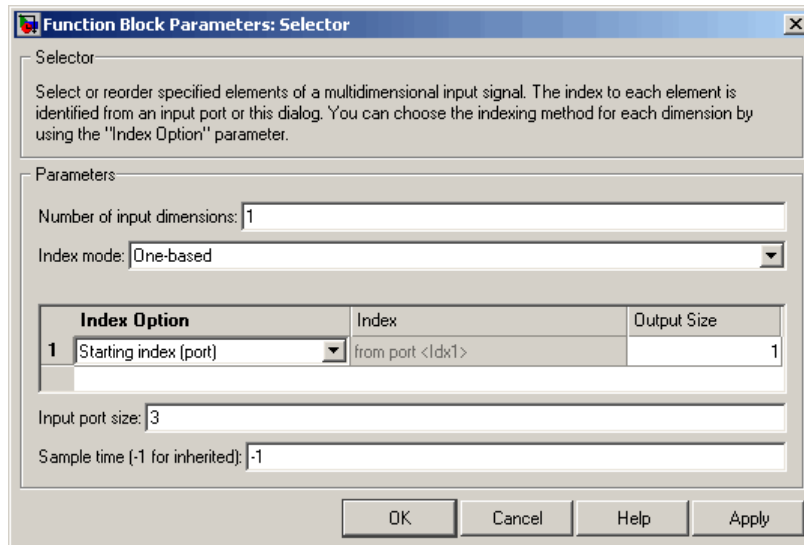
The data port of the Selector block accepts signals of any signal type and any data type supported by Simulink software, including fixed-point and enumerated data types. The data port accepts mixed-type signals. The index port accepts only built-in data types, except boolean data types. The elements of the output have the same type as the corresponding selected input elements.

For a discussion on the data types supported by Simulink software, see “Data Types Supported by Simulink” in the Simulink documentation.

# Selector

## Parameters and Dialog Box

The parameter dialog box appears as follows when you set **Index Option** to Starting index (port).



### Number of input dimensions

Enter the number of dimensions of the input signal.

### 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.

### Index Option

Define, by dimension, how the elements of the signal are to be indexed. From the list, choose:

- **Select all**

This is the default. No further configuration is required. All elements are selected.

- **Index vector (dialog)**  
Enables the **Index** column. Enter the vector of indices of the elements.
- **Index vector (port)**  
No further configuration is required.
- **Starting index (dialog)**  
Enables the **Index** and **Output Size** columns. Enter the starting index of the range of elements to be selected in the **Index** column and the number of elements to be selected in the **Output Size** column.
- **Starting index (port)**  
Enables the **Output Size** column. Enter the number of elements to be selected in the **Output Size** column.

The **Index** and **Output Size** columns are displayed as relevant.

## **Index**

If the **Index Option** is **Index vector (dialog)**, enter the index of each element you are interested in.

If the **Index Option** is **Starting index vector (dialog)**, enter the starting index of the range of elements to be selected.

## **Output Size**

Enter the width (number of elements from the starting point) of the block output signal.

## **Input port size**

Specify the width of the block input signal (-1 for inherited) — 1-D signals only.

## **Sample time (-1 for inherited)**

Specify the time interval between samples. To inherit the sample time, set this parameter to -1. See “How to Specify the Sample Time” in the online documentation for more information.

# Selector

---

---

**Note** For 1-D signals, the **Sample time** parameter is applicable only with the **Index Option** set to **Starting index (port)** or **Index vector (port)**. For all other **Input Option** settings, the Selector block becomes a virtual block and the **Sample time** parameter does not appear.

---

## Characteristics

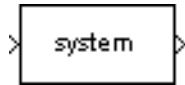
Sample Time	Specified in the <b>Sample time</b> parameter.
Dimensionalized	Yes
Multidimensionalized	Yes
Zero crossing	No



**Purpose** Include S-function in 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.

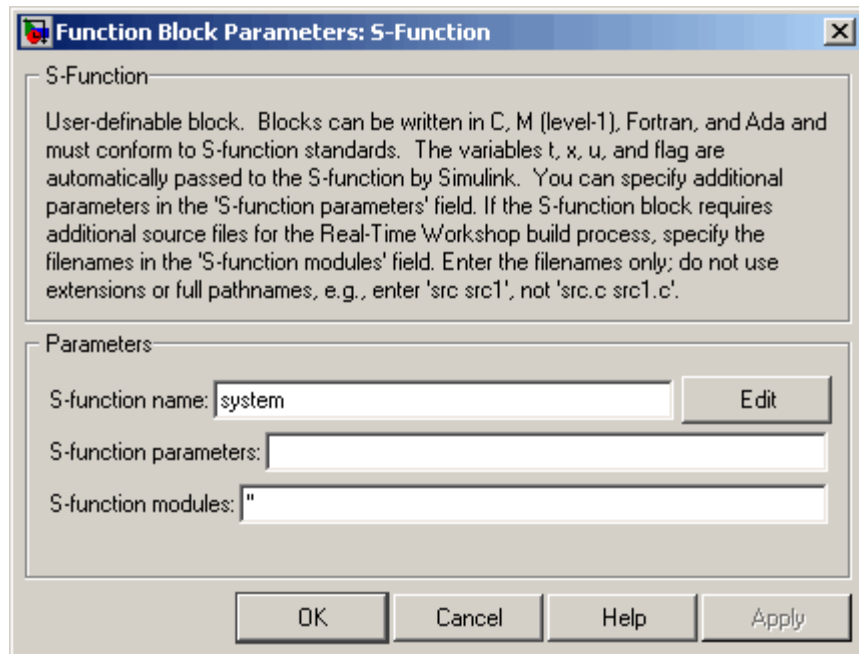
The S-Function block displays the name of the specified S-function and the number of input and output ports specified by the S-function. Signals connected to the inputs must have the dimensions specified by the S-function for the inputs.

**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 software 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.

<b>Characteristics</b>	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
	Multidimensionalized	Yes
	Zero Crossing	No

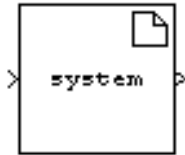
# S-Function Builder

---

**Purpose** Create 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 software invokes the generated S-function associated with each instance to compute the instance’s output at each time step.

---

**Note** The S-Function Builder block does not support masking. However, you can mask a Subsystem block that contains an S-Function Builder block. See “Working with Block Masks” in the Simulink documentation for more information.

---

## 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 software.

For a discussion on the data types supported by Simulink software, 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.

**Purpose** Shift bits or binary point of signal

**Library** Logic and Bit Operations

**Description** The Shift Arithmetic block can 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 `sfixed(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

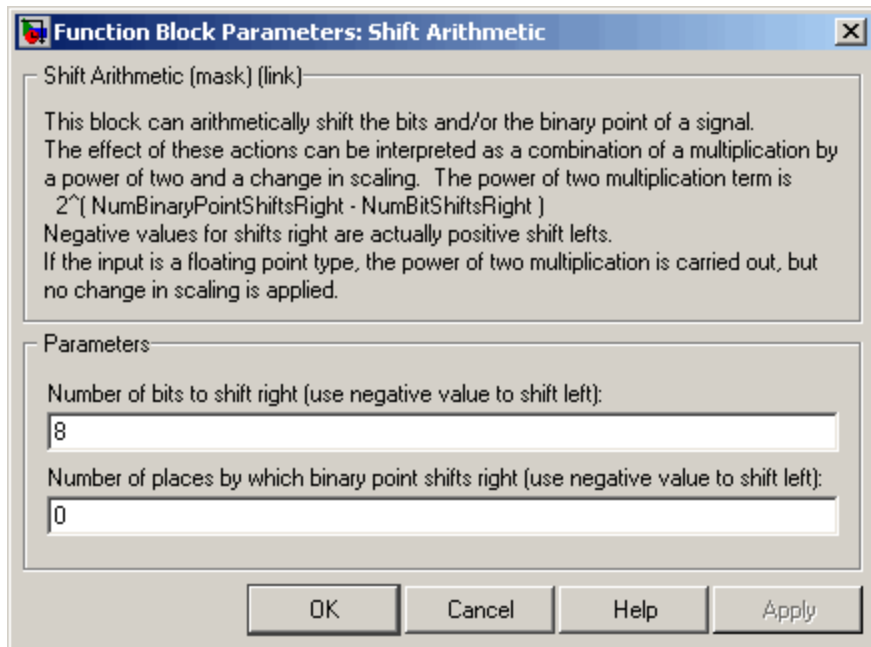
This block performs arithmetic bit shifts on signed numbers. Therefore, the most significant bit is recycled for each bit shift. The effects of bit shifts two places to the right and two places to the left on an input of data type `sfixed(8)` follow.

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 numeric data type supported by Simulink software, including fixed-point data types, except boolean type.

# Shift Arithmetic

## Parameters and Dialog Box



### 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.

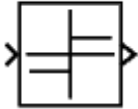
## Characteristics

Direct Feedthrough	Yes
Sample Time	Inherited
Scalar Expansion	Yes

**Purpose** Indicate sign of input

**Library** Math Operations

**Description** The Sign block indicates the sign of the input:



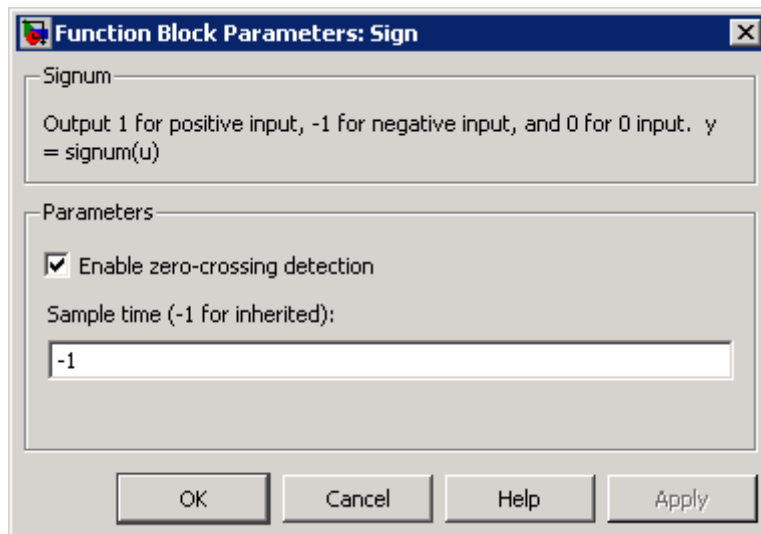
- The output is 1 when the input is greater than zero.
- The output is 0 when the input is equal to zero.
- The output is -1 when the input is less than zero.

## Data Type Support

The Sign block accepts real signals of any numeric data type supported by Simulink software, 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 software, 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 “How Blocks Work with Zero-Crossing Detection” in the “How Simulink Works” chapter of the Simulink documentation.

## **Sample time (-1 for inherited)**

Specify the time interval between samples. To inherit the sample time, set this parameter to -1. See “How to Specify the Sample Time” in the online documentation for more information.

## **Characteristics**

Direct Feedthrough	Yes
Sample Time	Specified in the <b>Sample time</b> parameter
Scalar Expansion	N/A
Dimensionalized	Yes
Zero-Crossing Detection	Yes, if enabled.



**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 Simulink documentation.



---

**Note** Use the `signalbuilder` function to create and access Signal Builder blocks programmatically.

---

**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.

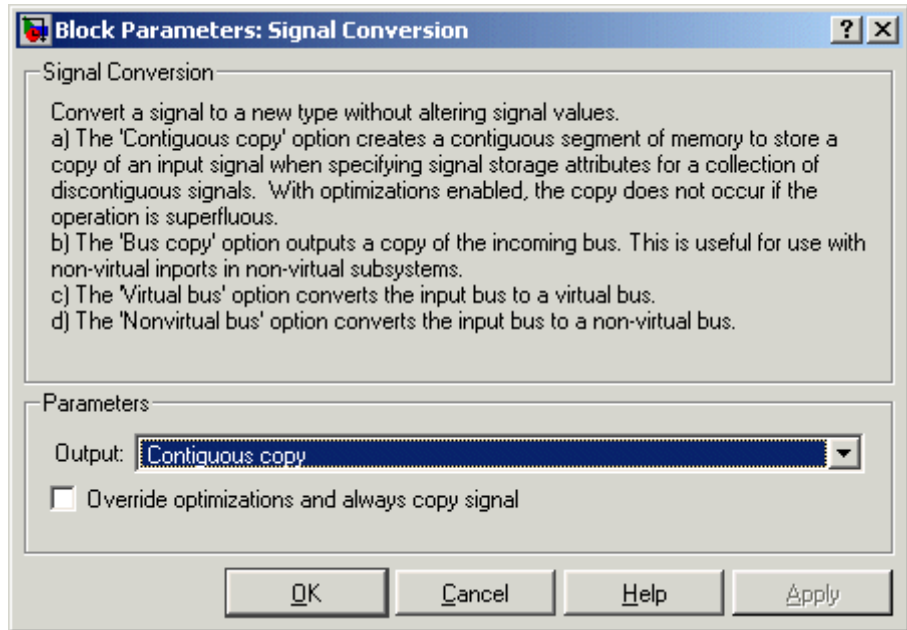
## Characteristics

Sample Time	Continuous
Scalar Expansion	Yes, of parameters
Dimensionalized	Yes
Zero Crossing	Yes

# Signal Conversion

- Purpose** Convert signal to 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 discontinuous 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 discontinuous areas (represented by the block's input) to the contiguous areas (represented by the block's output) at each time step. You can also use this setting to connect a block with a constant sample time to an output port of an enabled subsystem. For more information, see *Using Blocks with Constant Sample Times in Enabled Subsystems*. For an example involving Real-Time Workshop software, see "Reusable Code and Referenced Models".

- **Bus copy**

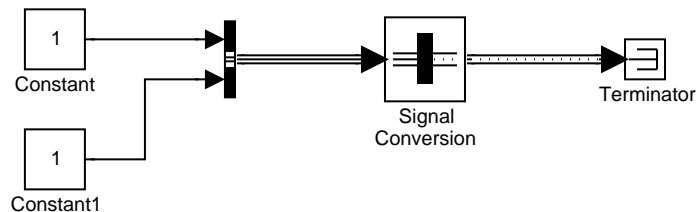
Outputs a copy of the bus connected to the block's input. This setting is useful when passing a bus signal whose components have different data types to a nonvirtual Inport block in an Atomic Subsystem. See "Using Composite Signals" in the Simulink documentation for more information.

- **Virtual bus**

Converts a nonvirtual bus to a virtual bus. In general, virtual buses can save memory where nonvirtual buses are not required.

- **Nonvirtual bus**

Converts a virtual bus to a nonvirtual bus as in the following example. This setting is useful when passing a virtual bus signal to a modeling construct that requires a nonvirtual bus, such as a Model block.



# Signal Conversion

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**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.

If the elements of the input signal occupy contiguous areas of memory, Simulink software eliminates the block from the compiled model as an optimization unless you select this option.

## **Characteristics**

Sample Time	Inherited
Scalar Expansion	n/a
Dimensionalized	n/a
Multidimensionalized	Yes
Zero Crossing	No

**Purpose** Generate various waveforms

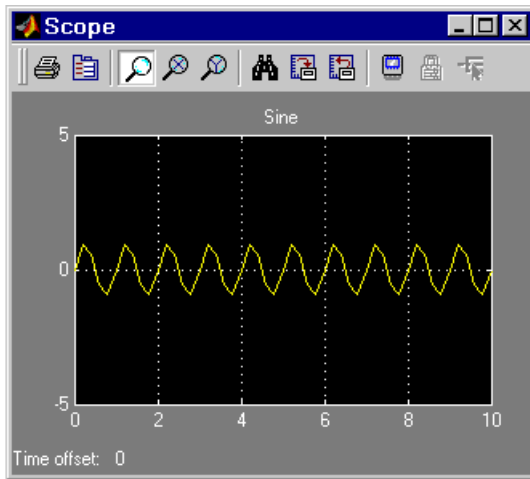
**Library** Sources

**Description**

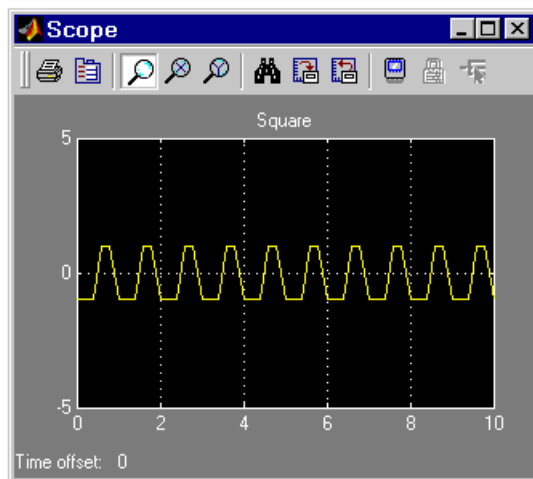


The Signal Generator block can produce one of four different waveforms: sine wave, square wave, sawtooth wave, and random wave. The signal parameters can be expressed in Hertz (the default) or radians per second. This figure shows each signal displayed on a Scope using default parameter values.

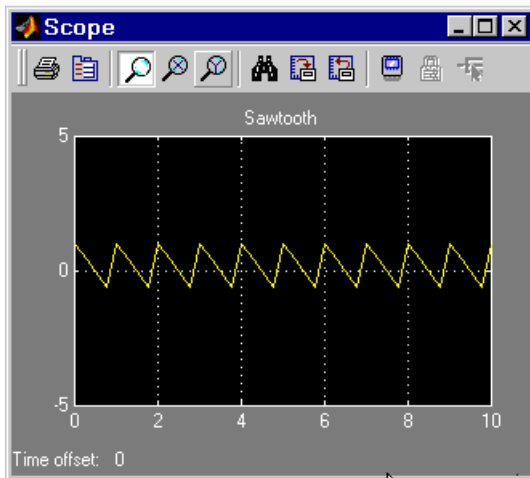
# Signal Generator



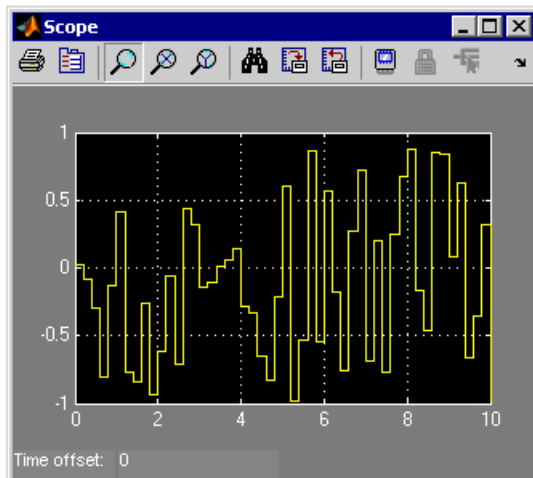
Sine Wave



Square Wave



Sawtooth Wave



Random 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.

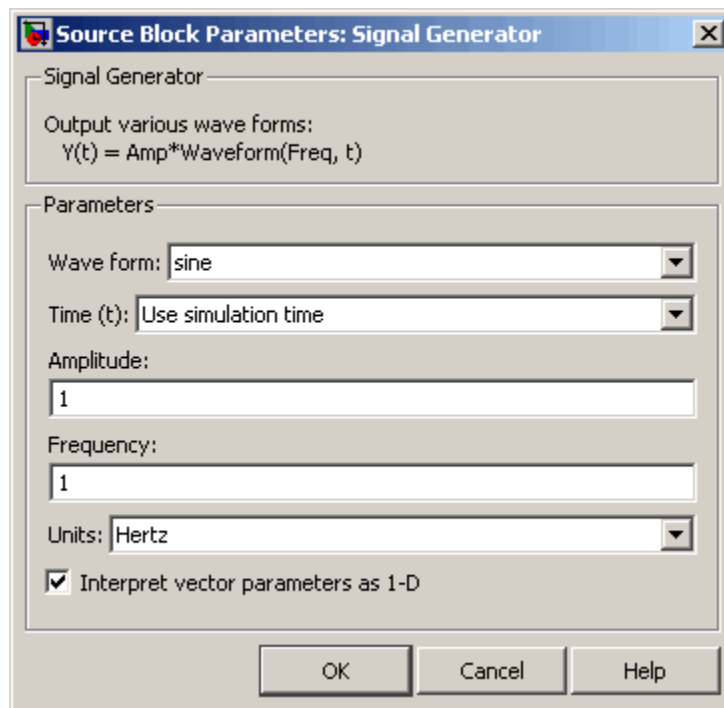
The block's **Amplitude** and **Frequency** parameters determine the amplitude and frequency of the output signal. The parameters must be of the same dimensions after scalar expansion. If the **Interpret vector parameters as 1-D** option is off, the block outputs a signal of the same dimensions as the **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.

# Signal Generator

## Parameters and Dialog Box



Opening this dialog box causes a running simulation to pause. See “Changing Source Block Parameters During Simulation” in the online Simulink documentation for details.

### Wave form

The wave form: a sine wave, square wave, sawtooth wave, or random 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 Simulink documentation). This option is not available when an external signal specifies time. In this case, if the **Amplitude** and **Frequency** parameters are column or row matrix values, the output is a 1-D vector.

## Characteristics

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

# Signal Specification

---

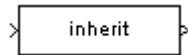
## Purpose

Specify desired dimensions, sample time, data type, numeric type, and other attributes of 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 software displays an error when it compiles the model, for example, at the beginning of a simulation. If no conflict exists, Simulink software 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.

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 software reports an appropriate error.

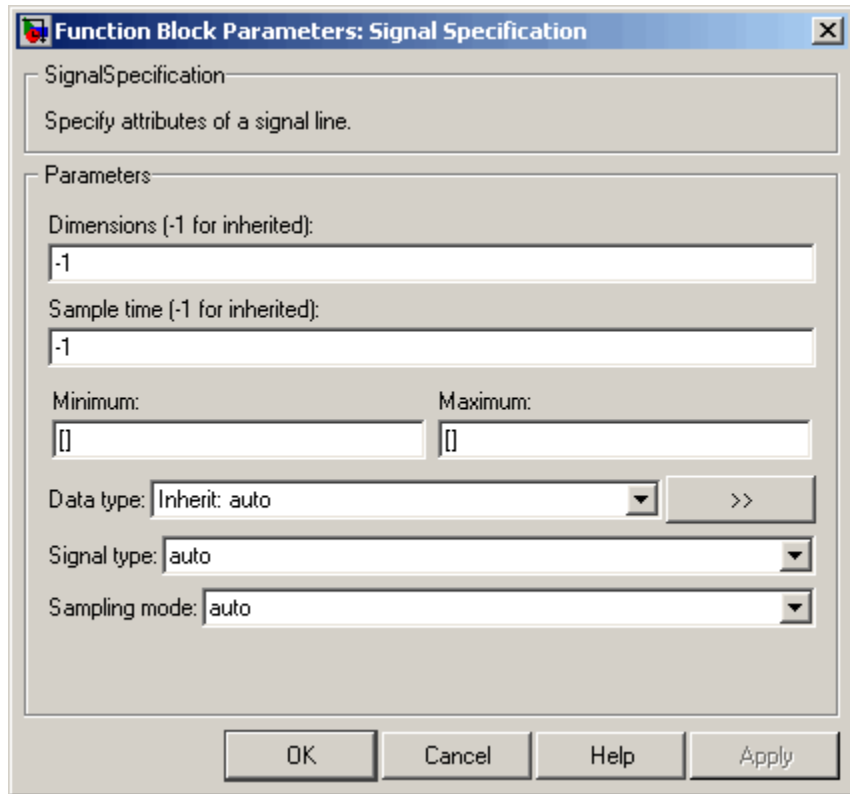
The Signal Specification block can also be used to ensure correct propagation of signal attributes throughout a model. The capability of allowing many attributes to be propagated from block to block in Simulink software is very powerful. However, because blocks may not specify some or all of the attributes 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 software 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 software, including fixed-point and enumerated data types. The input data type must match the data type specified by the **Data type** parameter.

For a discussion on the data types supported by Simulink software, 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

# Signal Specification

---

- -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 “How to Specify the Sample Time” in the online documentation for more information.

## Minimum

Specify the minimum value that the block should output. The default value, `[]`, is equivalent to `-Inf`. Simulink software uses this value to perform:

- Simulation range checking (see “Checking Signal Ranges”)
- Automatic scaling of fixed-point data types

## Maximum

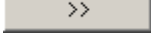
Specify the maximum value that the block should output. The default value, `[]`, is equivalent to `Inf`. Simulink software uses this value to perform:

- Simulation range checking (see “Checking Signal Ranges”)
- Automatic scaling of fixed-point data types

## Data type

Specify the output data type. You can set it to:

- A rule that inherits a data type, for example, `Inherit: auto`
- The name of a built-in data type, for example, `single`
- The name of a data type object, for example, a `Simulink.NumericType` object
- An expression that evaluates to a data type, for example, `fixdt(1,16,0)`

Click the **Show data type assistant** button  to display the **Data Type Assistant**, which helps you set the **Data type** parameter.

See “Specifying Block Output Data Types” in *Simulink User’s Guide* for more information.

## Lock output scaling against changes by the autoscaling tool

Select to lock scaling of outputs. This parameter is visible only if you enter an expression for the **Data type** parameter.

## Signal type

Specify the numeric type (`real` or `complex`) of the input and output signal. To let Simulink software 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 software determine the sampling mode, set this parameter to `auto`.

## Characteristics

Direct Feedthrough	Yes
Sample Time	Specified by the block’s <b>Sample time</b> parameter.

# Signal Specification

---

Scalar Expansion	No
Dimensionalized	Yes
Multidimensionalized	Yes
Zero Crossing	No

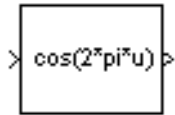
## Purpose

Implement sine and/or cosine wave in fixed point using 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.

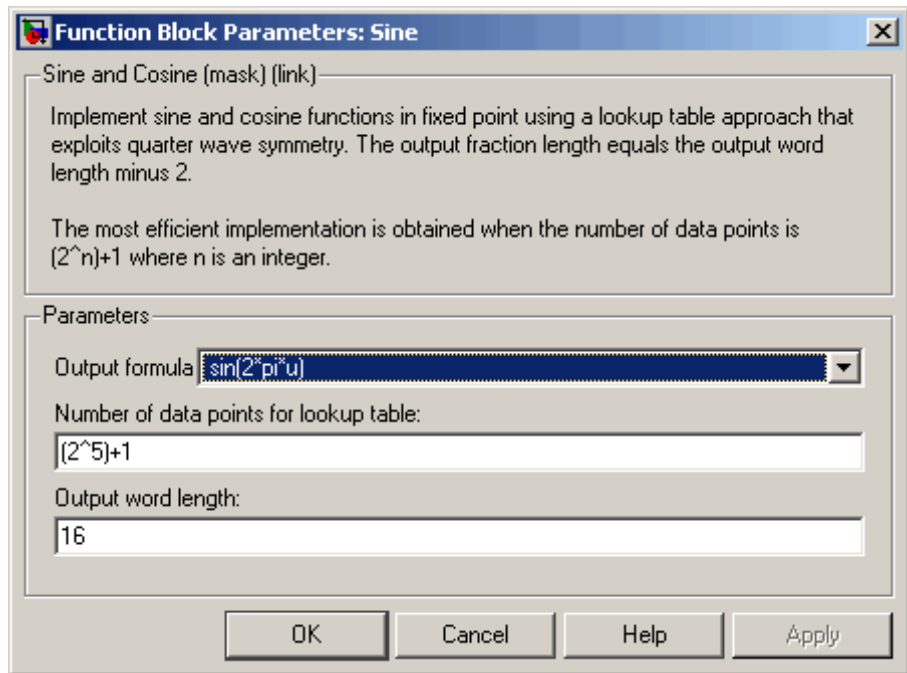
Use the **Output word length** parameter to specify the word length of the fixed-point output data type. The fraction length of the output is the output word length minus 2.

## Data Type Support

The Sine and Cosine block accepts signals of any numeric data type supported by Simulink software, including fixed-point data types. The output of the block is a fixed-point data type.

# Sine, Cosine

## 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

**See Also**

Sine Wave, Trigonometric Function

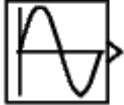
# Sine Wave

---

**Purpose** Generate 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

$$y = \textit{Amplitude} \times \sin(\textit{frequency} \times \textit{time} + \textit{phase}) + \textit{bias}$$

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 “How to Specify the 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.

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:

$$\begin{aligned}\sin(t + \Delta t) &= \sin(t) \cos(\Delta t) + \sin(\Delta t) \cos(t) \\ \cos(t + \Delta t) &= \cos(t) \cos(\Delta t) - \sin(t) \sin(\Delta t)\end{aligned}$$

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  $\Delta t$  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 software 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 software increments  $k$  and recomputes the output of the block. When  $k$  reaches  $p$ , Simulink software resets  $k$  to 0 before computing the block's output. This process continues until the end of the simulation.

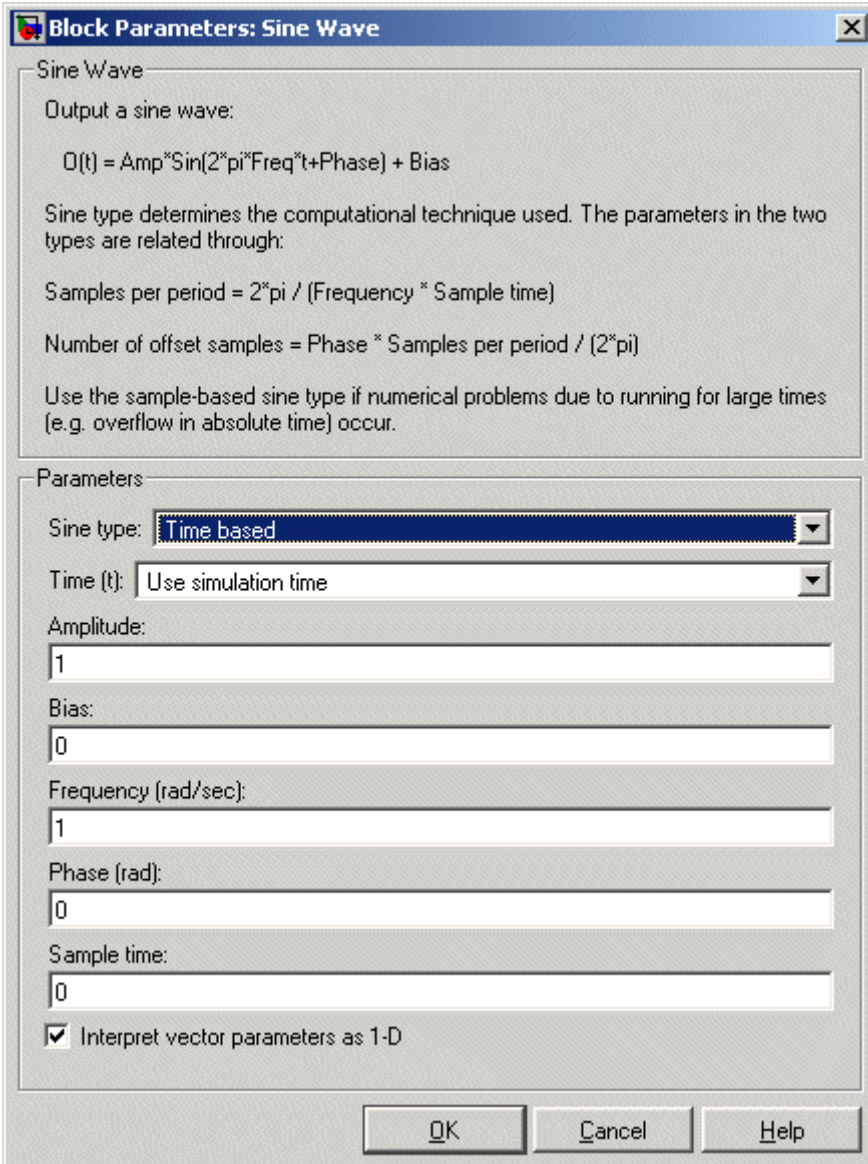
The sample-based method of computing the block's output does not depend on the result of the previous time step to compute the result at the current time step. It therefore avoids roundoff error accumulation. However, it has one potential drawback. If the block is in a conditionally executed subsystem 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.

**Parameters  
and  
Dialog  
Box**

**Block Parameters: Sine Wave**

Sine Wave

Output a sine wave:

$$O(t) = \text{Amp} \cdot \sin(2 \cdot \pi \cdot \text{Freq} \cdot t + \text{Phase}) + \text{Bias}$$

Sine type determines the computational technique used. The parameters in the two types are related through:

$$\text{Samples per period} = 2 \cdot \pi / (\text{Frequency} \cdot \text{Sample time})$$
$$\text{Number of offset samples} = \text{Phase} \cdot \text{Samples per period} / (2 \cdot \pi)$$

Use the sample-based sine type if numerical problems due to running for large times (e.g. overflow in absolute time) occur.

Parameters

Sine type: **Time based**

Time (t): **Use simulation time**

Amplitude: **1**

Bias: **0**

Frequency (rad/sec): **1**

Phase (rad): **0**

Sample time: **0**

Interpret vector parameters as 1-D

**OK** **Cancel** **Help**

# Sine Wave

---

Opening this dialog box causes a running simulation to pause. See “Changing Source Block Parameters During Simulation” 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 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 “How to Specify the 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 Simulink documentation. This option is not available when an external signal specifies time. In this case, if the block’s numeric parameters are column or row matrix values, the output is a 1-D vector.

## Characteristics

Sample Time	Specified in the <b>Sample time</b> parameter
Scalar Expansion	Yes, of parameters
Dimensionalized	Yes
Zero Crossing	No

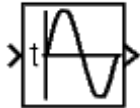
# Sine Wave Function

---

**Purpose** Generate sine wave, using external signal as 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.





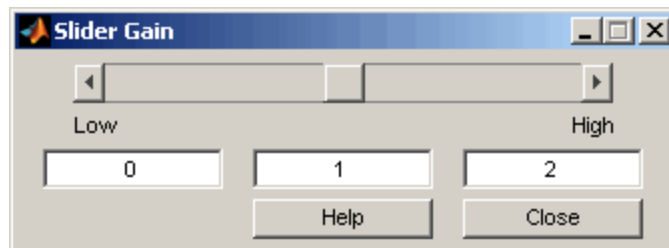
**Purpose** Vary scalar gain using slider

**Library** Math Operations

**Description** Use the Slider Gain block to vary a scalar gain during a simulation using a slider. The block accepts one input and generates one output.

**Data Type Support** Data type support for the Slider Gain block is the same as that for the 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

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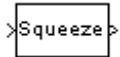
## Characteristics

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

**Purpose** Remove singleton dimensions from multidimensional signal

**Library** Math Operations

**Description**



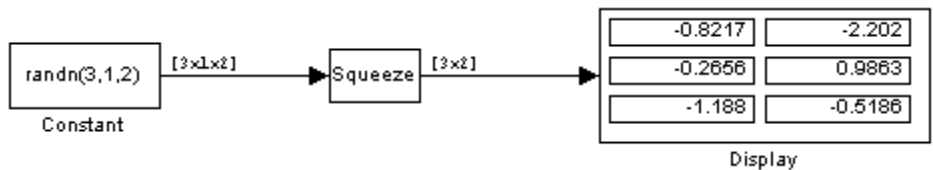
The Squeeze block removes singleton dimensions from its multidimensional input signal. A singleton dimension is any dimension whose size is one.

---

**Note** The Squeeze block operates only on signals whose number of dimensions is greater than two. Scalar, one-dimensional (vector), and two-dimensional (matrix) signals pass through the Squeeze block unchanged.

---

For example, the Squeeze block in the following diagram converts a multidimensional array of size 3-by-1-by-2 into a 3-by-2 signal.

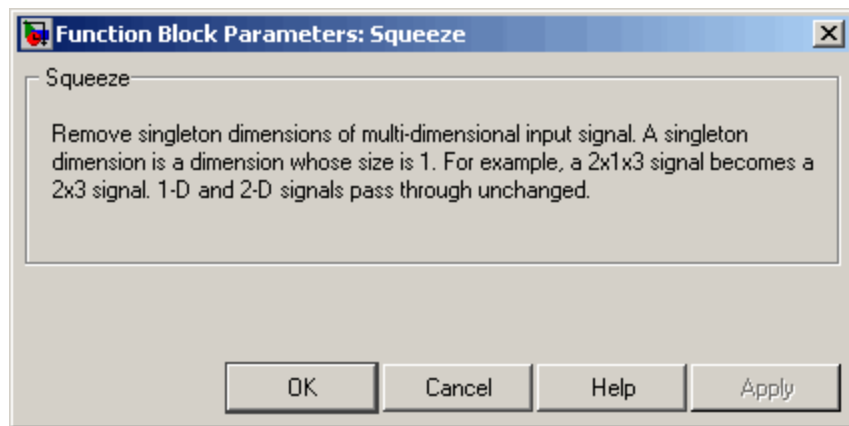


**Data Type Support**

The Squeeze block accepts input signals of any dimension and of any data type that Simulink software supports, including fixed-point and enumerated data types. For a discussion on the data types supported by Simulink software, see “Data Types Supported by Simulink”.

# Squeeze

## Parameters and Dialog Box



## Characteristics

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

## See Also

Reshape

**Purpose** Implement linear state-space system

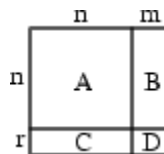
**Library** Continuous

**Description** The State-Space block implements a system whose behavior is defined by

$$\begin{array}{l} \boxed{\begin{array}{l} x' = Ax + Bu \\ y = Cx + Du \end{array}} \end{array} \quad \begin{array}{l} x = Ax + Bu \\ y = Cx + Du \end{array}$$

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 software converts a matrix containing zeros to a sparse matrix for efficient multiplication.

### Specifying the Absolute Tolerance for the Block's States

By default Simulink software uses the absolute tolerance value specified in the **Configuration Parameters** dialog box (see “Solver Pane”)

# State-Space

---

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

Function Block Parameters: State-Space

State Space

State-space model:  
 $\frac{dx}{dt} = Ax + Bu$   
 $y = Cx + Du$

Parameters

A:  
1

B:  
1

C:  
1

D:  
1

Initial conditions:  
0

Absolute tolerance:  
auto

State Name: (e.g., 'position')  
"

OK Cancel Help Apply

### A, B, C, D

The matrix coefficients.

### Initial conditions

The initial state vector. Simulink software does not allow the initial conditions of this block to be  $\text{inf}$  or  $\text{NaN}$ .

## Absolute tolerance

Absolute tolerance used to solve the block's states. You can enter `auto` or a numeric value. If you enter `auto`, Simulink software determines the absolute tolerance (see "Solver Pane"). If you enter a numeric value, Simulink software 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.

## State Name

Use this to assign a unique name to each state. The state names apply only to the selected block. If left blank, no name is assigned.

To assign a name to a single state, enter the name between quotes, for example, `'velocity'`.

To assign names to multiple states, enter a comma-delimited list surrounded by braces. For example, `{ 'a', 'b', 'c' }`. Each name must be unique.

The number of states must be evenly divided by the number of state names. There can be fewer names than the number of states, but there cannot be more names than states.

For example, you can specify two names in a system with four states. Simulink software will assign the first name to the first two states and the second name to the last two.

To assign state names with a variable that has been defined in the MATLAB workspace, enter the variable without quotes. A variable can be a string, cell, or structure.

## 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 step function

**Library** Sources

## Description



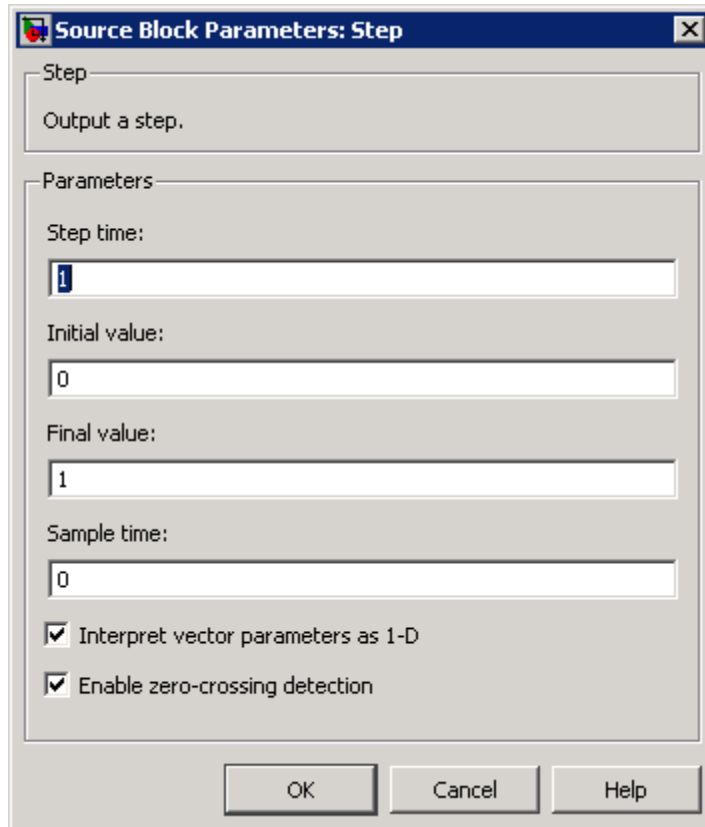
The Step block provides a step between two definable levels at a specified time. If the simulation time is less than the **Step time** parameter value, the block's output is the **Initial value** parameter value. For simulation time greater than or equal to the **Step time**, the output is the **Final 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 Support

The Step 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 During Simulation” 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.

# Step

---

## 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 “How to Specify the 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 Simulink documentation.

## Enable zero-crossing detection

Select to enable zero-crossing detection to detect step times. For more information, see “How Blocks Work with Zero-Crossing Detection” in the “How Simulink Works” chapter of the Simulink documentation.

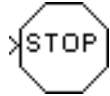
## Characteristics

Sample Time	Specified in the <b>Sample time</b> parameter
Scalar Expansion	Yes, of parameters
Dimensionalized	Yes
Zero-Crossing Detection	Yes, if enabled.

**Purpose** Stop simulation when input is nonzero

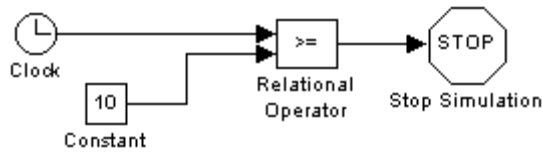
**Library** Sinks

**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.



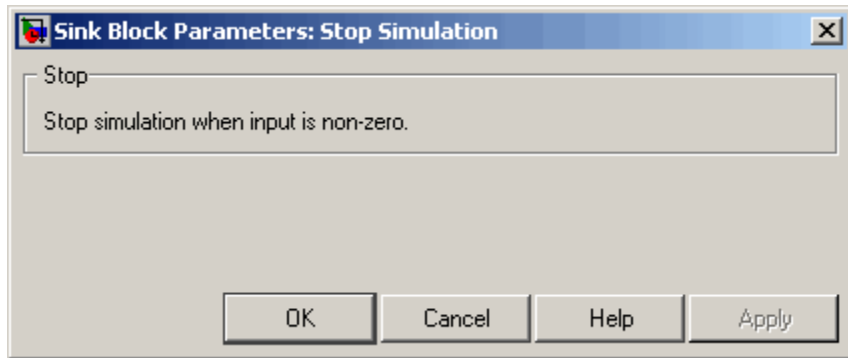
The Stop block cannot be used to pause the simulation. To create a block that pauses the simulation, see “Creating Pause Blocks” in the Simulink documentation for more information.

**Data Type Support** The Stop Simulation block accepts real signals of type double or Boolean.

# Stop Simulation

---

## Parameters and Dialog Box



## Characteristics

Sample Time	Inherited from driving block
Dimensionalized	Yes

# Subsystem, Atomic Subsystem, Nonvirtual Subsystem, CodeReuse Subsystem

---

**Purpose** Represent 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 nonvirtual subsystem. The primary difference is that nonvirtual subsystems provide the ability to control when the contents of the subsystem are evaluated. Nonvirtual subsystems are executed as a single unit (atomic execution) by the Simulink engine. A subsystem is virtual unless the block is conditionally executed and/or you have selected the block **Treat as atomic unit** check box.

---

**Note** To determine if a subsystem is virtual, use the `get_param` function to obtain the value of the `IsSubsystemVirtual` property for the block. This property returns a read-only boolean value for the block. See “Block-Specific Parameters” on page 8-96 for the subsystem block you are interested in.

---

An Atomic Subsystem block is a Subsystem block that has its **Treat as atomic unit** parameter selected by default. You can create conditionally executed nonvirtual subsystems that are executed only when a transition occurs on a triggering, function-call, action, or enabling input (see “Creating Conditional Subsystems”).

You can 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 software replaces the blocks with a Subsystem block. When you open the block, the window displays the blocks you

# Subsystem, Atomic Subsystem, Nonvirtual Subsystem, CodeReuse Subsystem

---

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" in the Simulink User's Guide for more information about subsystems.

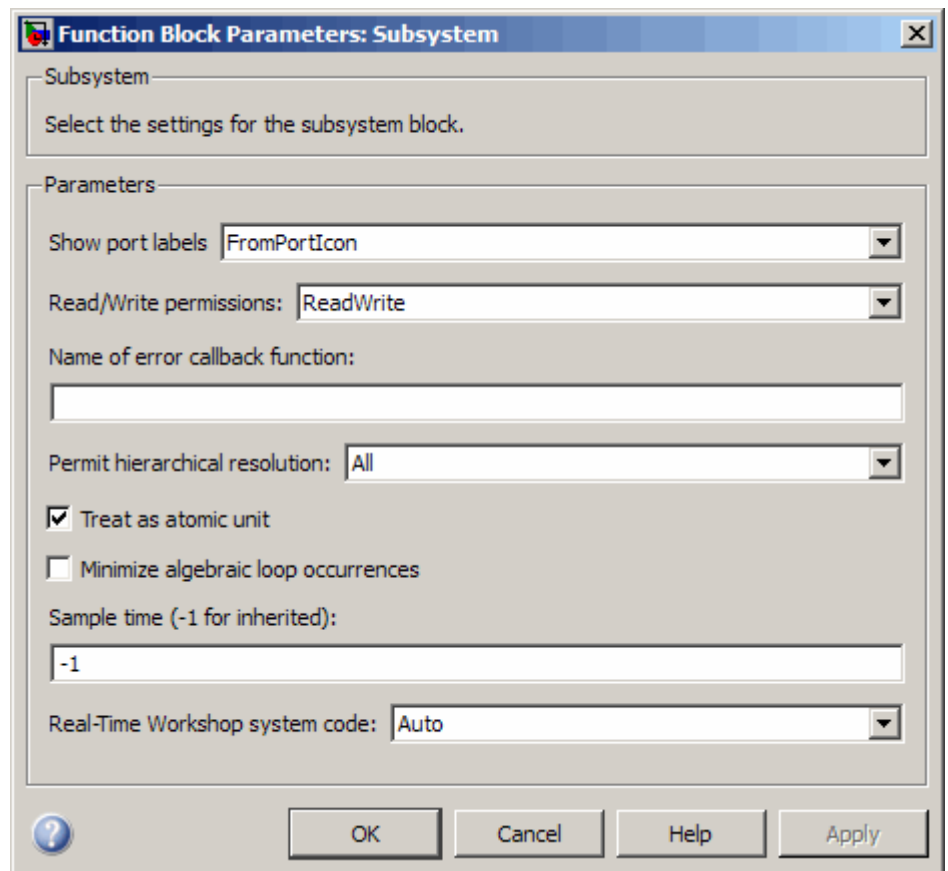
## **Data Type Support**

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, Nonvirtual Subsystem, CodeReuse Subsystem

## Parameters and Dialog Box



The dialog box, titled "Function Block Parameters: Subsystem", contains the following settings:

- Subsystem:** Select the settings for the subsystem block.
- Parameters:**
  - Show port labels:** FromPortIcon
  - Read/Write permissions:** ReadWrite
  - Name of error callback function:** (empty text field)
  - Permit hierarchical resolution:** All
  - Treat as atomic unit**
  - Minimize algebraic loop occurrences**
  - Sample time (-1 for inherited):** -1
  - Real-Time Workshop system code:** Auto

Buttons at the bottom: ? (Help), OK, Cancel, Help, Apply.

# Subsystem, Atomic Subsystem, Nonvirtual Subsystem, CodeReuse Subsystem

---

## Show port labels

Cause Simulink software to display labels for the subsystem's ports on the subsystem's icon.

### Settings

**Default:** FromPortIcon

none

Does not display port labels on the subsystem block.

FromPortIcon

If the corresponding port icon displays a signal name, display the signal name on the subsystem block. Otherwise, display the port block's name.

FromPortBlockName

Display the name of the corresponding port block on the subsystem block.

SignalName

If a name exists, display the name of the signal connected to the port on the subsystem block; otherwise, the name of the corresponding port block.

### Command-Line Information

See "Block-Specific Parameters" on page 8-96 for the command-line information.

# Subsystem, Atomic Subsystem, Nonvirtual Subsystem, CodeReuse Subsystem

---

## **Read/Write permissions**

Control user access to the contents of the subsystem.

### **Settings**

**Default:** ReadWrite

ReadWrite

Enables opening and modification of subsystem contents.

ReadOnly

Enables opening but not modification of the subsystem. If the subsystem resides in a block library, you 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

Disables opening or modification of subsystem. If the subsystem resides in a library, you can create links to the subsystem in a model but cannot open, modify, change permissions, or create local copies of the subsystem.

## **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

# Subsystem, Atomic Subsystem, Nonvirtual Subsystem, CodeReuse Subsystem

---

## **Name of error callback function**

Enter name of a function to be called if an error occurs while Simulink software is executing the subsystem.

## **Settings**

**Default:** ' '

Simulink software 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 software displays a generic error message if executing the subsystem causes an error.

## **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

# Subsystem, Atomic Subsystem, Nonvirtual Subsystem, CodeReuse Subsystem

---

## Permit hierarchical resolution

Specify whether to resolve names of workspace variables referenced by this subsystem.

### Settings

**Default:** All

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).

None

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”.

ExplicitOnly

Do not resolve any workspace variable names.

### Command-Line Information

See “Block-Specific Parameters” on page 8-96 for the command-line information.

# Subsystem, Atomic Subsystem, Nonvirtual Subsystem, CodeReuse Subsystem

---

## Treat as atomic unit

Causes Simulink software to treat the subsystem as a unit when determining the execution order of block methods.

### Settings

Default: Off



On

Cause Simulink software 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 software invokes the output methods of all the blocks in the subsystem before invoking the output methods of other blocks at the same level as the subsystem block.



Off

Cause Simulink software to treat 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.

## Dependencies

This parameter enables:

- **Minimize algebraic loop occurrences.**
- **Sample time**
- **Real-Time Workshop system code** (requires a Real-Time Workshop license)

## Command-Line Information

See “Block-Specific Parameters” on page 8-96 for the command-line information.

# Subsystem, Atomic Subsystem, Nonvirtual Subsystem, CodeReuse Subsystem

---

## Minimize algebraic loop occurrences

Try to eliminate any algebraic loops that include the subsystem.

### Settings

Default: Off



On

Try to eliminate any algebraic loops that include the subsystem.



Off

Does not try to eliminate any algebraic loops that include the subsystem.

### Dependency

This parameter is enabled by **Treat as atomic unit**.

### Command-Line Information

See “Block-Specific Parameters” on page 8-96 for the command-line information.

# Subsystem, Atomic Subsystem, Nonvirtual Subsystem, CodeReuse Subsystem

---

## **Propagate execution context across subsystem boundary**

Enable execution context propagation across this subsystem's boundary.

### **Settings**

**Default:** Off

On

Enables execution context propagation across this subsystem's boundary.

Off

Does not enable execution context propagation across this subsystem's boundary.

### **Dependency**

This parameter is enabled only if the subsystem is conditionally executed.

### **Command-Line Information**

See "Block-Specific Parameters" on page 8-96 for the command-line information.



# Subsystem, Atomic Subsystem, Nonvirtual Subsystem, CodeReuse Subsystem

---

## Warn if function-call inputs are context-specific

Simulink software 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.

### Settings

**Default:** Off



On

Simulink software 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.



Off

Simulink software does not display a warning if it has to compute any of this function-call subsystem's inputs directly or indirectly during execution of a function-call.

### Dependency

This parameter is enabled only if the subsystem is a function-call subsystem.

The option is effective only if the **Context-dependent inputs** diagnostic on the **Configuration Parameters > Connectivity** dialog box is set to `Use local settings`.

### Command-Line Information

See "Block-Specific Parameters" on page 8-96 for the command-line information.

# Subsystem, Atomic Subsystem, Nonvirtual Subsystem, CodeReuse Subsystem

---

## Sample time (-1 for inherited)

Specify whether all blocks in this subsystem must run at the same rate or can run at different rates.

### Settings

Default: -1

- -1

Specify the inherited sample time. Use this sample time if the blocks in the subsystem can run at different rates.

- `inf`

Specify constant sample time

- `[Ts 0]`

Specify periodic sample time.

### Tips

- 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 software 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 software displays an error when you update or simulate the model.

### Dependencies

This parameter is enabled by **Treat as atomic unit**.

# Subsystem, Atomic Subsystem, Nonvirtual Subsystem, CodeReuse Subsystem

---

## **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

# Subsystem, Atomic Subsystem, Nonvirtual Subsystem, CodeReuse Subsystem

---

## Real-Time Workshop system code

Specify the code format to be generated for an atomic (nonvirtual) subsystem.

### Settings

**Default:** Auto

#### Auto

Real-Time Workshop software chooses the optimal format for you based on the type and number of instances of the subsystem that exist in the model.

#### Inline

Real-Time Workshop software inlines the subsystem unconditionally.

#### Function

Real-Time Workshop software generates a separate, non-reentrant function with no arguments, and optionally place the subsystem code in a separate file.

#### Reusable function

Real-Time Workshop software generates a function with arguments that allows the subsystem's code to be shared by other instances of it in the model.

### Tip

If you select `Reusable function` while your generated code is under source control, set **Real-Time Workshop file name options** to `Use subsystem name`, `Use function name`, or `User specified`. Otherwise, the names of your code files change whenever you modify your model, which prevents source control on your files.

### Dependencies

- Real-Time Workshop license required
- This parameter is enabled by **Treat as atomic unit**.
- Setting this parameter to `Function` or `Reusable function` enables the following parameters:

# Subsystem, Atomic Subsystem, Nonvirtual Subsystem, CodeReuse Subsystem

---

- **Real-Time Workshop function name options**
- **Real-Time Workshop file name options**
- **Function with separate data** (requires a Real-Time Workshop Embedded Coder license and an ERT-based system target file)
- **Memory section for initialize/terminate functions** (requires a Real-Time Workshop Embedded Coder license and an ERT-based system target file)
- **Memory section for execution functions** (requires a Real-Time Workshop Embedded Coder license and an ERT-based system target file)

## **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

# Subsystem, Atomic Subsystem, Nonvirtual Subsystem, CodeReuse Subsystem

---

## Real-Time Workshop function name options

Specify how Real-Time Workshop software is to name the function it generates for the subsystem.

### Settings

**Default:** Auto

Auto

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).

Use subsystem name

Use the subsystem name as the function name.

User specified

Assign a unique, valid C or C++ function name that you specify.

### Tip

If you specify **Use subsystem name** and the subsystem is a library block, Real-Time Workshop software names the function (and filename) with the name of the library block, regardless of the names used for that subsystem in the model.

### Dependencies

- Real-Time Workshop license required
- Selecting **User specified** enables the **Real-Time Workshop function name option** parameter.
- This parameter is enabled by **Treat as atomic unit**.

### Command-Line Information

See “Block-Specific Parameters” on page 8-96 for the command-line information.

# Subsystem, Atomic Subsystem, Nonvirtual Subsystem, CodeReuse Subsystem

---

## **Real-Time Workshop function name**

Specify a unique, valid C or C++ function name for subsystem code.

### **Settings**

**Default:** ' '

Use this parameter if you want to give the function a specific name instead of allowing the Real-Time Workshop code generator to assign its own autogenerated name or use the subsystem name.

### **Dependencies**

This parameter is enabled by setting **Real-Time Workshop function name options** to `User specified`.

### **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

# Subsystem, Atomic Subsystem, Nonvirtual Subsystem, CodeReuse Subsystem

---

## Real-Time Workshop file name options

Specify how Real-Time Workshop software is to name the separate file for the function it generates for the subsystem.

### Settings

**Default:** Auto

Auto

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`

Use subsystem name

Generate a separate file and name it with the name of the subsystem or library block

Use function name

Generate a separate file and name it with the function name you specify for **Real-Time Workshop function name options**

User specified

Assign a unique, valid C or C++ function name that you specify

### Tip

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.

### Dependencies

- Real-Time Workshop license required
- Setting this parameter to `User specified` enables the **Real-Time Workshop filename (no extension)** parameter.

### Command-Line Information

See "Block-Specific Parameters" on page 8-96 for the command-line information.



# Subsystem, Atomic Subsystem, Nonvirtual Subsystem, CodeReuse Subsystem

---

## **Real-Time Workshop file name (no extension)**

Specify how Real-Time Workshop software is to name the file for the function it generates for the subsystem.

### **Settings**

**Default:** ' '

- 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`).

### **Dependencies**

- Real-Time Workshop license required
- This parameter is enabled by setting **Real-Time Workshop file name options** to `User specified`.

### **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

# Subsystem, Atomic Subsystem, Nonvirtual Subsystem, CodeReuse Subsystem

---

## Function with separate data

Generate subsystem function code in which the internal data for an atomic subsystem is separated from its parent model and is owned by the subsystem.

### Settings

**Default:** Off



Generate 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.



Do not generate subsystem function code in which the internal data for an atomic subsystem is separated from its parent model and is owned by the subsystem.

### Dependencies

- Requires a Real-Time Workshop Embedded Coder license and an ERT-based system target file.
- This parameter is enabled by setting **Real-Time Workshop system code** to **Function**.
- Selecting this check box enables **Memory section for constants**, **Memory section for internal data**, and **Memory section for parameters**.

### Command-Line Information

See “Block-Specific Parameters” on page 8-96 for the command-line information.

# Subsystem, Atomic Subsystem, Nonvirtual Subsystem, CodeReuse Subsystem

---

## Memory section for initialize/terminate functions

Indicate how the Real-Time Workshop Embedded Coder software is to apply memory sections to the subsystem's initialization and termination functions.

### Settings

**Default:** Inherit from model

Inherit from model

Apply the root model's memory sections to the subsystem's function code

Default

Not apply memory sections to the subsystem's system code, overriding any model-level specification

The memory section of interest

Apply one of the model's memory sections to the subsystem

### Tips

- The possible values vary depending on what (if any) package of memory sections you have set for the model's configuration. See "Memory Sections", "Configuring Memory Sections", and "Real-Time Workshop Pane: Memory Sections" 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.
- These options can be useful for overriding the model's memory section settings for the given subsystem.

### Dependencies

- Requires a Real-Time Workshop Embedded Coder license and an ERT-based system target file.
- This parameter is enabled by setting **Real-Time Workshop system code** to `Function`.

# Subsystem, Atomic Subsystem, Nonvirtual Subsystem, CodeReuse Subsystem

---

## **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

# Subsystem, Atomic Subsystem, Nonvirtual Subsystem, CodeReuse Subsystem

---

## Memory section for execution functions

Indicate how the Real-Time Workshop Embedded Coder software is to apply memory sections to the subsystem's execution functions.

### Settings

**Default:** `Inherit from model`

`Inherit from model`

Apply the root model's memory sections to the subsystem's function code

`Default`

Not apply memory sections to the subsystem's system code, overriding any model-level specification

The memory section of interest

Apply one of the model's memory sections to the subsystem

### Tips

- The possible values vary depending on what (if any) package of memory sections you have set for the model's configuration. See "Memory Sections", "Configuring Memory Sections", and "Real-Time Workshop Pane: Memory Sections" 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.
- These options can be useful for overriding the model's memory section settings for the given subsystem.

### Dependencies

- Requires a Real-Time Workshop Embedded Coder license and an ERT-based system target file.
- This parameter is enabled by setting **Real-Time Workshop system code** to `Function`.

# Subsystem, Atomic Subsystem, Nonvirtual Subsystem, CodeReuse Subsystem

---

## **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

# Subsystem, Atomic Subsystem, Nonvirtual Subsystem, CodeReuse Subsystem

---

## Memory section for constants

Indicate how the Real-Time Workshop Embedded Coder software is to apply memory sections to the subsystem's data.

### Settings

**Default:** `Inherit from model`

`Inherit from model`

Apply the root model's memory sections to the subsystem's data

`Default`

Not apply memory sections to the subsystem's data, overriding any model-level specification

The memory section of interest

Apply one of the model's memory sections to the subsystem

### Tips

- Can be useful for overriding the model's memory section settings for the given subsystem.
- The possible values vary depending on what (if any) package of memory sections you have set for the model's configuration. See "Configuring Memory Sections" in the Real-Time Workshop Embedded Coder User's Guide.
- 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.

### Dependencies

- Requires a Real-Time Workshop Embedded Coder license and an ERT-based system target file.
- This parameter is enabled by setting **Real-Time Workshop system code** to **Function** and by selecting the **Function with separate data** check box.

# Subsystem, Atomic Subsystem, Nonvirtual Subsystem, CodeReuse Subsystem

---

## **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.



# Subsystem, Atomic Subsystem, Nonvirtual Subsystem, CodeReuse Subsystem

---

## Memory section for internal data

Indicate how the Real-Time Workshop Embedded Coder software is to apply memory sections to the subsystem's data.

### Settings

**Default:** `Inherit from model`

`Inherit from model`

Apply the root model's memory sections to the subsystem's data

`Default`

Not apply memory sections to the subsystem's data, overriding any model-level specification

The memory section of interest

Apply one of the model's memory sections to the subsystem

### Tips

- Can be useful for overriding the model's memory section settings for the given subsystem.
- The possible values vary depending on what (if any) package of memory sections you have set for the model's configuration. See "Configuring Memory Sections" in the Real-Time Workshop Embedded Coder User's Guide.
- 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.

### Dependencies

- Requires a Real-Time Workshop Embedded Coder license and an ERT-based system target file.
- This parameter is enabled by setting **Real-Time Workshop system code** to **Function** and by selecting the **Function with separate data** check box.

# Subsystem, Atomic Subsystem, Nonvirtual Subsystem, CodeReuse Subsystem

---

## **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

# Subsystem, Atomic Subsystem, Nonvirtual Subsystem, CodeReuse Subsystem

---

## Memory section for parameters

Indicate how the Real-Time Workshop Embedded Coder software is to apply memory sections to the subsystem's data.

### Settings

**Default:** `Inherit from model`

`Inherit from model`

Apply the root model's memory sections to the subsystem's function code

`Default`

Not apply memory sections to the subsystem's system code, overriding any model-level specification

The memory section of interest

Apply one of the model's memory sections to the subsystem

### Tips

- Can be useful for overriding the model's memory section settings for the given subsystem.
- The possible values vary depending on what (if any) package of memory sections you have set for the model's configuration. See "Configuring Memory Sections" in the Real-Time Workshop Embedded Coder User's Guide.
- 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.

### Dependencies

- Requires a Real-Time Workshop Embedded Coder license and an ERT-based system target file.
- This parameter is enabled by setting **Real-Time Workshop system code** to **Function** and by selecting the **Function with separate data** check box.

# Subsystem, Atomic Subsystem, Nonvirtual Subsystem, CodeReuse Subsystem

---

## Command-Line Information

See “Block-Specific Parameters” on page 8-96 for the command-line information.

## Characteristics

Sample Time	Depends on the blocks in the subsystem
Dimensionalized	Depends on the blocks in the subsystem
Multidimensionalized	Depends on the blocks in the subsystem
Zero Crossing	Yes, for enable and trigger ports if present

# Sum, Add, Subtract, Sum of Elements

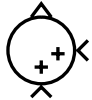
## Purpose

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 signal.

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.
- For a round Sum block, the first input port is the port closest to the 12 o’clock position going in a counterclockwise direction around the block. Similarly, other input ports appear in counterclockwise order around the block.
- 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 input port is required, a single “+” or “-” collapses the element via the specified operation.

The Sum block first converts the input data type(s) to its accumulator data type, then performs the specified operations. The block converts the result to its output data type using the specified rounding and overflow modes.

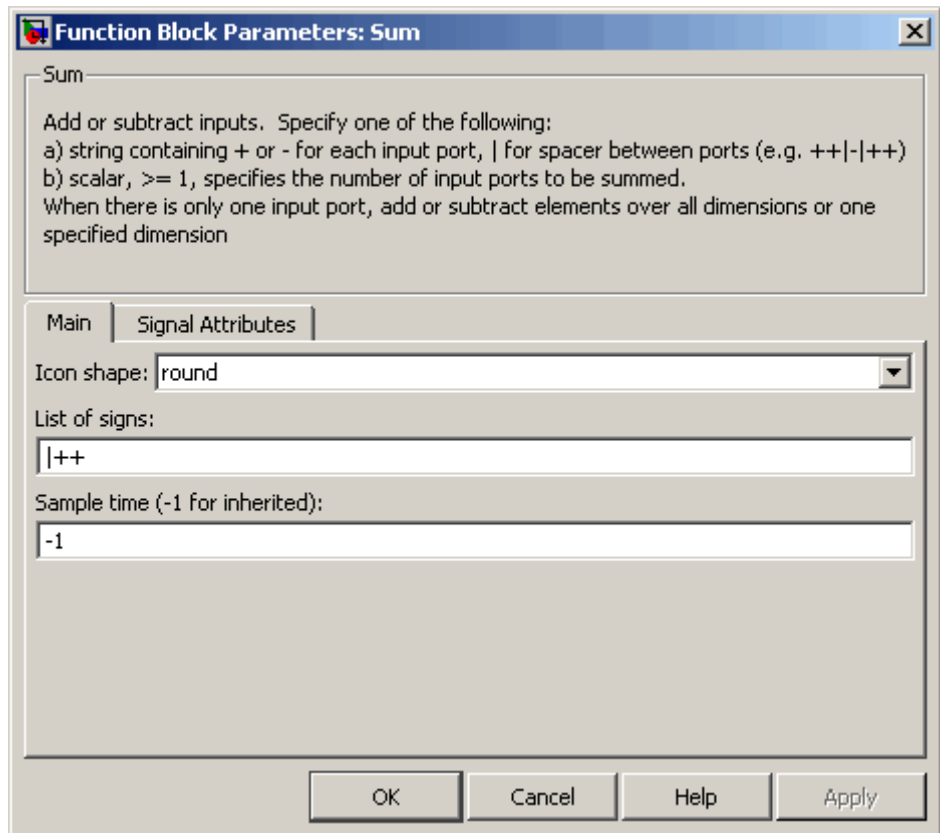
# Sum, Add, Subtract, Sum of Elements

## Data Type Support

The Sum block accepts real or complex signals of any numeric data type supported by Simulink software, including fixed-point data types. The inputs may be of different data types unless you select the **Require all inputs to have the same data type** parameter.

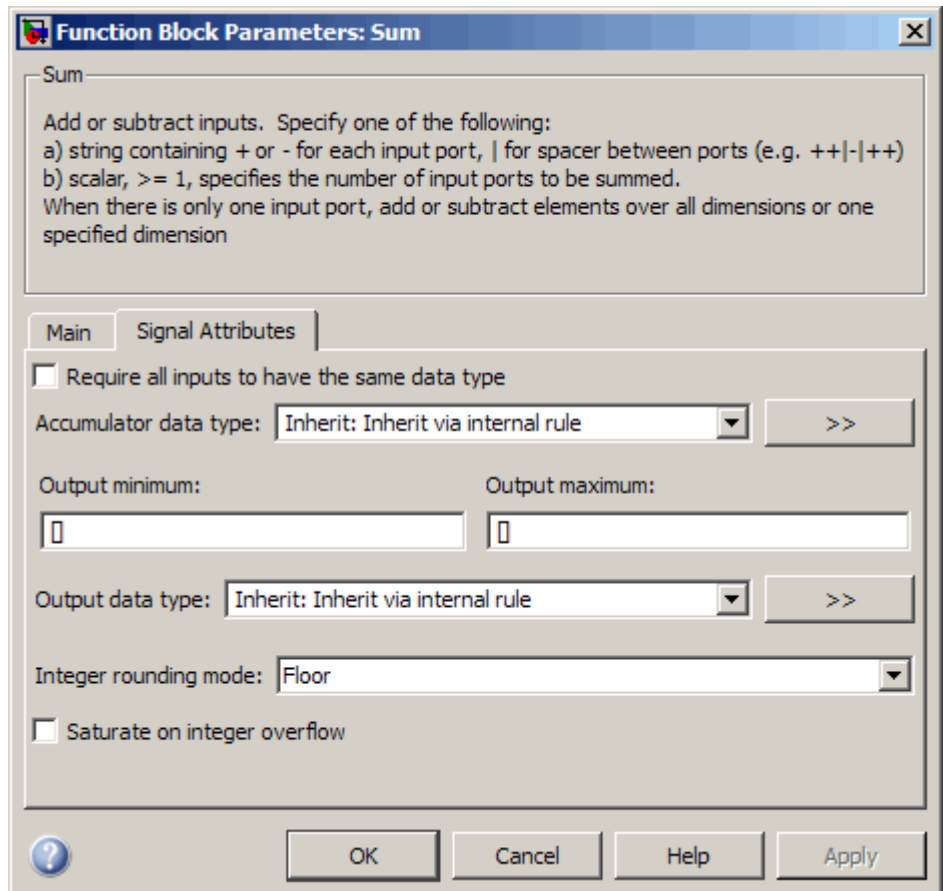
## Parameters and Dialog Box

The **Main** pane of the Sum block dialog box appears as follows:



The **Signal Attributes** pane of the Sum block dialog box appears as follows:

# Sum, Add, Subtract, Sum of Elements



# Sum, Add, Subtract, Sum of Elements

---

## **Show data type assistant**

Display the **Data Type Assistant**.

## **Settings**

The **Data Type Assistant** helps you set the **Output data type** parameter.

See “Specifying Block Output Data Types” in *Simulink User’s Guide* for more information.

## **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.



## **Icon shape**

Designate the icon shape of the block.

## **Settings**

**Default:** round

rectangular

Designate the icon shape of the block as rectangular.

round

Designate the icon shape of the block as round.

## **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

# Sum, Add, Subtract, Sum of Elements

---

## List of signs

Enter plus (+) and minus (-) characters.

## Settings

**Default:** |++

- 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.
- Enter as many plus (+) and minus (-) characters as there are inputs.

## Tips

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.

## Dependencies

Entering only one element enables the **Sum over** parameter.

## Command-Line Information

See “Block-Specific Parameters” on page 8-96 for the command-line information.

## **Sum over**

Select dimension over which to perform the sum over operation.

### **Settings**

**Default:** All dimensions

All dimensions

Sum all input elements, yielding a scalar.

Specified dimension

Display the **Dimension** parameter, where you specify the dimension over which to perform the operation.

### **Dependencies**

Selecting Specified dimension enables the **Dimension** parameter.

This parameter is enabled by **List of signs** when that parameter has only one element.

### **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

# Sum, Add, Subtract, Sum of Elements

---

## Dimension

Specify the dimension over which to perform the operation.

## Settings

**Default:** 1

The block follows the same summation rules as the MATLAB `sum` function.

Suppose that you have a 2-by-3 matrix  $U$ .

- Setting **Dimension** to 1 results in the output  $Y$  being computed as:

$$Y = \sum_{i=1}^2 U(i, j)$$

- Setting **Dimension** to 2 results in the output  $Y$  being computed as:

$$Y = \sum_{j=1}^3 U(i, j)$$

If the specified dimension is greater than the dimension of the input, an error message appears.

## Dependencies

This parameter is enabled by setting **Sum over** to Specified dimension.

## Command-Line Information

See “Block-Specific Parameters” on page 8-96 for the command-line information.

## **Sample time (-1 for inherited)**

Enter the discrete interval between sample time hits or specify another appropriate sample time such as continuous or inherited.

### **Settings**

**Default:** -1

By default, the block inherits its sample time based upon the context of the block within the model. To set a different sample time, enter a valid sample time based upon the table in “Types of Sample Time”.

See also “How to Specify the Sample Time” in the online documentation for more information.

### **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

# Sum, Add, Subtract, Sum of Elements

---

## **Require all inputs to have the same data type**

Require that all inputs have the same data type.

### **Settings**

**Default:** Off



On

Require that all inputs have the same data type.



Off

Do not require that all inputs have the same data type.

### **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

## Lock scaling against changes by the autoscaling tool

Select to lock scaling of outputs.

### Settings

Default: Off

On

Lock scaling of outputs.

Off

Do not lock scaling of outputs.

### Dependencies

This parameter is enabled when you enter an expression for the **Output data type** or **Data type** parameter.

### Command-Line Information

See “Block-Specific Parameters” on page 8-96 for the command-line information.

# Sum, Add, Subtract, Sum of Elements

---

## Integer rounding mode

Select the rounding mode for fixed-point operations.

### Settings

**Default:** Floor

#### Ceiling

Round both positive and negative numbers toward positive infinity.

#### Convergent

Round number to the nearest representable value. In the case of a tie, round to the nearest even stored value.

#### Floor

Round both positive and negative numbers toward negative infinity.

#### Nearest

Round number to the nearest representable value. In the case of a tie, round toward positive infinity.

#### Round

Round number to the nearest representable value. In the case of a tie, round positive numbers toward positive infinity and round negative numbers toward negative infinity.

#### Simplest

This option provides for an optimization of the rounding code for several blocks.

#### Zero

Round number toward zero.

## Command-Line Information

See “Block-Specific Parameters” on page 8-96 for the command-line information.

### See Also

For more information, see “Rounding” in the *Simulink Fixed Point User’s Guide*.



## Saturate on integer overflow

Specify whether overflows saturate.

### Settings

**Default:** Off

On  
Overflows saturate.

Off  
Overflows do not saturate.

### Tips

- When you select this check box, saturation applies to every internal operation on the block, not just the output or result.
- In general, the code generation process can detect when overflow is not possible, in which case, no saturation code is generated.

### Command-Line Information

See “Block-Specific Parameters” on page 8-96 for the command-line information.

# Sum, Add, Subtract, Sum of Elements

---

## Accumulator data type

Specify the accumulator data type.

### Settings

**Default:** `Inherit: Inherit via internal rule`

`Inherit: Inherit via internal rule`

Use internal rule to determine accumulator data type.

`Inherit: Same as first input`

Use data type of first input signal.

`double`

Accumulator data type is double.

`single`

Accumulator data type is single.

`int8`

Accumulator data type is int8.

`uint8`

Accumulator data type is uint8.

`int16`

Accumulator data type is int16.

`uint16`

Accumulator data type is uint16.

`int32`

Accumulator data type is int32.

`uint32`

Accumulator data type is uint32.

`fixdt(1,16,0)`

Accumulator data type is fixed point `fixdt(1,16,0)`.

`fixdt(1,16,2^0,0)`

Accumulator data type is fixed point `fixdt(1,16,2^0,0)`.

# Sum, Add, Subtract, Sum of Elements

---

<data type expression>

The name of a data type object, for example  
Simulink.NumericType

## **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

## **See Also**

See “Using the Data Type Assistant” in the *Simulink User’s Guide* for more information.

# Sum, Add, Subtract, Sum of Elements

---

## **Mode**

Select the category of accumulator data to specify

## **Settings**

**Default:** Inherit

### Inherit

Inheritance rules for data types. Selecting **Inherit** enables a second menu/text box to the right. Below are the possible values, which can vary by block:

- Inherit via internal rule
- Same as first input

### Built in

Built-in data types. Selecting **Built in** enables a second menu/text box to the right. Below are the possible values, which can vary by block:

- double
- single
- int8
- uint8
- int16
- uint16
- int32
- uint32

### Fixed point

Fixed-point data types.

### Enumerated

Enumerated data types. This option is available on some blocks.

## Expression

Expressions that evaluate to data types. Selecting Expression enables a second menu/text to the right. Below are the possible values, which can vary by block:

- <data type expression>

## Dependency

This parameter is enabled by the **Show data type assistant** button for the accumulator data type.

## Command-Line Information

See “Block-Specific Parameters” on page 8-96 for the command-line information.

## See Also

See “Using the Data Type Assistant” in the *Simulink User’s Guide*.

# Sum, Add, Subtract, Sum of Elements

---

## **Signedness**

Specify whether you want the fixed-point data to be signed or unsigned.

### **Settings**

**Default:** Signed

Signed

Specify the fixed-point data to be signed.

Unsigned

Specify the fixed-point data to be unsigned.

### **Dependencies**

This parameter is enabled by selecting **Mode** > Fixed point for the accumulator data type.

### **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

### **See Also**

See “Specifying a Fixed-Point Data Type” in the *Simulink User’s Guide* for more information.

## Word length

Specify the bit size of the word that will hold the quantized integer.

### Settings

**Default:** 16

**Minimum:** 0

**Maximum:** 32

Large word sizes represent large values with greater precision than small word sizes.

### Dependencies

This parameter is enabled by selecting **Mode** > **Fixed point** for the accumulator data type.

### Command-Line Information

See “Block-Specific Parameters” on page 8-96 for the command-line information.

### See Also

See “Specifying a Fixed-Point Data Type” in the *Simulink User’s Guide* for more information.

# Sum, Add, Subtract, Sum of Elements

---

## Scaling

Specify the method for scaling your fixed-point data to avoid overflow conditions and minimize quantization errors.

## Settings

**Default:** Best precision or Binary point

Binary point

Specify binary point location.

Slope and bias

Enter slope and bias.

Best precision

Specify best-precision values. This option appears for some blocks.

## Dependencies

This parameter is enabled by selecting **Mode** > Fixed point for the accumulator data type.

Selecting Binary point enables:

- **Fraction length**

Selecting Slope and bias enables:

- **Slope**
- **Bias**

## Command-Line Information

See “Block-Specific Parameters” on page 8-96 for the command-line information.

## See Also

See “Specifying a Fixed-Point Data Type” in the *Simulink User’s Guide* for more information.



## **Fraction length**

Specify fraction length for fixed-point data type.

### **Settings**

**Default:** 0

Binary points can be positive or negative integers.

### **Dependencies**

This parameter is enabled by selecting **Scaling** > Binary point for the accumulator data type.

### **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

### **See Also**

See “Specifying a Fixed-Point Data Type” in the *Simulink User’s Guide* for more information.

# Sum, Add, Subtract, Sum of Elements

---

## **Slope**

Specify slope for the fixed-point data type.

## **Settings**

**Default:** 2<sup>0</sup>

Specify any positive real number.

## **Dependencies**

This parameter is enabled by selecting **Scaling** > Slope and bias for the accumulator data type.

## **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

## **See Also**

See “Specifying a Fixed-Point Data Type” in the *Simulink User’s Guide* for more information.

## **Bias**

Specify bias for the fixed-point data type.

## **Settings**

**Default:** 0

Specify any real number.

## **Dependencies**

This parameter is enabled by selecting **Scaling** > Slope and bias for the accumulator data type.

## **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

## **See Also**

See “Specifying a Fixed-Point Data Type” in the *Simulink User’s Guide* for more information.

# Sum, Add, Subtract, Sum of Elements

---

## **Output minimum**

Specify the minimum value that the block should output.

## **Settings**

**Default:** []

The default value, [], is equivalent to `-Inf`.

Simulink software uses this value to perform:

- Parameter range checking (see “Checking Parameter Values”) for some blocks
- Simulation range checking (see “Checking Signal Ranges”)
- Automatic scaling of fixed-point data types

## **Tip**

This number must be a double scalar value.

## **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

## **Output maximum**

Specify the maximum value that the block should output.

### **Settings**

**Default:** []

The default value, [], is equivalent to Inf.

Simulink software uses this value to perform:

- Parameter range checking (see “Checking Parameter Values”) for some blocks
- Simulation range checking (see “Checking Signal Ranges”)
- Automatic scaling of fixed-point data types

### **Tip**

This number must be a double scalar value.

### **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

# Sum, Add, Subtract, Sum of Elements

---

## Output data type

Specify the output data type.

### Settings

**Default:** Inherit: Inherit via internal rule (Discrete-Time Integrator, Gain, Product, Sum, Switch block), Inherit: Inherit from 'Constant value' (Constant block default), Inherit: Inherit via back propagation (Data Type Conversion block), Inherit: Same as input (Saturation block)

Inherit: Inherit via internal rule

This option appears for some blocks. Simulink software chooses a combination of output scaling and data type that requires the smallest amount of memory consistent with accommodating the calculated 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 software chooses the output data type without regard to hardware constraints. Otherwise, Simulink software 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 `sfixed24`. 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 software displays an error message in the Simulation Diagnostics Viewer.

Inherit: Inherit from 'Constant value'

Use data type of **Constant value** parameter. This option appears for some blocks.

Inherit: Inherit via back propagation

A rule that inherits a data type

# Sum, Add, Subtract, Sum of Elements

---

Inherit: Same as input

Use data type of sole input signal. This option appears for some blocks.

Inherit: Same as first input

Use data type of first input signal. This option appears for some blocks.

Inherit: Same as accumulator

Output data type same as accumulator data type. This option appears for some blocks.

double

Output data type is double.

single

Output data type is single.

int8

Output data type is int8.

uint8

Output data type is uint8.

int16

Output data type is int16.

uint16

Output data type is uint16.

int32

Output data type is int32.

uint32

Output data type is uint32.

fixdt(1,16,0)

Output data type is fixed point fixdt(1,16,0).

fixdt(1,16,2<sup>0</sup>,0)

Output data type is fixed point fixdt(1,16,2<sup>0</sup>,0).

# Sum, Add, Subtract, Sum of Elements

---

<data type expression>

The name of a data type object, for example  
Simulink.NumericType

## **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

## **See Also**

See “Specifying Block Output Data Types” in the *Simulink User’s Guide* for more information.



## Mode

Select the category of data to specify

## Settings

**Default:** Inherit (Constant, Data Type Conversion, Discrete Time Integrator, Gain, Inport, Outport, Product, Saturation, Sum, Switch),  
**Built in** (Logical Operator, Relational Operator)

### Inherit

Inheritance rules for data types. Selecting **Inherit** enables a second menu/text box to the right. Below are the possible values, which can vary by block:

- Inherit from 'Constant value' (Constant block default)
- Inherit via internal rule (Discrete-Time Integrator, Gain, Product, Sum, Switch block default)
- Inherit via back propagation (Data Type Conversion block default)
- auto (Inport, Outport block default)
- Logical (see Configuration Parameters: Optimization)
- Same as first input
- Same as input (Saturation block default)
- Same as accumulator

### Built in

Built-in data types. Selecting **Built in** enables a second menu/text box to the right. Below are the possible values, which can vary by block:

- double (Constant, Data Type Conversion, Discrete-Time Integrator, Gain, Inport, Outport, Product, Saturation, Sum, Switch block default)
- single

# Sum, Add, Subtract, Sum of Elements

---

- int8
- uint8
- int16
- uint16
- int32
- uint32
- boolean (Logical Operator, Relational Operator block default)

## Fixed point

Fixed-point data types.

## Enumerated

Enumerated data types. This option is available on some blocks. Selecting Enumerated enables a second menu/text box to the right. Below are the possible values, which can vary by block:

- <class name>

## Expression

Expressions that evaluate to data types. Selecting Expression enables a second menu/text box to the right. Below are the possible values, which can vary by block:

- <data type expression>

## Dependency

This parameter is enabled by the **Show data type assistant** button.

## Command-Line Information

See “Block-Specific Parameters” on page 8-96 for the command-line information.

## See Also

See “Using the Data Type Assistant” in the *Simulink User’s Guide*.

## **Signedness**

Specify whether you want the fixed-point data to be signed or unsigned.

### **Settings**

**Default:** Signed

Signed

Specify the fixed-point data to be signed.

Unsigned

Specify the fixed-point data to be unsigned.

### **Dependencies**

This parameter is enabled by selecting **Mode** > Fixed point.

### **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

### **See Also**

See “Specifying a Fixed-Point Data Type” in the *Simulink User’s Guide* for more information.

# Sum, Add, Subtract, Sum of Elements

---

## **Word length**

Specify the bit size of the word that will hold the quantized integer.

### **Settings**

**Default:** 16

**Minimum:** 0

**Maximum:** 32

Large word sizes represent large values with greater precision than small word sizes.

### **Dependencies**

This parameter is enabled by selecting **Mode** > Fixed point.

### **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

### **See Also**

See “Specifying a Fixed-Point Data Type” in the *Simulink User’s Guide* for more information.

## Scaling

Specify the method for scaling your fixed-point data to avoid overflow conditions and minimize quantization errors.

### Settings

**Default:** Best precision (Constant), Binary point (Data Type Conversion, Discrete-Time Integrator, Gain, Inport, Outport, Product, Saturation, Sum, Switch), Integer (Logical Operator, Relational Operator)

Binary point

Specify binary point location.

Slope and bias

Enter slope and bias.

Best precision

Specify best-precision values. This option appears for some blocks.

Integer

Specify integer. This setting has the same result as specifying a binary point location and setting fraction length to 0. This option appears for some blocks.

### Dependencies

This parameter is enabled by selecting **Mode** > Fixed point.

Selecting Binary point enables:

- **Fraction length**
- **Calculate Best-Precision Scaling**

Selecting Slope and bias enables:

- **Slope**
- **Bias**
- **Calculate Best-Precision Scaling**

# Sum, Add, Subtract, Sum of Elements

---

## **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

## **See Also**

See “Specifying a Fixed-Point Data Type” in the *Simulink User’s Guide* for more information.

## **Fraction length**

Specify fraction length for fixed-point data type.

### **Settings**

**Default:** 0

Binary points can be positive or negative integers.

### **Dependencies**

This parameter is enabled by selecting **Scaling** > Binary point.

### **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

### **See Also**

See “Specifying a Fixed-Point Data Type” in the *Simulink User’s Guide* for more information.

# Sum, Add, Subtract, Sum of Elements

---

## **Slope**

Specify slope for the fixed-point data type.

## **Settings**

**Default:** 2<sup>0</sup>

Specify any positive real number.

## **Dependencies**

This parameter is enabled by selecting **Scaling** > Slope and bias.

## **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

## **See Also**

See “Specifying a Fixed-Point Data Type” in the *Simulink User’s Guide* for more information.



# Sum, Add, Subtract, Sum of Elements

## Bias

Specify bias for the fixed-point data type.

## Settings

**Default:** 0

Specify any real number.

## Dependencies

This parameter is enabled by selecting **Scaling** > Slope and bias.

## Command-Line Information

See “Block-Specific Parameters” on page 8-96 for the command-line information.

## See Also

See “Specifying a Fixed-Point Data Type” in the *Simulink User’s Guide* for more information.

## Characteristics

Direct Feedthrough	Yes
Sample Time	Specified in the <b>Sample time</b> parameter
Scalar Expansion	Yes
States	0
Dimensionalized	Yes
Multidimensionalized	Yes, only along the specified dimension
Zero Crossing	No

# Switch

---

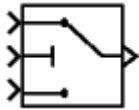
## Purpose

Switch output between first input and third input based on value of second input

## Library

Signal Routing

## Description



The Switch block passes through the first input or the third input based on the value of the second input. The first and third inputs are called *data inputs*. The second input is called the *control input*. See “How to Rotate a Block” in the Simulink User’s Guide for a description of the port order for various block orientations.

You select the condition 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, 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 Overview” for more information.

---

To immediately back propagate a known output data type to the first and third input ports, set the **Output data type** parameter to `Inherit: Inherit via internal rule` and select the **Require all data port inputs to have the same data type** check box.

## Data Type Support

The control signal can be of any data type supported by Simulink software, including fixed-point and enumerated types. The control signal cannot be complex. If it is enumerated, the block’s **Threshold** parameter must be a value of the same enumerated type, and the

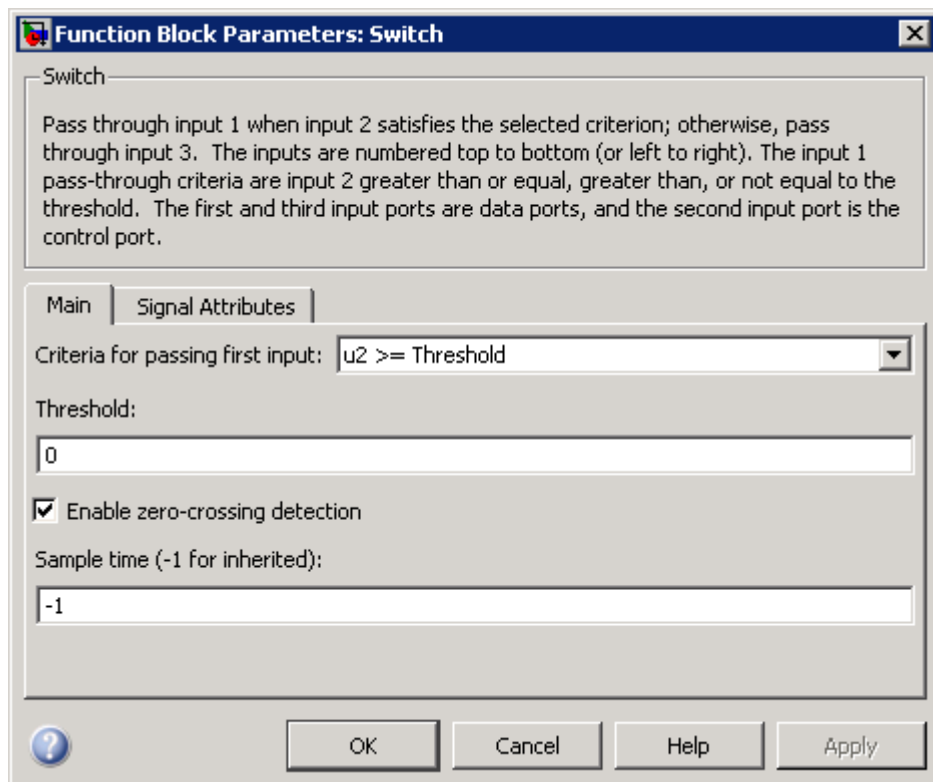
block compares the underlying integers of the control signal and the **Threshold**.

The data signals can be of any data type supported by Simulink software. If either data signal is of an enumerated type, the other must be of the same enumerated type.

For a discussion on the data types supported by Simulink software, see “Data Types Supported by Simulink” in the Simulink User’s Guide.

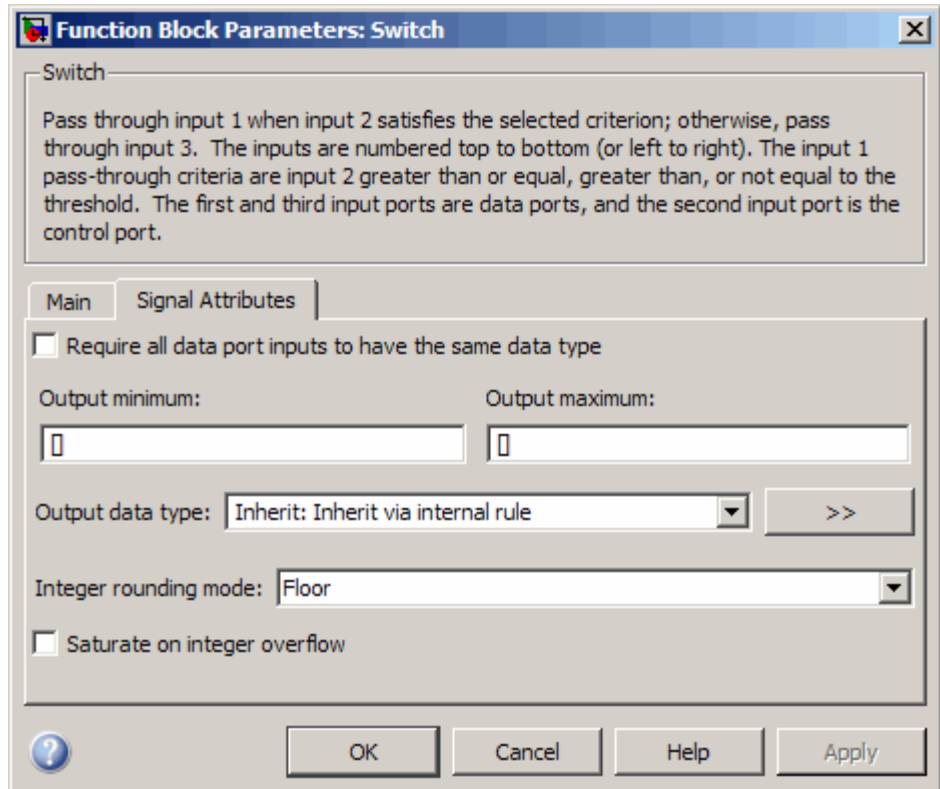
## Parameters and Dialog Box

The **Main** pane of the Switch block dialog box appears as follows:



# Switch

The **Signal Attributes** pane of the Switch block dialog box appears as follows:



## **Show data type assistant**

Display the **Data Type Assistant**.

### **Settings**

The **Data Type Assistant** helps you set the **Output data type** parameter.

See “Specifying Block Output Data Types” in *Simulink User’s Guide* for more information.

### **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

## Criteria for passing first input

Select the condition under which the first input is passed. If the control input meets the condition set in this parameter, the first input is passed. Otherwise, the third input is passed.

### Settings

**Default:** `u2 >= Threshold`

`u2 >= Threshold`

Check whether the control input is greater than or equal to the threshold value.

`u2 > Threshold`

Check whether the control input is greater than the threshold value.

`u2 ~=0`

Check whether the control input is nonzero.

---

**Note** The `u2 ~=0` mode is not supported for enumerated data types.

---

### Tip

When the control input is a Boolean signal, use one these combinations of condition and threshold value:

- `u2 >= Threshold`, where the threshold value equals 1
- `u2 > Threshold`, where the threshold value equals 0
- `u2 ~=0`

Otherwise, the Switch block ignores threshold values and uses the Boolean value for signal routing. For a value of 1, the first input is passed, and for a value of 0, the third input is passed. A warning message that describes this behavior also appears in the MATLAB Command Window.

**Dependencies**

Selecting `u2 ~=0` disables the **Threshold** parameter.

**Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

# Switch

---

## **Threshold**

Assign the switch threshold that determines which input is passed to the output.

## **Settings**

**Default:** 0

**Minimum:** value from the **Output minimum** parameter

**Maximum:** value from the **Output maximum** parameter

## **Dependencies**

This parameter is disabled by setting **Criteria for passing first input** to `u2 ~=0`.

## **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.



## Enable zero-crossing detection

Select to enable zero-crossing detection.

### Settings

**Default:** On

On

Enable zero-crossing detection.

Off

Do not enable zero-crossing detection.

### Command-Line Information

See “Block-Specific Parameters” on page 8-96 for the command-line information.

### See Also

For more information, see “How Blocks Work with Zero-Crossing Detection” in the “How Simulink Works” chapter of the Simulink documentation.

## **Sample time (-1 for inherited)**

Enter the discrete interval between sample time hits or specify another appropriate sample time such as continuous or inherited.

### **Settings**

**Default:** -1

By default, the block inherits its sample time based upon the context of the block within the model. To set a different sample time, enter a valid sample time based upon the table in “Types of Sample Time”.

See also “How to Specify the Sample Time” in the online documentation for more information.

### **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

## **Require all data port inputs to have the same data type**

Require all data inputs to have the same data type.

### **Settings**

**Default:** Off

On

Require all data inputs to have the same data type.

Off

Do not require all data inputs to have the same data type.

### **Command-Line Information**

Require all data inputs to have the same data type.

# Switch

---

## **Lock output scaling against changes by the autoscaling tool**

Select to lock scaling of outputs.

### **Settings**

**Default:** Off



On

Lock scaling of outputs.



Off

Do not lock scaling of outputs.

### **Dependencies**

This parameter is enabled when you enter an expression for the **Output data type** or **Data type** parameter.

### **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

## Integer rounding mode

Select the rounding mode for fixed-point operations.

### Settings

**Default:** Floor

#### Ceiling

Round both positive and negative numbers toward positive infinity.

#### Convergent

Round number to the nearest representable value. In the case of a tie, round to the nearest even stored value.

#### Floor

Round both positive and negative numbers toward negative infinity.

#### Nearest

Round number to the nearest representable value. In the case of a tie, round toward positive infinity.

#### Round

Round number to the nearest representable value. In the case of a tie, round positive numbers toward positive infinity and round negative numbers toward negative infinity.

#### Simplest

This option provides for an optimization of the rounding code for several blocks.

#### Zero

Round number toward zero.

### Command-Line Information

See “Block-Specific Parameters” on page 8-96 for the command-line information.

### See Also

For more information, see “Rounding” in the *Simulink Fixed Point User’s Guide*.

# Switch

---

## **Saturate on integer overflow**

Specify whether overflows saturate.

### **Settings**

**Default:** Off

On  
Overflows saturate.

Off  
Overflows do not saturate.

### **Tips**

- When you select this check box, saturation applies to every internal operation on the block, not just the output or result.
- In general, the code generation process can detect when overflow is not possible, in which case, no saturation code is generated.

### **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

## **Output minimum**

Specify the minimum value that the block should output.

### **Settings**

**Default:** []

The default value, [], is equivalent to `-Inf`.

Simulink software uses this value to perform:

- Parameter range checking (see “Checking Parameter Values”) for some blocks
- Simulation range checking (see “Checking Signal Ranges”)
- Automatic scaling of fixed-point data types

### **Tip**

This number must be a double scalar value.

### **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

## **Output maximum**

Specify the maximum value that the block should output.

### **Settings**

**Default:** []

The default value, [], is equivalent to Inf.

Simulink software uses this value to perform:

- Parameter range checking (see “Checking Parameter Values”) for some blocks
- Simulation range checking (see “Checking Signal Ranges”)
- Automatic scaling of fixed-point data types

### **Tip**

This number must be a double scalar value.

### **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.



## Output data type

Specify the output data type.

### Settings

**Default:** Inherit: Inherit via internal rule (Discrete-Time Integrator, Gain, Product, Sum, Switch block), Inherit: Inherit from 'Constant value' (Constant block default), Inherit: Inherit via back propagation (Data Type Conversion block), Inherit: Same as input (Saturation block)

Inherit: Inherit via internal rule

This option appears for some blocks. Simulink software chooses a combination of output scaling and data type that requires the smallest amount of memory consistent with accommodating the calculated 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 software chooses the output data type without regard to hardware constraints. Otherwise, Simulink software 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 software displays an error message in the Simulation Diagnostics Viewer.

Inherit: Inherit from 'Constant value'

Use data type of **Constant value** parameter. This option appears for some blocks.

Inherit: Inherit via back propagation

A rule that inherits a data type

# Switch

---

**Inherit: Same as input**  
Use data type of sole input signal. This option appears for some blocks.

**Inherit: Same as first input**  
Use data type of first input signal. This option appears for some blocks.

**Inherit: Same as accumulator**  
Output data type same as accumulator data type. This option appears for some blocks.

**double**  
Output data type is double.

**single**  
Output data type is single.

**int8**  
Output data type is int8.

**uint8**  
Output data type is uint8.

**int16**  
Output data type is int16.

**uint16**  
Output data type is uint16.

**int32**  
Output data type is int32.

**uint32**  
Output data type is uint32.

**fixdt(1,16,0)**  
Output data type is fixed point fixdt(1,16,0).

**fixdt(1,16,2<sup>0</sup>,0)**  
Output data type is fixed point fixdt(1,16,2<sup>0</sup>,0).

<data type expression>

The name of a data type object, for example  
Simulink.NumericType

### **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

### **See Also**

See “Specifying Block Output Data Types” in the *Simulink User’s Guide* for more information.

## Mode

Select the category of data to specify

## Settings

**Default:** Inherit (Constant, Data Type Conversion, Discrete Time Integrator, Gain, Inport, Outport, Product, Saturation, Sum, Switch),  
**Built in** (Logical Operator, Relational Operator)

### Inherit

Inheritance rules for data types. Selecting **Inherit** enables a second menu/text box to the right. Below are the possible values, which can vary by block:

- Inherit from 'Constant value' (Constant block default)
- Inherit via internal rule (Discrete-Time Integrator, Gain, Product, Sum, Switch block default)
- Inherit via back propagation (Data Type Conversion block default)
- auto (Inport, Outport block default)
- Logical (see Configuration Parameters: Optimization)
- Same as first input
- Same as input (Saturation block default)
- Same as accumulator

### Built in

Built-in data types. Selecting **Built in** enables a second menu/text box to the right. Below are the possible values, which can vary by block:

- double (Constant, Data Type Conversion, Discrete-Time Integrator, Gain, Inport, Outport, Product, Saturation, Sum, Switch block default)
- single

- int8
- uint8
- int16
- uint16
- int32
- uint32
- boolean (Logical Operator, Relational Operator block default)

#### Fixed point

Fixed-point data types.

#### Enumerated

Enumerated data types. This option is available on some blocks. Selecting Enumerated enables a second menu/text box to the right. Below are the possible values, which can vary by block:

- <class name>

#### Expression

Expressions that evaluate to data types. Selecting Expression enables a second menu/text box to the right. Below are the possible values, which can vary by block:

- <data type expression>

#### **Dependency**

This parameter is enabled by the **Show data type assistant** button.

#### **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

#### **See Also**

See “Using the Data Type Assistant” in the *Simulink User’s Guide*.

# Switch

---

## **Signedness**

Specify whether you want the fixed-point data to be signed or unsigned.

## **Settings**

**Default:** Signed

Signed

Specify the fixed-point data to be signed.

Unsigned

Specify the fixed-point data to be unsigned.

## **Dependencies**

This parameter is enabled by selecting **Mode** > Fixed point.

## **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

## **See Also**

See “Specifying a Fixed-Point Data Type” in the *Simulink User’s Guide* for more information.

## **Word length**

Specify the bit size of the word that will hold the quantized integer.

### **Settings**

**Default:** 16

**Minimum:** 0

**Maximum:** 32

Large word sizes represent large values with greater precision than small word sizes.

### **Dependencies**

This parameter is enabled by selecting **Mode** > Fixed point.

### **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

### **See Also**

See “Specifying a Fixed-Point Data Type” in the *Simulink User’s Guide* for more information.

## Scaling

Specify the method for scaling your fixed-point data to avoid overflow conditions and minimize quantization errors.

## Settings

**Default:** Best precision (Constant), Binary point (Data Type Conversion, Discrete-Time Integrator, Gain, Inport, Outport, Product, Saturation, Sum, Switch), Integer (Logical Operator, Relational Operator)

Binary point

Specify binary point location.

Slope and bias

Enter slope and bias.

Best precision

Specify best-precision values. This option appears for some blocks.

Integer

Specify integer. This setting has the same result as specifying a binary point location and setting fraction length to 0. This option appears for some blocks.

## Dependencies

This parameter is enabled by selecting **Mode** > Fixed point.

Selecting Binary point enables:

- **Fraction length**
- **Calculate Best-Precision Scaling**

Selecting Slope and bias enables:

- **Slope**
- **Bias**
- **Calculate Best-Precision Scaling**



**Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

**See Also**

See “Specifying a Fixed-Point Data Type” in the *Simulink User’s Guide* for more information.

## **Fraction length**

Specify fraction length for fixed-point data type.

### **Settings**

**Default:** 0

Binary points can be positive or negative integers.

### **Dependencies**

This parameter is enabled by selecting **Scaling** > Binary point.

### **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

### **See Also**

See “Specifying a Fixed-Point Data Type” in the *Simulink User’s Guide* for more information.

## **Slope**

Specify slope for the fixed-point data type.

### **Settings**

**Default:**  $2^0$

Specify any positive real number.

### **Dependencies**

This parameter is enabled by selecting **Scaling** > Slope and bias.

### **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

### **See Also**

See “Specifying a Fixed-Point Data Type” in the *Simulink User’s Guide* for more information.

# Switch

---

## Bias

Specify bias for the fixed-point data type.

## Settings

**Default:** 0

Specify any real number.

## Dependencies

This parameter is enabled by selecting **Scaling** > Slope and bias.

## Command-Line Information

See “Block-Specific Parameters” on page 8-96 for the command-line information.

## See Also

See “Specifying a Fixed-Point Data Type” in the *Simulink User’s Guide* for more information.

## Bus Support

The Switch block is a bus-capable block. The data inputs can be virtual or nonvirtual bus signals subject to the following restrictions:

- All the buses must be equivalent (same hierarchy with identical names and attributes for all elements).
- All signals in a nonvirtual bus input to a Switch block must have the same sample time, even if the elements of the associated bus object specify inherited sample times.

You can use a Rate Transition block to change the sample time of an individual signal, or of all signals in a bus. See Using Buses and Bus-Capable Blocks for more information.

## Characteristics

Bus-capable	Yes, with restrictions as noted above
Direct Feedthrough	Yes
Sample Time	Specified in the <b>Sample time</b> parameter

Scalar Expansion	Yes
Dimensionalized	Yes
Multidimensionalized	Yes
Zero Crossing	Yes, if enabled

## See Also

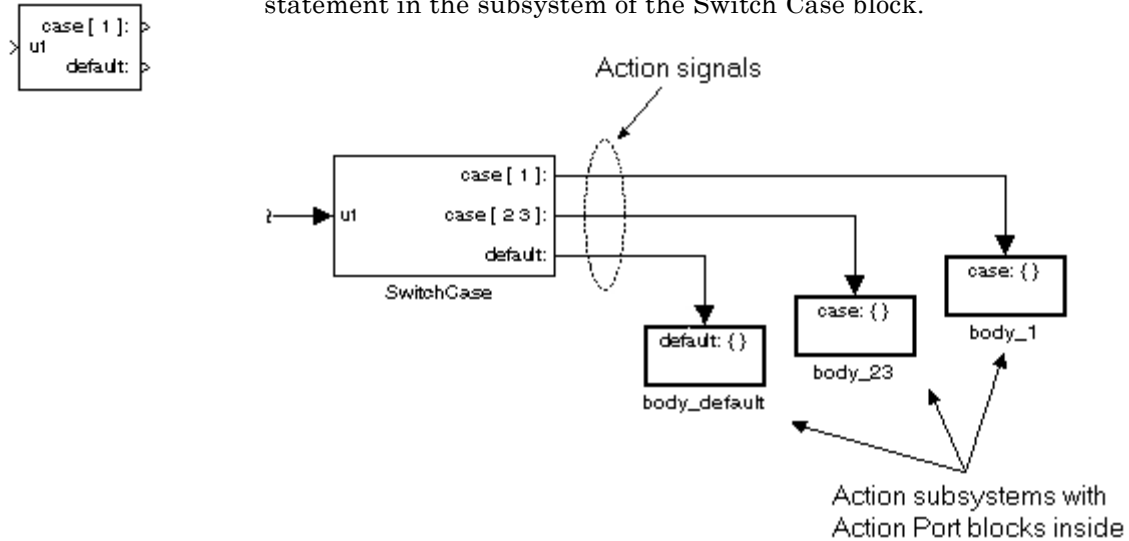
Multiport Switch

# Switch Case

**Purpose** Implement 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.



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.

# Switch Case

---

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.

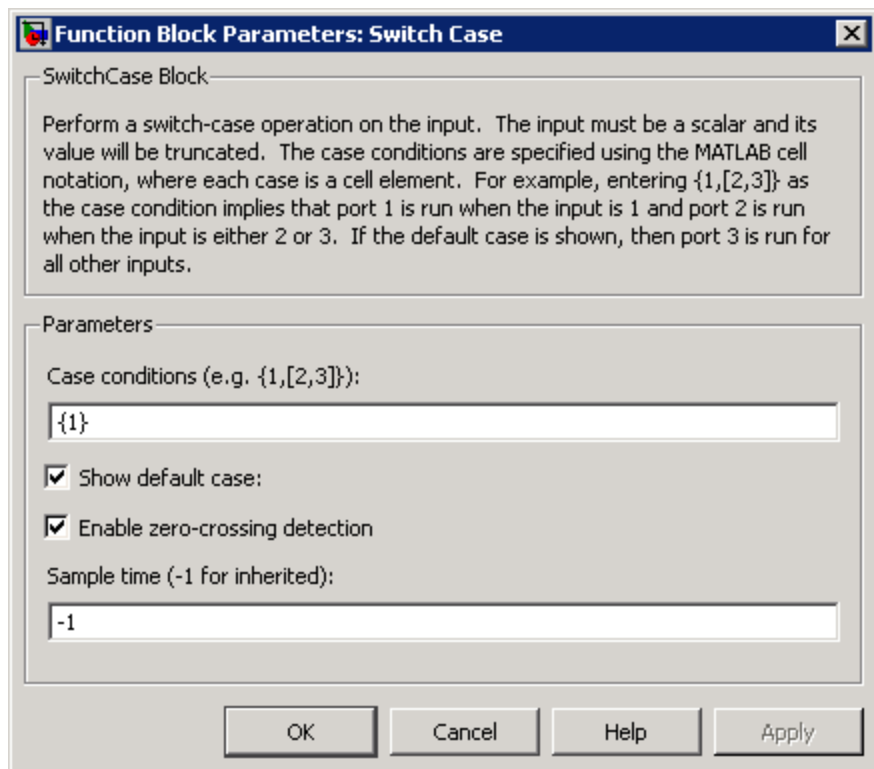
---

## Data Type Support

Input to the port labeled `u1` of a Switch Case block can be a scalar value of any numeric data type supported by Simulink software, including a fixed-point data type. The input to `u1` cannot be `Boolean` or have an enumerated type. Noninteger inputs are truncated. Data outputs are action signals to Switch Case Action subsystems that are created with Action Port blocks and subsystems. See Action Port.



## Parameters and Dialog Box



### 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.

# Switch Case

---

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 “How Blocks Work with Zero-Crossing Detection” in the “How Simulink Works” chapter of the Simulink documentation.

## Sample time (-1 for inherited)

Specify the time interval between samples. To inherit the sample time, set this parameter to -1. See “How to Specify the 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 Detection	Yes, if enabled

# Switch Case Action Subsystem

---

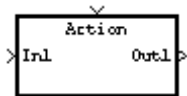
## Purpose

Represent subsystem whose execution is triggered by 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.

---

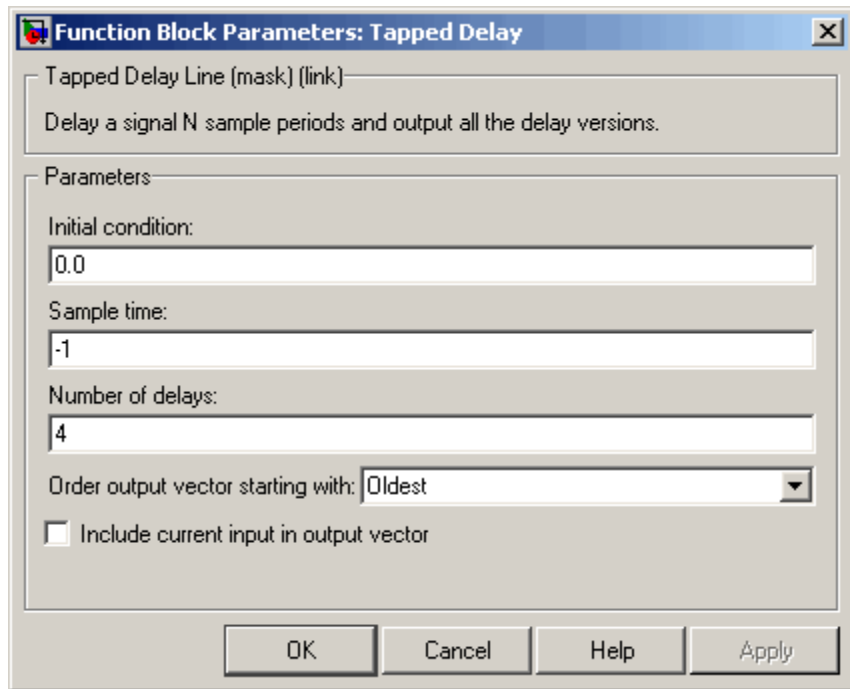
For more information, see the Switch Case block and “Modeling Control Flow Logic” in the “Creating a Model” chapter of the Simulink documentation.

# Tapped Delay

---

<b>Purpose</b>	Delay scalar signal multiple sample periods and output all delayed versions
<b>Library</b>	Discrete
<b>Description</b>	<p>The Tapped Delay block delays an input by the specified number of sample periods and outputs all the delayed versions. Use this block to discretize a signal in time or resample a signal at a different rate.</p> <p>The block accepts one scalar input and generates an output vector that contains each delay. Specify the order of the delays in the output vector with the <b>Order output vector starting with</b> parameter:</p> <ul style="list-style-type: none"><li>• <b>Oldest</b> orders the output vector starting with the oldest delay version and ending with the newest delay version.</li><li>• <b>Newest</b> orders the output vector starting with the newest delay version and ending with the oldest delay version.</li></ul> <p>Specify the output vector for the first sampling period with the <b>Initial condition</b> parameter. Careful selection of this parameter can minimize unwanted output behavior.</p> <p>Specify the time between samples with the <b>Sample time</b> parameter. Specify the number of delays with the <b>Number of delays</b> parameter. A value of -1 instructs the block to inherit the number of delays by back propagation. Each delay is equivalent to the <math>z^{-1}</math> discrete-time operator, which is represented by the Unit Delay block.</p>
<b>Data Type Support</b>	The Tapped Delay block accepts signals of any data type supported by Simulink software, including fixed-point and enumerated data types.

## 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 software does not allow you to set the initial condition of this block to  $\text{inf}$  or  $\text{NaN}$ .

### Sample time

Specify the time interval between samples. To inherit the sample time, set this parameter to -1. See “How to Specify the Sample Time” in the online Simulink documentation for more information.

### Number of delays

Specify the number of discrete-time operators.

# Tapped Delay

---

## **Order output vector starting with**

Specify whether to output the oldest delay version first, or the newest delay version first.

## **Include current input in output vector**

Select to include the current input in the output vector.

## **Characteristics**

Direct Feedthrough	Yes, when <b>Include current input in output vector</b> check box is selected. No, otherwise.
Sample Time	Specified in the <b>Sample time</b> parameter
Scalar Expansion	Yes, of initial conditions

**Purpose** Terminate unconnected output port

**Library** Sinks

**Description**



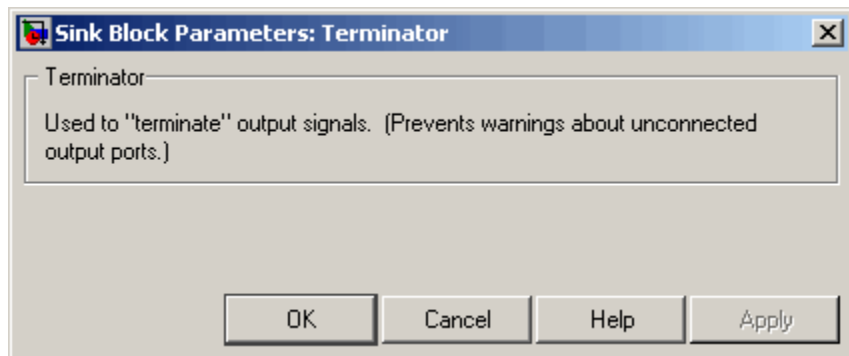
The Terminator block can be used to cap blocks whose output ports are not connected to other blocks. If you run a simulation with blocks having unconnected output ports, Simulink software issues warning messages. Using Terminator blocks to cap those blocks avoids warning messages.

**Data Type Support**

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

For a discussion on the data types supported by Simulink software, see “Data Types Supported by Simulink” in the Simulink documentation.

**Parameters and Dialog Box**



**Characteristics**

Sample Time	Inherited from driving block
Dimensionalized	Yes
Multidimensionalized	Yes

# Time-Based Linearization

---

**Purpose** Generate linear models in base workspace at specific times

**Library** Model-Wide Utilities

## Description

T=1

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.

The block sets the following model parameters to the indicated values:

- `BufferReuse` = 'off'
- `RTWInlineParameters` = 'on'
- `BlockReductionOpt` = 'off'

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
<code>a</code>	The A matrix of the linearization
<code>b</code>	The B matrix of the linearization
<code>c</code>	The C matrix of the linearization
<code>d</code>	The D matrix of the linearization
<code>StateName</code>	Names of the model's states
<code>OutputName</code>	Names of the model's output ports
<code>InputName</code>	Names of the model's input ports



Field	Description
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.

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.

# Time-Based Linearization

- 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);
```

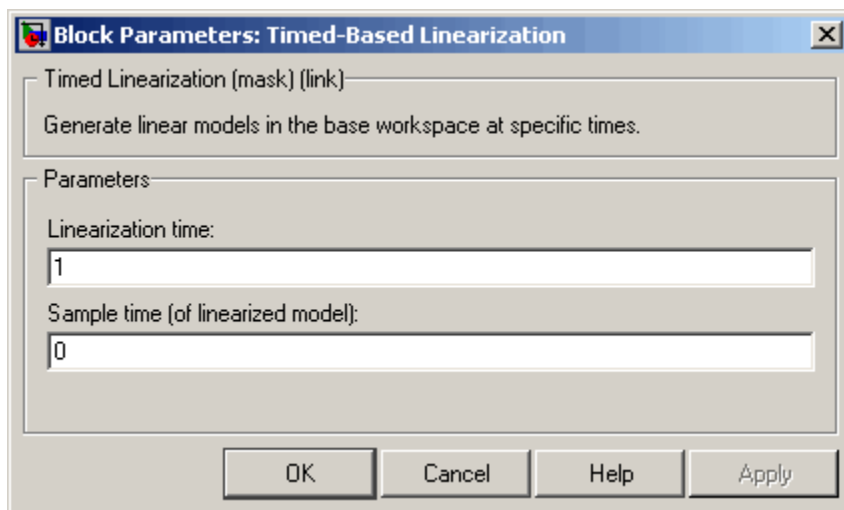
- 9 Get the state vectors at the operating points.

```
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 4-122).

<b>Characteristics</b>	Sample Time	Specified in the <b>Sample time</b> parameter
	Dimensionalized	No

**See Also** Trigger-Based Linearization

# To File

---

**Purpose** Write data to file

**Library** Sinks

**Description**



The To File block inputs a scalar or vector signal of type double and writes the signal data to a MAT-file. The block's icon shows the name of the output file. If the output file exists at the time the simulation starts, the block overwrites the file. The block writes to the output file incrementally, so memory overhead during simulation is low. The file automatically closes when simulation is complete.

---

**Note** If simulation terminates abnormally, the To File block may have written a MAT-file that contains some data, but the file is unusable.

---

The To File block writes data as a matrix of two or more rows. The block writes one column to the MAT-file for each time step. The first element of the column contains the simulation time. The remainder of the column contains scalar or vector data for the time shown at the top of the column. The stored matrix has this form:

$$\begin{bmatrix} t_1 & t_2 & \dots & t_{final} \\ u1_1 & u1_2 & \dots & u1_{final} \\ \dots & \dots & \dots & \dots \\ un_1 & un_2 & \dots & un_{final} \end{bmatrix}$$

To avoid the overhead of compressing data in real time, the To File block writes an uncompressed MAT-file. To compress the file, load and save it in MATLAB. The resaved file will be smaller because MATLAB software automatically compresses MAT-files.

The MAT-file can contain at most  $10^8$  elements, where each timestamp and each data value counts as one element. Thus if  $N$  is the number of time steps in the file, and  $W$  is the width of the data,  $N(W+1)$  cannot exceed  $10^8$ . If writing the next column to the file would cause the number of elements to exceed  $10^8$ , the To File block discards the

unwritten column, closes the file, and posts a warning. Simulation continues without interruption, but the To File block discards all subsequent data. The truncated MAT-file is syntactically valid and can be used as input to a subsequent simulation, or loaded into MATLAB for any purpose.

## Controlling When Data is Written to the File

For a fixed-step solver, the block's **Decimation** and **Sample Time** parameters control when data is written to the file. For a variable-step solver, the **Configuration Parameters > Data Import/Export Pane > "Output options"** parameter controls the amount of data available to the To File block, and the block's **Decimation** and **Sample Time** parameters control how much of this data the block actually writes.

For example, if you need to ensure that data is written at identical time points over multiple simulations with a varying-step solver, set **Output Options** to **Produce specified output only** and enter the desired time vector in the **Output times** field. See "Importing Data from a Workspace" for guidelines on choosing time vectors for discrete systems.

## Saving Data for Use by a From File Block

The From File block can use data written by a To File block without any modifications to the data or other special provisions.

## Saving Data for Use by a From Workspace Block

The From Workspace block requires data that is the transposition of the data written by the To File block. To provide the required format, use MATLAB commands to load and transpose the data from MAT-file. You will then be able to use a From Workspace block to access the data.

## Limitation on To File block in a Referenced Model

When a To File block exists in a referenced model, that model must be a single-instance model. Only one instance of such a model can exist in a model hierarchy. Otherwise, the corresponding To File blocks in different instances of the referenced model would all try to write to the same data file, which could not provide a useful result. See "General Reusability Limitations" for more information.

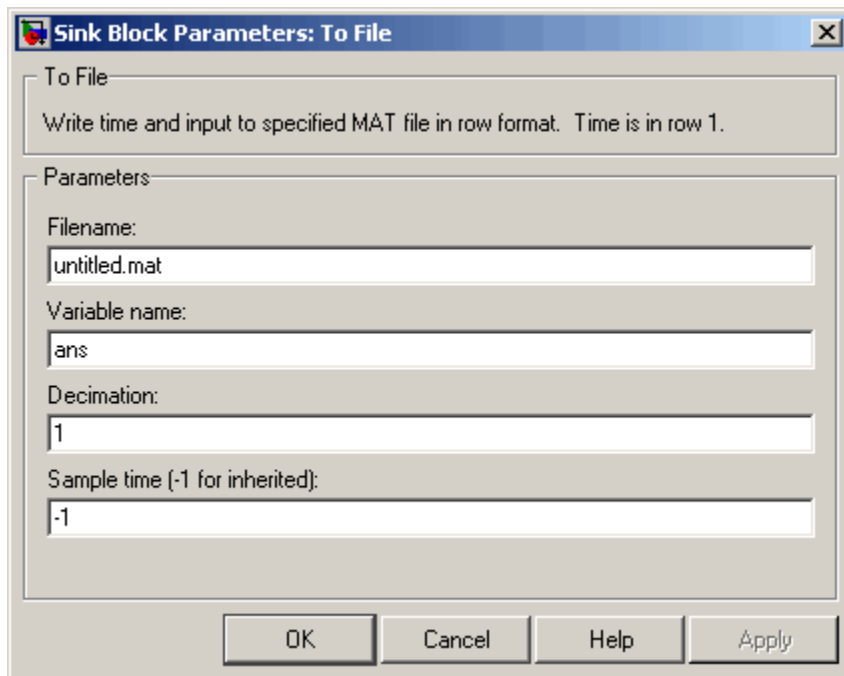
# To File

---

## Data Type Support

The To File block accepts only vector and scalar data, and all data must be of type double. The To File block does not accept matrix signals or complex data. To save other kinds of data, use a To Workspace block to save the data to the MATLAB workspace. You can then save the data to a file.

## Parameters and Dialog Box



### Filename

The pathname or filename of the MAT-file in which to store the output. On UNIX systems, the pathname can start with a tilde (~) character signifying your home directory. The default filename is `untitled.mat`. If you specify a filename without path information, Simulink software stores the file in the MATLAB working directory. (To determine the working directory, type

pwd at the MATLAB command line.) If the file already exists, Simulink software overwrites it.

**Variable name**

The name of the matrix contained in the named file. The default name is ans.

**Decimation**

Specifies writing data at every nth sample, where n is the decimation factor. The default decimation is 1, which writes data at every time step.

**Sample time**

Specifies the sample period and offset 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 constant. The default is -1, which inherits the sample time from the driving block when determining the points to write. See “How to Specify the Sample Time” for more information.

**Characteristics**

Sample Time	Specified in the <b>Sample time</b> parameter
Dimensionalized	Yes

**See Also**

“Importing and Exporting Data”, From File, From Workspace, To Workspace

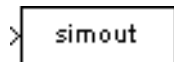
# To Workspace

---

**Purpose** Write data to MATLAB workspace

**Library** Sinks

## Description



The To Workspace block inputs a signal and writes the signal data to the MATLAB workspace. The block writes the data 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.

### 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.

For variable-step solvers, the **Output options** found on the **Data Import/Export** pane of the Configuration Parameters dialog box determine the amount of data available to the To Workspace block. For example, if you need to ensure that data is written at identical time points over multiple simulations, select the **Produce specified output only** option in the Configuration Parameters dialog box and enter the desired time vector.



Block parameters then control when and how much of this data the To Workspace block writes:

- 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`.
- The **Decimation** parameter allows you to write data at every  $n$ th 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 “How to Specify the 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. This is the only format output by a To

# To Workspace

---

Workspace block that can be read directly by a From Workspace block. Structure with Time format does not support frame-based signals: use Array or Structure format instead.

## 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).

## Saving Data for Use by a From File Block

The From File block can read data written by a To Workspace block subject to the following requirements:

- 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 “Data Import/Export Pane” for more information.
- The data must be the transposition of the data saved to the workspace by the To Workspace block. Before saving the data to a MAT-file, transpose it to the form expected by the From File block.
- The data in the file must be scalar or vector data of type double.

## **Saving Data for Use by a From Workspace Block**

In a To Workspace block, use the Structure with Time format to save sample-based data if you intend to use a From Workspace block to play back the data in another simulation.

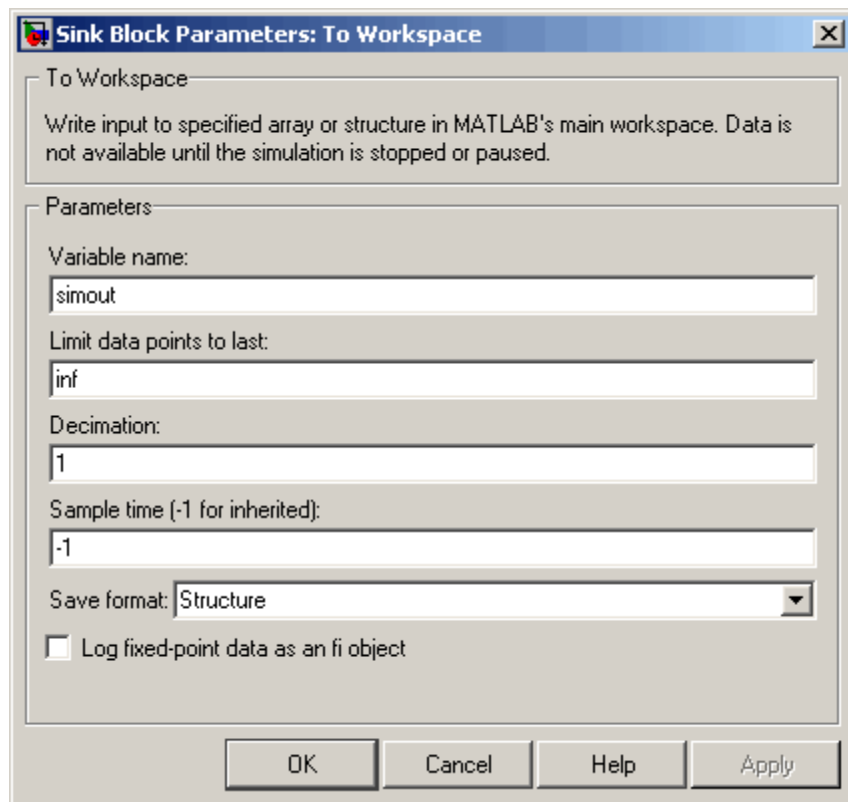
## **Data Type Support**

The To Workspace block can save real or complex inputs of any data type supported by Simulink software, including fixed-point and enumerated data types, to the MATLAB workspace.

For a discussion on the data types supported by Simulink software, see “Data Types Supported by Simulink” in the Simulink documentation.

# To Workspace

## Parameters and Dialog Box



### 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 “How to Specify the Sample Time” 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 <b>Sample time</b> parameter
Dimensionalized	Yes
Multidimensionalized	Yes

**See Also**

“Importing and Exporting Data”, From File, From Workspace, To File

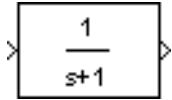
# Transfer Fcn

---

**Purpose** Model linear system by 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

$$H(s) = \frac{y(s)}{u(s)} = \frac{num(s)}{den(s)} = \frac{num(1)s^{nn-1} + num(2)s^{nn-2} + \dots + num(nn)}{den(1)s^{nd-1} + den(2)s^{nd-2} + \dots + den(nd)}$$

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.

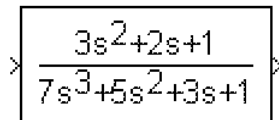
To model a multiple-output system, enter a matrix in the **Numerator coefficient** field where each row of the matrix contains the numerator coefficients of a transfer function that determines one of the block's outputs. Enter a vector containing the denominator coefficients common to the system's transfer 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*.

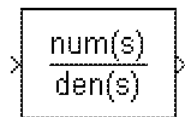
## Transfer Fcn Display

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:


$$\frac{\text{num}(s)}{\text{den}(s)}$$

## Specifying the Absolute Tolerance for the Block's States

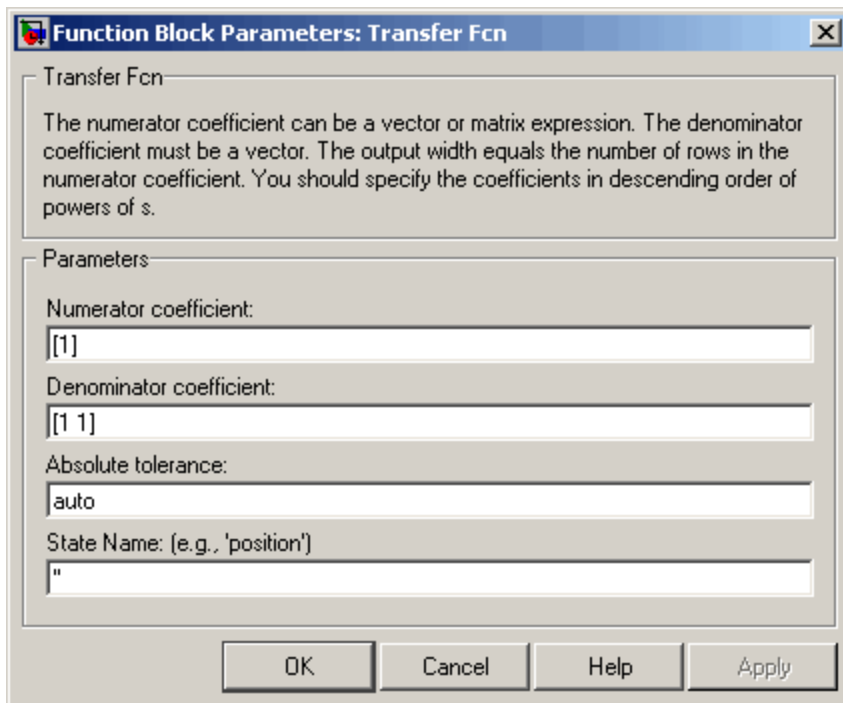
By default Simulink software uses the absolute tolerance value specified in the **Configuration Parameters** dialog box (see “Absolute tolerance”) to solve the states of the Transfer Fcn block. If this value does not provide sufficient error control, specify a more appropriate value in the **Absolute 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 software



determines the absolute tolerance (see “Specifying Variable-Step Solver Error Tolerances”). If you enter a numeric value, Simulink software 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.

## State Name

Use this to assign a unique name to each state. The state names apply only to the selected block. If left blank, no name is assigned.

To assign a name to a single state, enter the name between quotes, for example, 'velocity'.

To assign names to multiple states, enter a comma-delimited list surrounded by braces. For example, {'a', 'b', 'c'}. Each name must be unique.

The number of states must be evenly divided by the number of state names. There can be fewer names than the number of states, but there cannot be more names than states.

For example, you can specify two names in a system with four states. Simulink software will assign the first name to the first two states and the second name to the last two.

To assign state names with a variable that has been defined in the MATLAB workspace, enter the variable without quotes. A variable can be a string, cell, or structure.

## Characteristics

Direct Feedthrough	Only if the lengths of the <b>Numerator</b> and <b>Denominator</b> parameters are equal
Sample Time	Continuous
Scalar Expansion	No

# Transfer Fcn

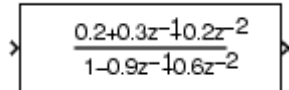
---

States	Length of <b>Denominator</b> -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

**Purpose** Implement Direct Form II realization of transfer function

**Library** Additional Math & Discrete / Additional Discrete

## Description


$$\frac{0.2+0.3z^{-1}+0.2z^{-2}}{1-0.9z^{-1}+0.6z^{-2}}$$

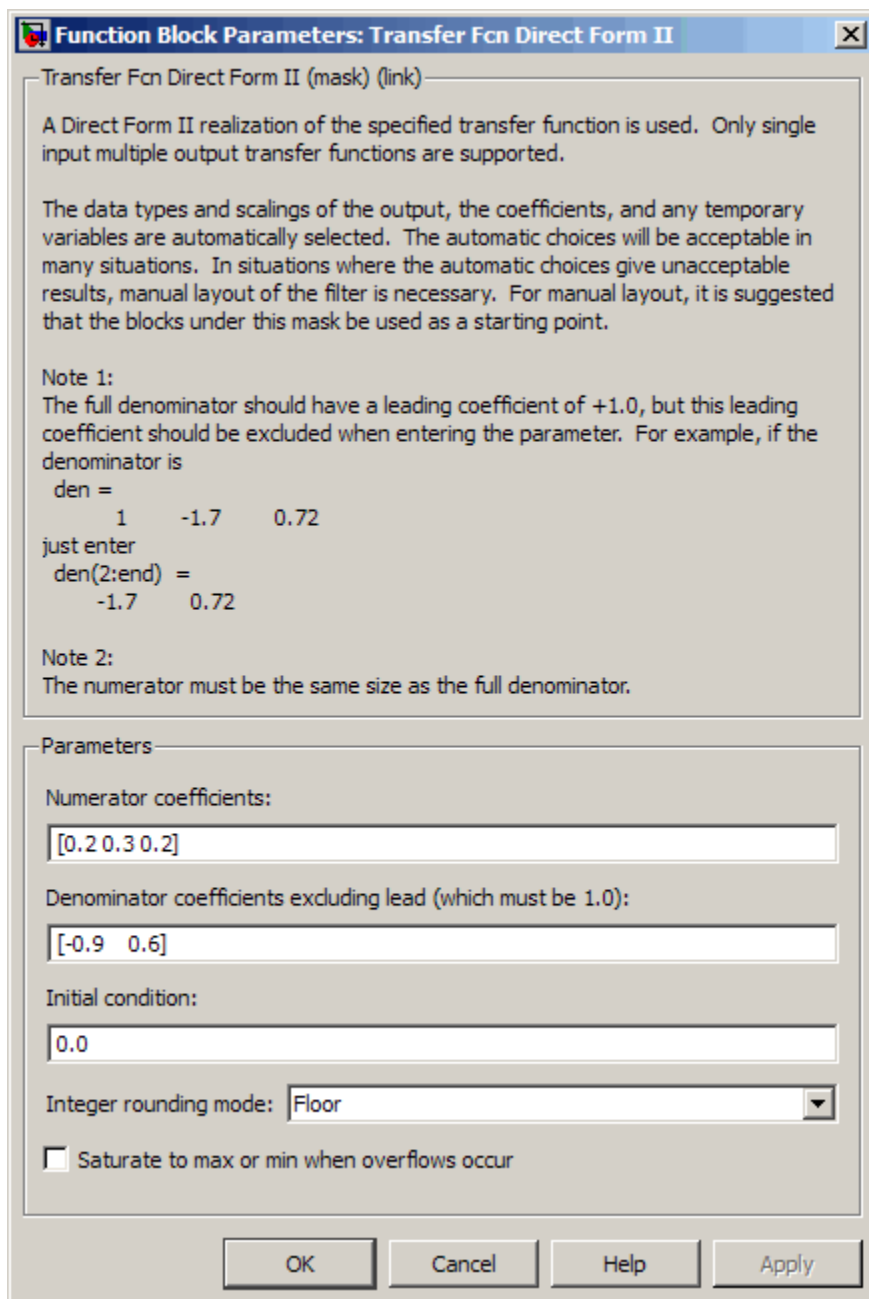
The Transfer Fcn Direct Form II block implements a Direct Form II realization of the transfer function specified by the **Numerator coefficients** and the **Denominator coefficients excluding lead** parameters. The block only supports single input-single output transfer functions.

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 numeric data type supported by Simulink software, including fixed-point data types.

# Transfer Fcn Direct Form II

## 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.

**Integer rounding mode**

Select the rounding mode for fixed-point operations. For more information, see “Rounding” in the *Simulink Fixed Point User’s Guide*.

**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

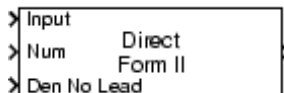
# Transfer Fcn Direct Form II Time Varying

---

**Purpose** Implement time varying Direct Form II realization of 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 supports only single input-single output (SISO) transfer functions.

The input signal labeled Den No Lead contains the denominator coefficients of the transfer function. The full denominator has a leading coefficient of one, but it is excluded from the input signal. For example, a denominator of [1 -1.7 0.72] is represented by a signal with the value [-1.7 0.72]. The input signal labeled Num contains the numerator coefficients. The data types of the numerator and denominator coefficients can be different, but the length of the numerator vector and the full denominator vector must be the same. Pad the numerator vector with zeros, if needed.

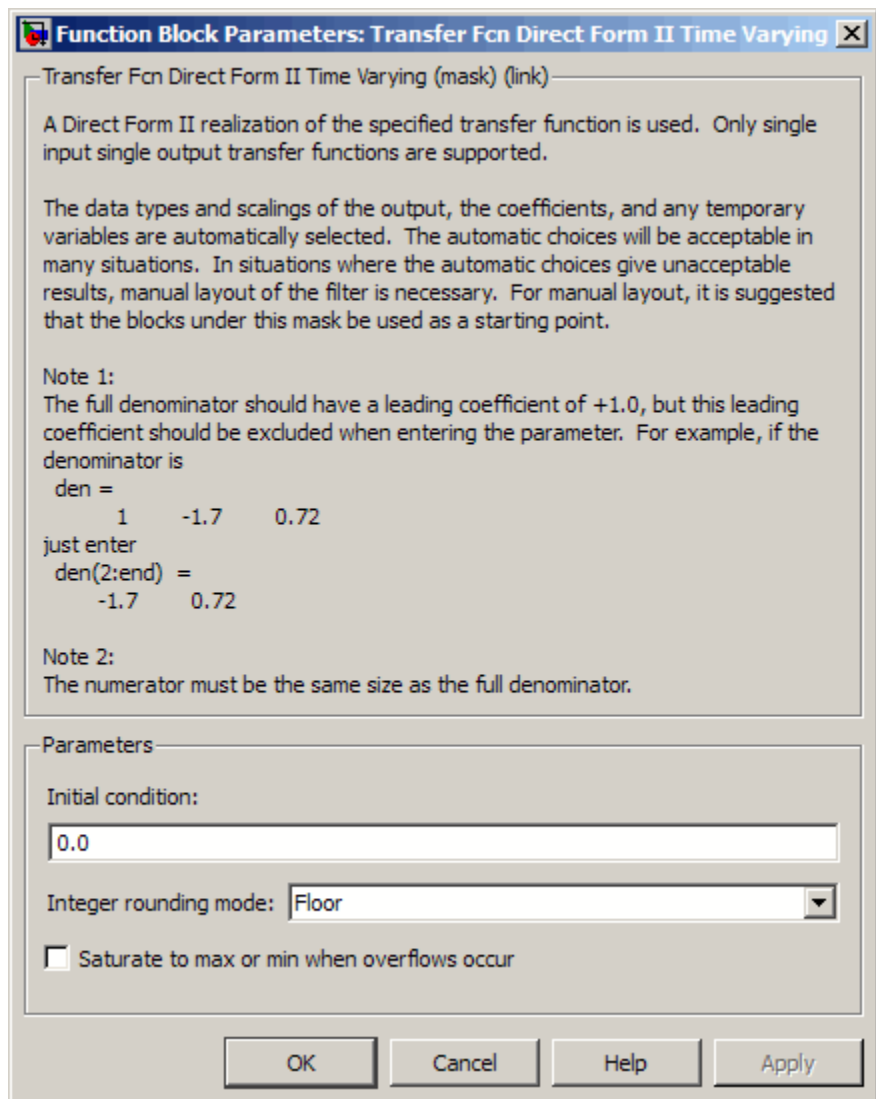
The block automatically selects the data types and scalings of the output, the coefficients, and any temporary variables.

## Data Type Support

The Transfer Fcn Direct Form II Time Varying block accepts signals of any numeric data type supported by Simulink software, including fixed-point data types.

# Transfer Fcn Direct Form II Time Varying

## Parameters and Dialog Box



# Transfer Fcn Direct Form II Time Varying

---

## Initial condition

Set the initial condition.

## Integer rounding mode

Select the rounding mode for fixed-point operations. For more information, see “Rounding” in the *Simulink Fixed Point User’s Guide*.

## 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

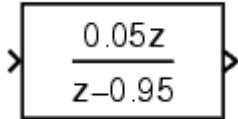


# Transfer Fcn First Order

**Purpose** Implement discrete-time first order transfer function

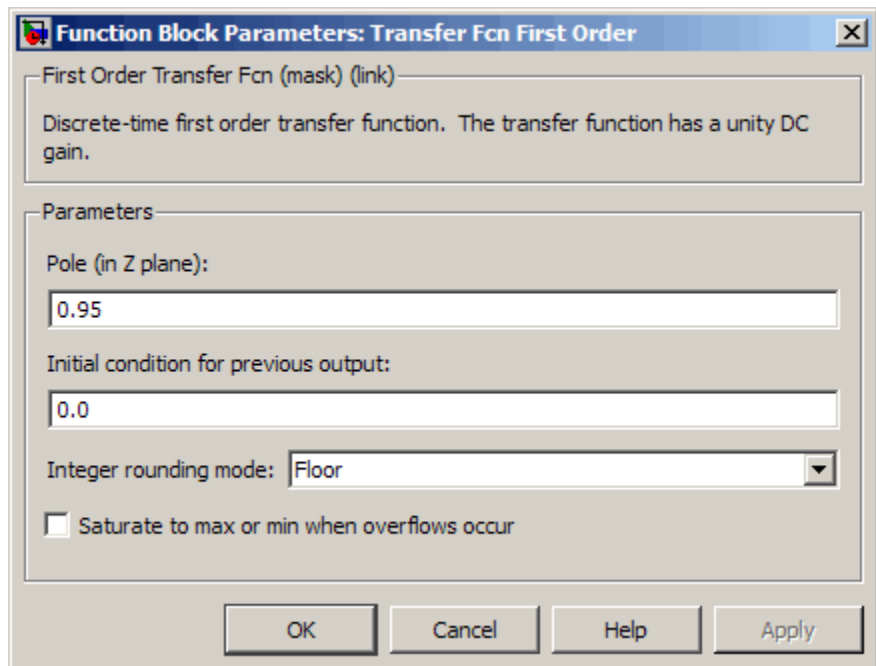
**Library** Discrete

**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.



**Data Type Support** The Transfer Fcn First Order block accepts signals of any numeric data type supported by Simulink software, including fixed-point data types.

## Parameters and Dialog Box



# Transfer Fcn First Order

---

**Pole (in Z plane)**

Set the pole.

**Initial condition for previous output**

Set the initial condition for the previous output.

**Integer rounding mode**

Select the rounding mode for fixed-point operations. For more information, see “Rounding” in the *Simulink Fixed Point User’s Guide*.

**Saturate to max or min when overflows occur**

If selected, fixed-point overflows saturate.

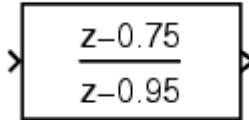
**Characteristics**

Direct Feedthrough	Yes
Scalar Expansion	Yes, of initial conditions

**Purpose** Implement 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.

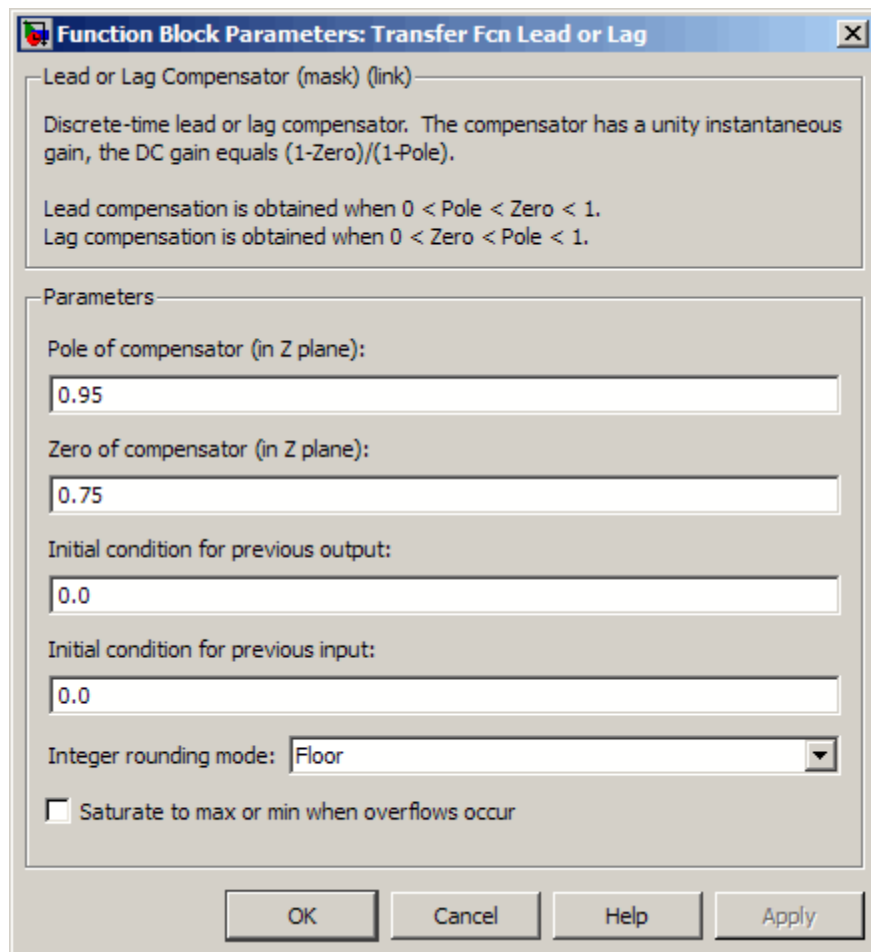


The block implements a lead compensator when  $0 < z < p < 1$ , and implements a lag compensator when  $0 < p < z < 1$ .

**Data Type Support** The Transfer Fcn Lead or Lag block accepts signals of any numeric data type supported by Simulink software, including fixed-point data types.

# Transfer Fcn Lead or Lag

## Parameters and Dialog Box



### Pole of compensator (in Z plane)

Set the pole.

### 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.

**Integer rounding mode**

Select the rounding mode for fixed-point operations. For more information, see “Rounding” in the *Simulink Fixed Point User’s Guide*.

**Saturate to max or min when overflows occur**

If selected, fixed-point overflows saturate.

**Characteristics**

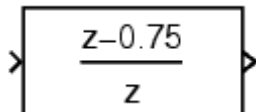
Direct Feedthrough	Yes
Scalar Expansion	Yes, of initial conditions

# Transfer Fcn Real Zero

**Purpose** Implement discrete-time transfer function that has real zero and no pole

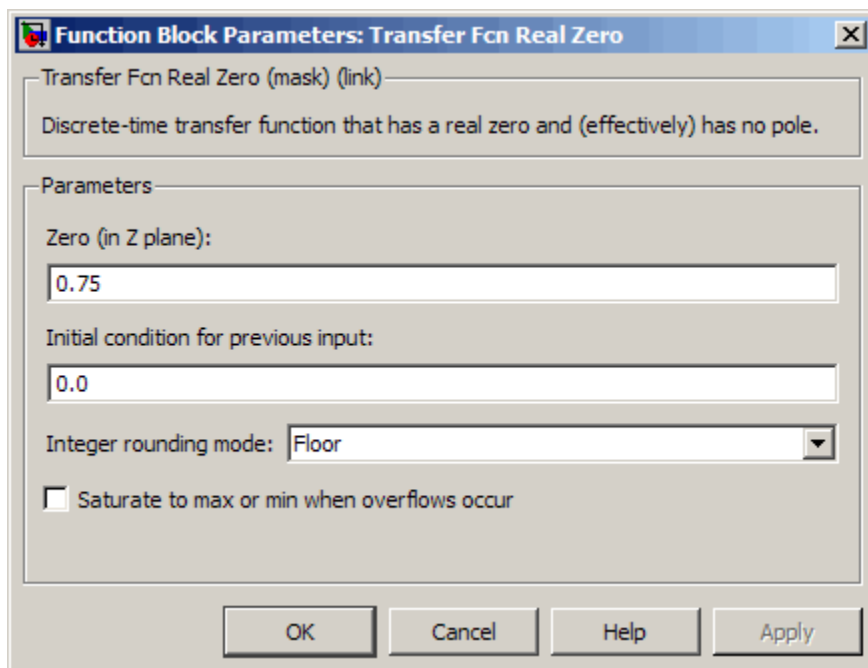
**Library** Discrete

**Description** The Transfer Fcn Real Zero block implements a discrete-time transfer function that has a real zero and effectively has no pole.



**Data Type Support** The Transfer Fcn Real Zero block accepts signals of any numeric data type supported by Simulink software, 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.

**Integer rounding mode**

Select the rounding mode for fixed-point operations. For more information, see “Rounding” in the *Simulink Fixed Point User’s Guide*.

**Saturate to max or min when overflows occur**

If selected, fixed-point overflows saturate.

**Characteristics**

Direct Feedthrough	Yes
Scalar Expansion	Yes, of initial conditions

# Transport Delay

---

**Purpose** Delay input by 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 software 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.

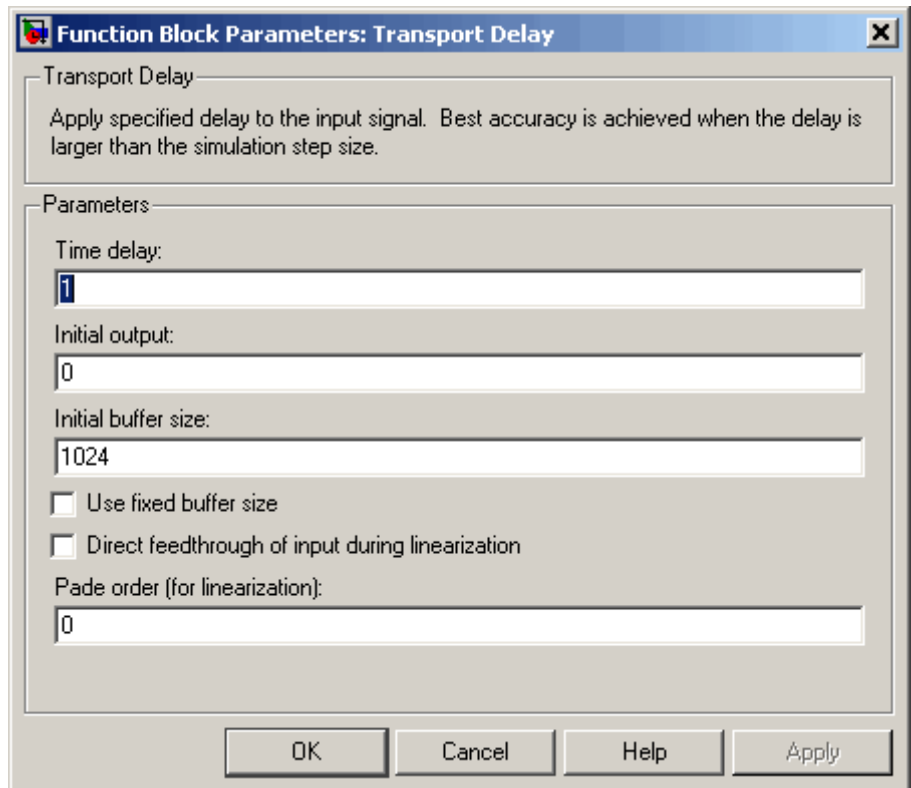


Using `linmod` to linearize a model that contains a Transport Delay block can be troublesome. For more information about ways to avoid the problem, see “Linearizing Models” in the “Analyzing Simulation Results” chapter of the Simulink documentation.

## Data Type Support

The Transport Delay block accepts and outputs real signals of type `double`.

## Parameters and Dialog Box



# Transport Delay

---

## **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 software 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 <b>Initial buffer size</b>
Dimensionalized	Yes
Zero Crossing	No

# Trigger

---

**Purpose** Add trigger port to 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 action 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 “Defining 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. Only function-call signals can trigger execution of a model.

---

You can output the trigger signal by selecting the **Show output port** check box. This action 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

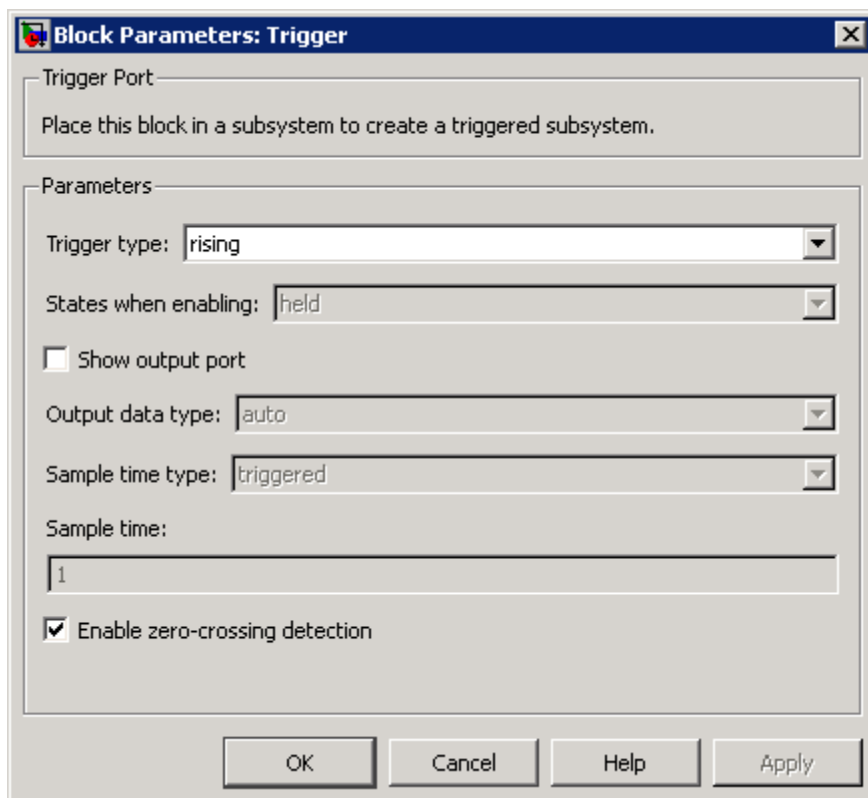
## Data Type Support

The Trigger block accepts signals of any numeric data type supported by Simulink software, including fixed-point data types.

For a discussion on the data types supported by Simulink software, see “Data Types Supported by Simulink” in the Simulink documentation.

# Trigger

## Parameters and Dialog Box



### Trigger type

The type of event that triggers execution of the subsystem.

### States when enabling

This parameter is enabled only if you select `function-call` as the block's trigger type and the setting applies only if the function-call subsystem is explicitly enabled and disabled. For example:

- The function-call subsystem resides in an enabled subsystem. In this case, the function-call subsystem is enabled and disabled along with the parent subsystem.

- The function-call initiator that controls the function-call subsystem resides in an enabled subsystem. In this case, the function-call subsystem is enabled and disabled along with the enabled subsystem containing the function-call initiator.
- The function-call initiator is a Stateflow event that is bound to a particular state. See “Using Bind Actions to Control Function-Call Subsystems” in the Stateflow documentation.
- The function-call initiator is an S-function that explicitly enables and disables the function-call subsystem. See `ssEnableSystemWithTid` for an example.

Selecting `held` (the default) causes Simulink software to leave the states at their current values.

Selecting `reset` for this option causes Simulink software 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` or `reset` setting, i.e., either all `held` or all `reset`.

### Show output port

If selected and this block is in a subsystem, Simulink software displays the Trigger block output port and outputs the trigger signal.

---

**Note** This parameter 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 software 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 software displays an error.

---

**Note** The Trigger block ignores the **Data type override** setting of the Fixed-Point Tool.

---

## Enable zero-crossing detection

Select to enable zero-crossing detection. For more information, see “How Blocks Work with Zero-Crossing Detection” in the “How Simulink Works” chapter of the Simulink documentation.

## Sample time type

This parameter is active only when **Trigger type** is set to `function-call`. The value can 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`. For more information, see “Function-Call Subsystems” in the Simulink documentation and “Using Bind Actions to Control Function-Call Subsystems” in the Stateflow documentation.

## 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 “How to Specify the Sample Time” in the Simulink documentation for information on how to set the value of this parameter. Simulink software 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 Detection	Yes, if enabled

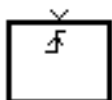
# Trigger-Based Linearization

---

**Purpose** Generate linear models in 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 block sets the following model parameters to the indicated values:

- `BufferReuse` = 'off'
- `RTWInlineParameters` = 'on'
- `BlockReductionOpt` = 'off'

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
<code>a</code>	The A matrix of the linearization
<code>b</code>	The B matrix of the linearization
<code>c</code>	The C matrix of the linearization
<code>d</code>	The D matrix of the linearization
<code>StateName</code>	Names of the model's states
<code>OutputName</code>	Names of the model's output ports
<code>InputName</code>	Names of the model's input ports

Field	Description
OperPoint	A structure that specifies the operating point of the linearization. The structure specifies the value of the model's states ( <code>OperPoint.x</code> ) and inputs ( <code>OperPoint.u</code> ) at the operating point time ( <code>OperPoint.t</code> ).
Ts	The sample time of the linearization for a discrete linearization

Use the Time-Based Linearization block to generate linear models at predetermined times.

You can use state and simulation time logging to extract the model states at operating points. For example, suppose that you want to get the states of the vdp demo model when the signal x1 triggers the Trigger-Based Linearization block on a rising edge.

- 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 Connect the block's trigger port to the signal labeled x1.
- 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: `vdp_Trigger_Based_Linearization`, `tout`, and `xout`.

- 8 Get the index to the first operating point time by entering the following at the MATLAB command line:

# Trigger-Based Linearization

```
ind1 = find(vdp_Trigger_Based_Linearization(1).OperPoint.t==tout);
```

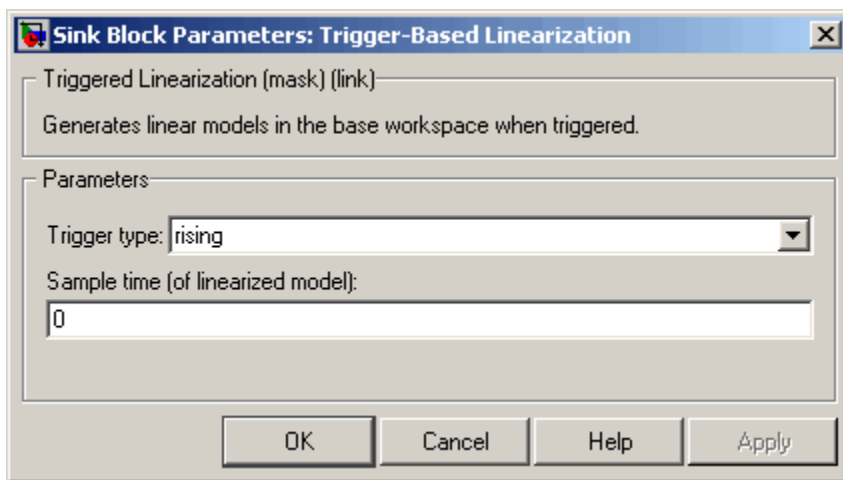
- 9 Get the state vector at this operating point.

```
x1 = xout(ind1,:);
```

## Data Type Support

The trigger port accepts signals of any numeric data type supported by Simulink software.

## Parameters and Dialog Box



### 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 4-122).

<b>Characteristics</b>	Sample Time	Specified in the <b>Sample time</b> parameter
	Dimensionalized	No

**See Also** Time-Based Linearization

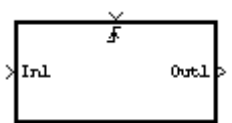
# Triggered Subsystem

---

**Purpose** Represent 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 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`, `atanh`, and `sincos`. The name of the function appears on the block. Each block output is the result of the function operating on one or more inputs.

If you select the `atan2` function, the block displays two inputs. The first input is the  $y$ -axis or complex part of the function argument. The second input is the  $x$ -axis or real part of the function argument. (See “How to Rotate a Block” in the Simulink User’s Guide for a description of the port order for various block orientations.)

If you select the `sincos` function, the block displays two outputs. The first output is the sine of the function argument, and the second output is the cosine 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.

---

**Note** If you use a compiler that does not support the `asinh`, `acosh`, and `atanh` functions, the Real-Time Workshop software issues a warning for the Trigonometric Function block and the generated code fails to link. For more information, see “Simulink Block Support” in the Real-Time Workshop Reference documentation.

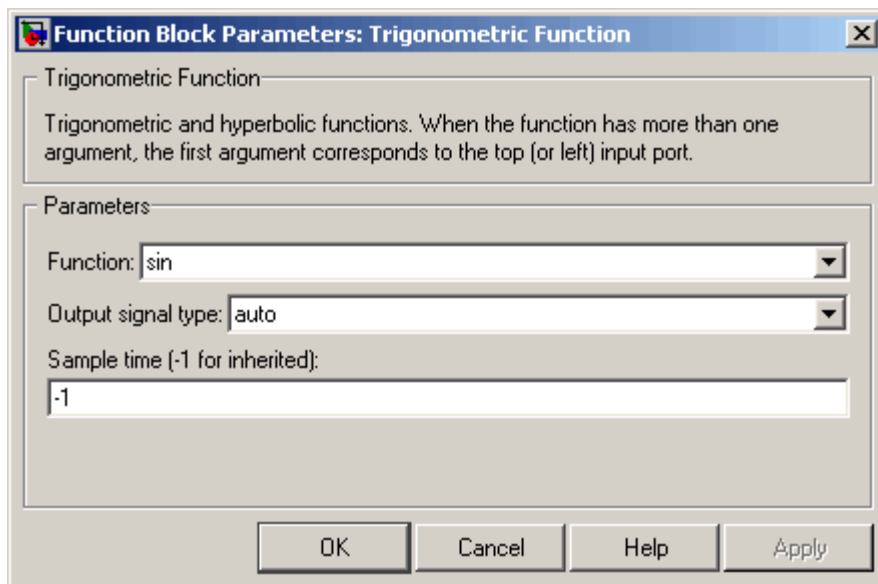
---

**Data Type Support** The Trigonometric Function block accepts and outputs real or complex signals of type `single` or `double`.

# Trigonometric Function

---

## Parameters and Dialog Box



### Function

The trigonometric function.

### Output signal type

Type of signal (complex or real) to output.

---

**Note** The Trigonometric Function block cannot output complex signals in Real-Time Workshop generated code. The imaginary part of a complex signal is always set to zero in the generated code.

---

### Sample time (-1 for inherited)

Specify the time interval between samples. To inherit the sample time, set this parameter to -1. See “How to Specify the Sample Time” in the Simulink User’s Guide for more information.



<b>Characteristics</b>	Direct Feedthrough	Yes
	Sample Time	Inherited from driving block
	Scalar Expansion	Yes, of the input when the function requires two inputs
	Dimensionalized	Yes
	Multidimensionalized	Yes
	Zero Crossing	No

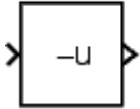
# Unary Minus

---

**Purpose** Negate input

**Library** Math Operations

**Description** The Unary Minus block negates the input. The block accepts only signed data types.

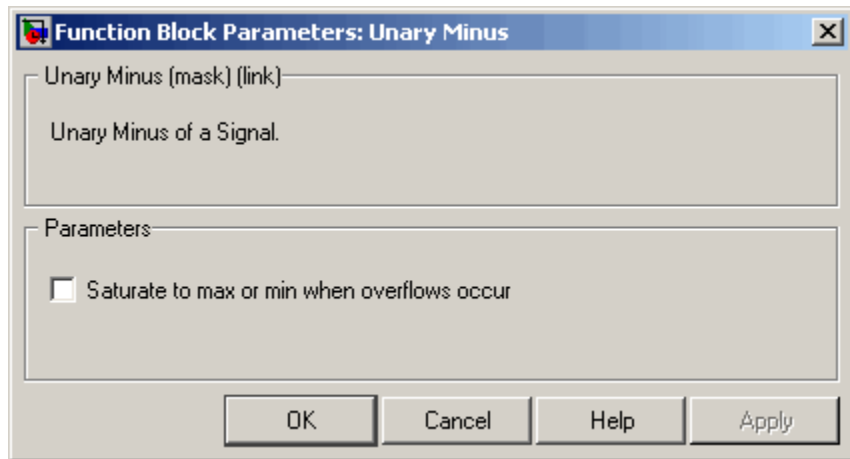


For signed data types, you cannot accurately negate the most negative value since the result is not representable by the data type. In this case, the behavior of the block is controlled by the **Saturate to max or min when overflows occur** check box. If selected, the most negative value of the data 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 numeric data type supported by Simulink software except unsigned integers, including fixed-point data types.

## Parameters and Dialog Box



### Saturate to max or min when overflows occur

If selected, fixed-point overflows saturate.

## Characteristics

Direct Feedthrough	No
Scalar Expansion	Yes, of input or initial conditions
Multidimensionalized	Yes

# 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.

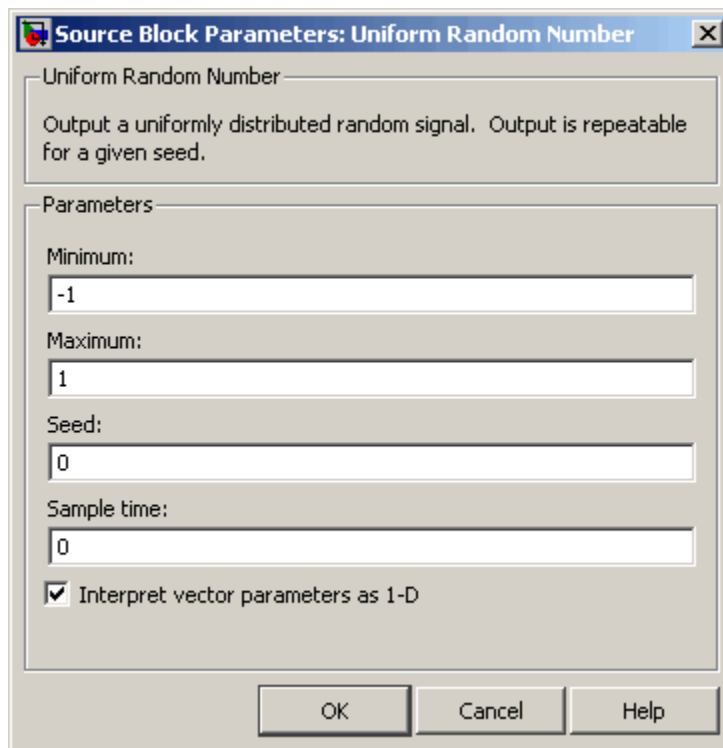
Avoid integrating a random signal, because solvers are meant to integrate relatively smooth signals. Instead, use the Band-Limited White Noise block.

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.

## Data Type Support

The Uniform Random Number block outputs a real signal of type double.

## Parameters and Dialog Box



Opening this dialog box causes a running simulation to pause. See “Changing Source Block Parameters During Simulation” 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.

### Seed

The starting seed for the random number generator. The default is 0.

# Uniform Random Number

---

## Sample time

The sample period. The default is 0. See “How to Specify the Sample Time” in the online documentation for more information.

## Interpret vector parameters as 1-D

If selected, column or row matrix values for the Uniform Random Number 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 Simulink documentation.

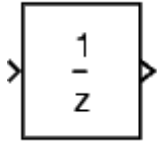
## Characteristics

Sample Time	Specified in the <b>Sample time</b> parameter
Scalar Expansion	No
Dimensionalized	Yes
Multidimensionalized	Yes
Zero Crossing	No

**Purpose** Delay 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.

---

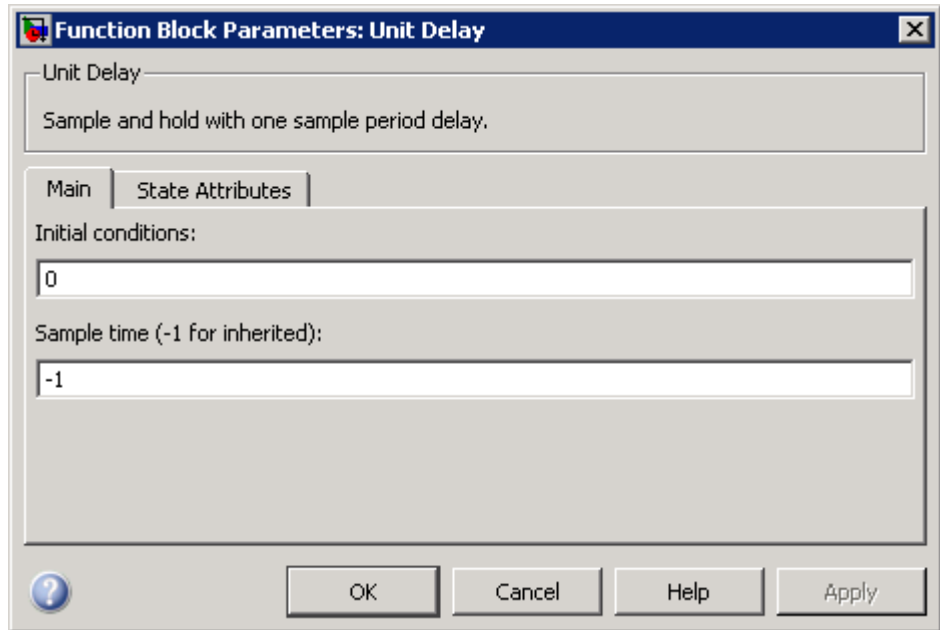
## Data Type Support

The Unit Delay block accepts real or complex signals of any data type supported by Simulink software, including fixed-point and enumerated data types. If the data type of the input signal is user-defined, the initial condition must be zero.

# Unit Delay

For a discussion on the data types supported by Simulink software, see “Data Types Supported by Simulink” in the Simulink documentation.

## Parameters and Dialog Box



During simulation, the block uses the following values:

- The initial value of the signal object to which the state name is resolved
- Min and Max values of the signal object

See “Block State Storage and Interfacing” in the Real-Time Workshop documentation for more information.



## **Initial conditions**

Specify the output of the simulation for the first sampling period, during which the output of the Unit Delay block is otherwise undefined.

## **Settings**

**Default:** 0

The **Initial conditions** parameter is converted from a double to the input data type offline using round-to-nearest and saturation.

## **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

# Unit Delay

---

## **Sample time (-1 for inherited)**

Enter the discrete interval between sample time hits or specify another appropriate sample time such as continuous or inherited.

### **Settings**

**Default:** -1

By default, the block inherits its sample time based upon the context of the block within the model. To set a different sample time, enter a valid sample time based upon the table in “Types of Sample Time”.

See also “How to Specify the Sample Time” in the online documentation for more information.

### **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

## State name

Use this to assign a unique name to each state.

## Settings

Default: ' '

- If left blank, no name is assigned.

## Tips

- To assign a name to a single state, enter the name between quotes, for example, 'velocity' .
- The state names apply only to the selected block.
- To assign names to multiple states, enter a comma-delimited list surrounded by braces. For example, { 'a' , 'b' , 'c' } . Each name must be unique.
- The number of states must be evenly divided by the number of state names. There can be fewer names than states, but there cannot be more names than states.
- For example, you can specify two names in a system with four states. Simulink software will assign the first name to the first two states and the second name to the last two.
- To assign state names with a variable that has been defined in the MATLAB workspace, enter the variable without quotes. A variable can be a string, cell, or structure.

## Dependencies

This parameter enables **State name must resolve to Simulink signal object** when you click the **Apply** button.

## Command-Line Information

See “Block-Specific Parameters” on page 8-96 for the command-line information.

# Unit Delay

---

## **State name must resolve to Simulink signal object**

Require that state name resolve to Simulink signal object.

### **Settings**

**Default:** Off

On

Require that state name resolve to Simulink signal object.

Off

Do not require that state name resolve to Simulink signal object.

### **Dependencies**

This parameter is enabled by **State name**.

Selecting this check box enables **Real-Time Workshop storage class**.

### **Command-Line Information**

See “Block-Specific Parameters” on page 8-96 for the command-line information.

## Real-Time Workshop storage class

Select state storage class.

### Settings

**Default:** Auto

#### Auto

Auto is the appropriate storage class for states that you do not need to interface to external code.

#### ExportedGlobal

State is stored in a global variable

#### ImportedExtern

`model_private.h` declares the state as an extern variable.

#### ImportedExternPointer

`model_private.h` declares the state as an extern pointer.

### Dependencies

This parameter is enabled by **State name**.

Setting this parameter to `ExportedGlobal`, `ImportedExtern`, or `ImportedExternPointer` enables **Real-Time Workshop storage type qualifier**.

### Command-Line Information

See “Block-Specific Parameters” on page 8-96 for the command-line information.

### See Also

“Block State Storage Classes” in the *Real-Time Workshop User’s Guide*.

# Unit Delay

---

## Real-Time Workshop storage type qualifier

Specify Real-Time storage type qualifier.

### Settings

Default: ' '

If left blank, no qualifier is assigned.

### Dependencies

This parameter is enabled by setting **Real-Time Workshop storage class** to ExportedGlobal, ImportedExtern, or ImportedExternPointer.

### Command-Line Information

See “Block-Specific Parameters” on page 8-96 for the command-line information.

## Bus Support

The Unit Delay block is a bus-capable block. The input can be a virtual or nonvirtual bus signal subject to the following restrictions:

- **Initial conditions** must be zero or a non-zero scalar.
- If **Initial conditions** is zero and a **State name** is specified, the input cannot be a virtual bus.
- If **Initial conditions** is a non-zero scalar, no **State name** can be specified.

All signals in a nonvirtual bus input to a Unit Delay block must have the same sample time, even if the elements of the associated bus object specify inherited sample times. You can use a Rate Transition block to change the sample time of an individual signal, or of all signals in a bus. See Using Buses and Bus-Capable Blocks for more information.

## Characteristics

Bus-capable	Yes, with restrictions as noted above
Direct Feedthrough	No

Sample Time	Specified in the <b>Sample time</b> parameter
Scalar Expansion	Yes, of input or initial conditions
States	Yes—inherited from driving block for nonfixed-point data types.
Dimensionalized	Yes
Multidimensionalized	Yes
Zero Crossing	No

## See Also

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

# Unit Delay Enabled

---

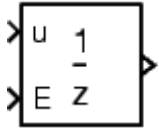
## Purpose

Delay signal one sample period, if 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.

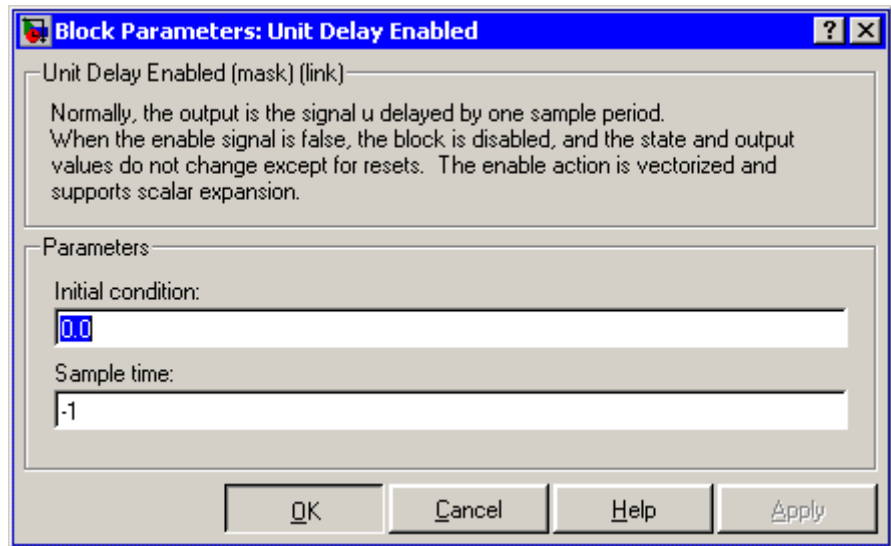
You input the sample time with the **Sample time** parameter. A setting of -1 means the **Sample time** is inherited.

## Data Type Support

The Unit Delay Enabled block accepts signals of any data type supported by Simulink software, including fixed-point and enumerated data types.



## Parameters and Dialog Box



### Initial condition

Initial condition.

### Sample time

Specify the time interval between samples. To inherit the sample time, set this parameter to -1. See “How to Specify the Sample Time” in the online documentation for more information.

## Characteristics

Direct Feedthrough	No
Sample Time	Specified in the <b>Sample time</b> 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

# Unit Delay Enabled

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Resettable, Unit Delay With Preview Enabled Resettable External  
RV, Unit Delay With Preview Resettable, Unit Delay With Preview  
Resettable External RV

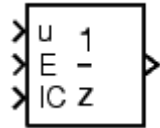
## Purpose

Delay signal one sample period, if external enable signal is on, with 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.

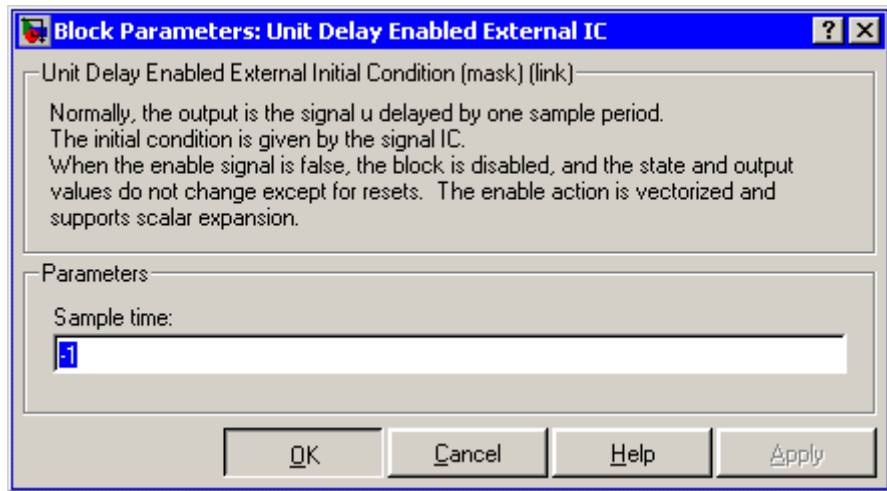
You specify the time between samples with the **Sample time** parameter. A setting of -1 means the **Sample time** is inherited.

## Data Type Support

The Unit Delay Enabled External IC block accepts signals of any data type supported by Simulink software, including fixed-point and enumerated data types.

# Unit Delay Enabled External IC

## Parameters and Dialog Box



### Sample time

Specify the time interval between samples. To inherit the sample time, set this parameter to -1. See “How to Specify the Sample Time” in the online documentation for more information.

### 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 <b>Sample time</b> 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

# Unit Delay Enabled External IC

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Delay With Preview Enabled Resettable External RV, Unit Delay With  
Preview Resettable, Unit Delay With Preview Resettable External RV

# Unit Delay Enabled Resettable

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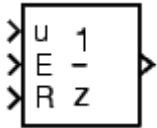
## Purpose

Delay signal one sample period, if external enable signal is on, with external Boolean reset

## Library

Additional Math & Discrete / Additional Discrete

## Description



The Unit Delay Enabled Resettable block combines the features of the Unit Delay Enabled 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, specified by the **Initial condition** parameter, 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.

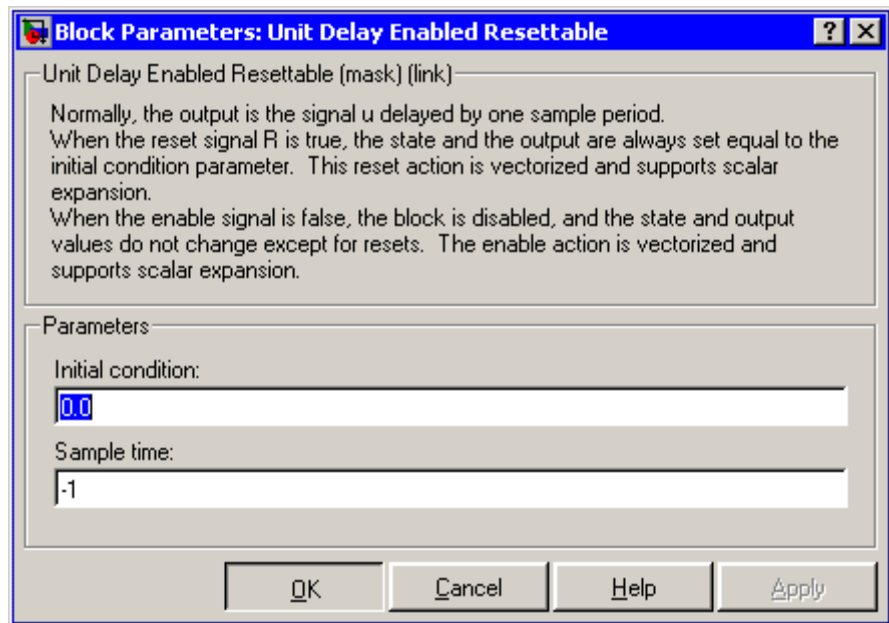
You specify the time between samples with the **Sample time** parameter. A setting of -1 means the **Sample time** is inherited.

## Data Type Support

The Unit Delay Enabled Resettable block accepts signals of any data type supported by Simulink software, including fixed-point and enumerated data types.

# 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 “How to Specify the Sample Time” in the online documentation for more information.

# Unit Delay Enabled Resettable

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## Characteristics

Direct Feedthrough	No, of the input port No, of the enable port Yes, of the reset port
Sample Time	Specified in the <b>Sample time</b> 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

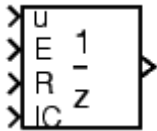
## Purpose

Delay signal one sample period, if external enable signal is on, with 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.

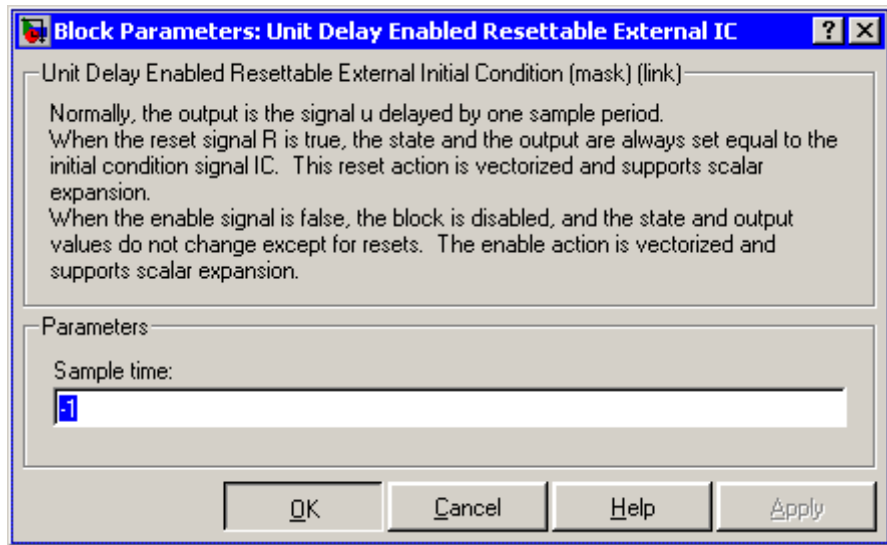
You specify the time between samples with the **Sample time** parameter. A setting of -1 means the **Sample time** is inherited.

## Data Type Support

The Unit Delay Enabled Resettable External IC block accepts signals of any data type supported by Simulink software, including fixed-point and enumerated data types.

# Unit Delay Enabled Resettable External IC

## Parameters and Dialog Box



### Sample time

Specify the time interval between samples. To inherit the sample time, set this parameter to -1. See “How to Specify the 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 <b>Sample time</b> 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

# Unit Delay Enabled Resettable External IC

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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

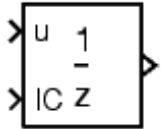
## Purpose

Delay signal one sample period, with 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.

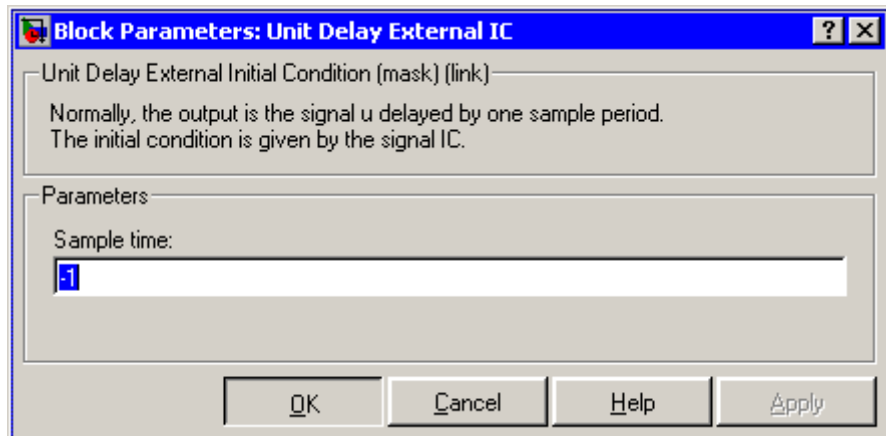
The input  $u$  and initial condition IC data types must be the same, and are any data type.

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 software, including fixed-point and enumerated 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 “How to Specify the 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 <b>Sample time</b> 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

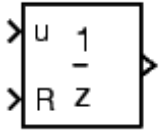
# Unit Delay Resettable

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**Purpose** Delay signal one sample period, with 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 both its state and output 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.

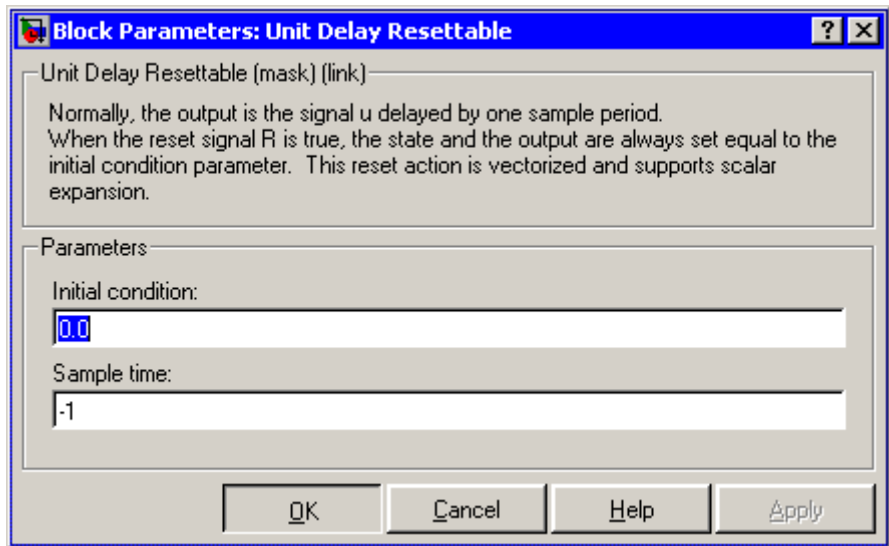
At the start of simulation, the block's **Initial condition** parameter determines its initial output. During simulation, when the reset signal is false, the block outputs the input signal delayed by one time step. When the reset signal is true, the block resets the current state and its output to the **Initial condition**.

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 software, including fixed-point and enumerated data types.

# Unit Delay Resettable

## 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 “How to Specify the 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 <b>Sample time</b> 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

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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 signal one sample period, with 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.

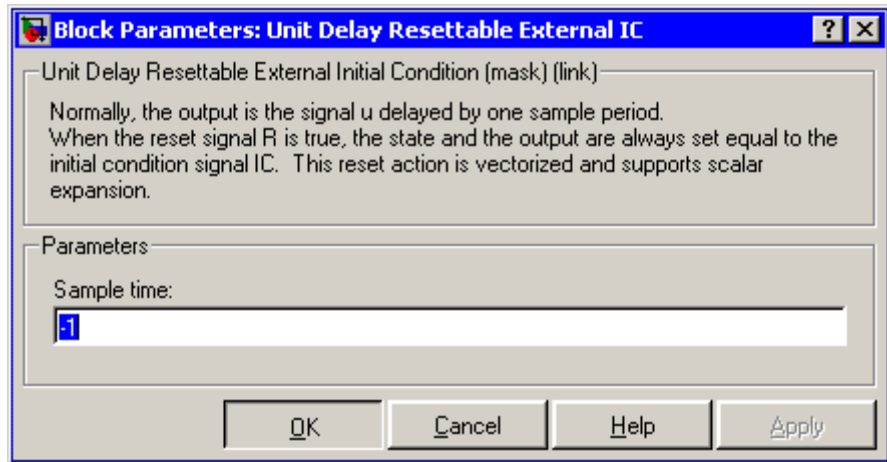
You specify the time between samples with the **Sample time** parameter. A setting of -1 means the **Sample time** is inherited.

## Data Type Support

The Unit Delay Resettable External IC block accepts signals of any data type supported by Simulink software, including fixed-point and enumerated data types.

# Unit Delay Resetable External IC

## Parameters and Dialog Box



### Sample time

Specify the time interval between samples. To inherit the sample time, set this parameter to -1. See “How to Specify the 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 <b>Sample time</b> parameter
Scalar Expansion	Yes

### See Also

Unit Delay, Unit Delay Enabled, Unit Delay Enabled External IC, Unit Delay Enabled Resetable, Unit Delay Enabled Resetable External IC, Unit Delay External IC, Unit Delay Resetable, Unit Delay With Preview Enabled, Unit Delay With Preview Enabled Resetable, Unit Delay With Preview Enabled Resetable External RV, Unit Delay With Preview Resetable, Unit Delay With Preview Resetable External RV

# Unit Delay With Preview Enabled

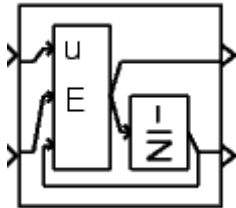
## Purpose

Output signal and signal delayed by one sample period, if 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 input ports: one for the input signal  $u$  and one for the external enable signal  $E$ .

When the enable signal  $E$  is on, the first port outputs the signal and the second port outputs the signal delayed by one sample period. When the enable signal  $E$  is off, the block is disabled, and the state and output values do not change, except during resets.

The enable signal is on when  $E$  is not 0, and off when  $E$  is 0. This enable action is vectorized and supports scalar expansion.

Having two outputs is useful for implementing recursive calculations where the result includes the most recent inputs. The second output can feed back into calculations of the block's inputs without causing an algebraic loop. Meanwhile, the first output shows the most up-to-date calculations.

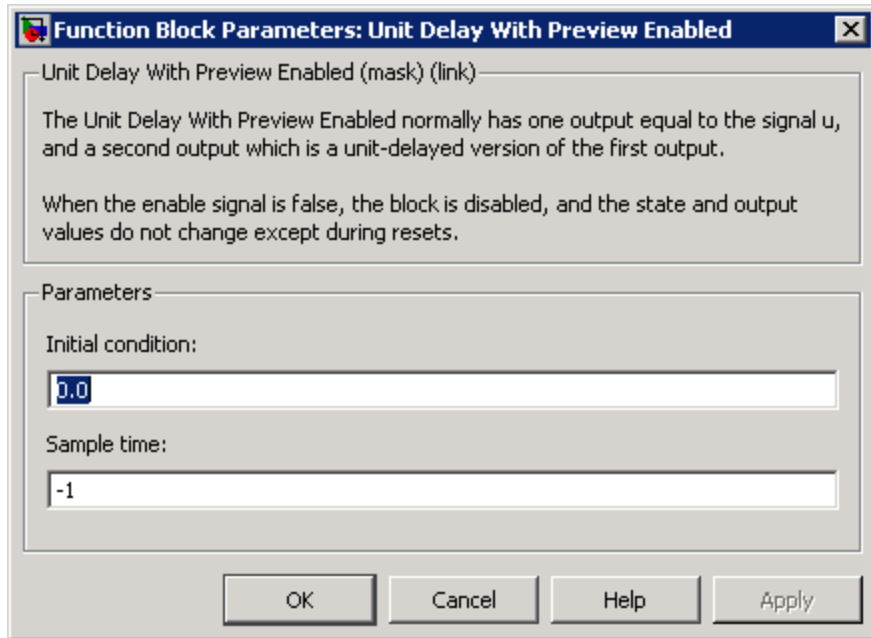
The **Initial condition** parameter specifies the block output for the first sampling period. The **Sample time** parameter specifies the time between samples. To inherit the sample time, set this parameter to -1.

## Data Type Support

The Unit Delay With Preview Enabled block accepts input signals of any data type supported by Simulink software, including fixed-point and enumerated data types. The outputs are the same data type as the input  $u$ .

# Unit Delay With Preview Enabled

## 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 “How to Specify the Sample Time” in the online documentation for more information.

## Characteristics

Direct Feedthrough	Yes, to first output port No, to second output port
Sample Time	Specified in the <b>Sample time</b> parameter
Scalar Expansion	Yes

# Unit Delay With Preview Enabled

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## **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 With Preview Enabled Resettable External RV, Unit Delay With Preview Resettable, Unit Delay With Preview Resettable External RV

# Unit Delay With Preview Enabled Resettable

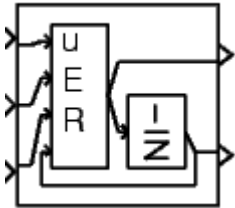
## Purpose

Output signal and signal delayed by one sample period, if external enable signal is on, with external 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 a reset signal R.

The block has three input ports: one for the input signal  $u$ , one for the external enable signal  $E$ , and one for the external reset signal  $R$ .

When the enable signal  $E$  is on and the reset signal  $R$  is false, the first port outputs the signal and the second port outputs the 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 **Initial condition** parameter. The first output signal is forced to equal the initial condition. The second output signal is not affected until one time step later.

When the enable signal is off, the block is disabled, and the state and output values do not change, except during resets.

The enable signal is on when  $E$  is not 0, and off when  $E$  is 0. The enable and reset actions are vectorized and support scalar expansion.

Having two outputs is useful for implementing recursive calculations where the result includes the most recent inputs. The second output can feed back into calculations of the block's inputs without causing an algebraic loop. Meanwhile, the first output shows the most up-to-date calculations.

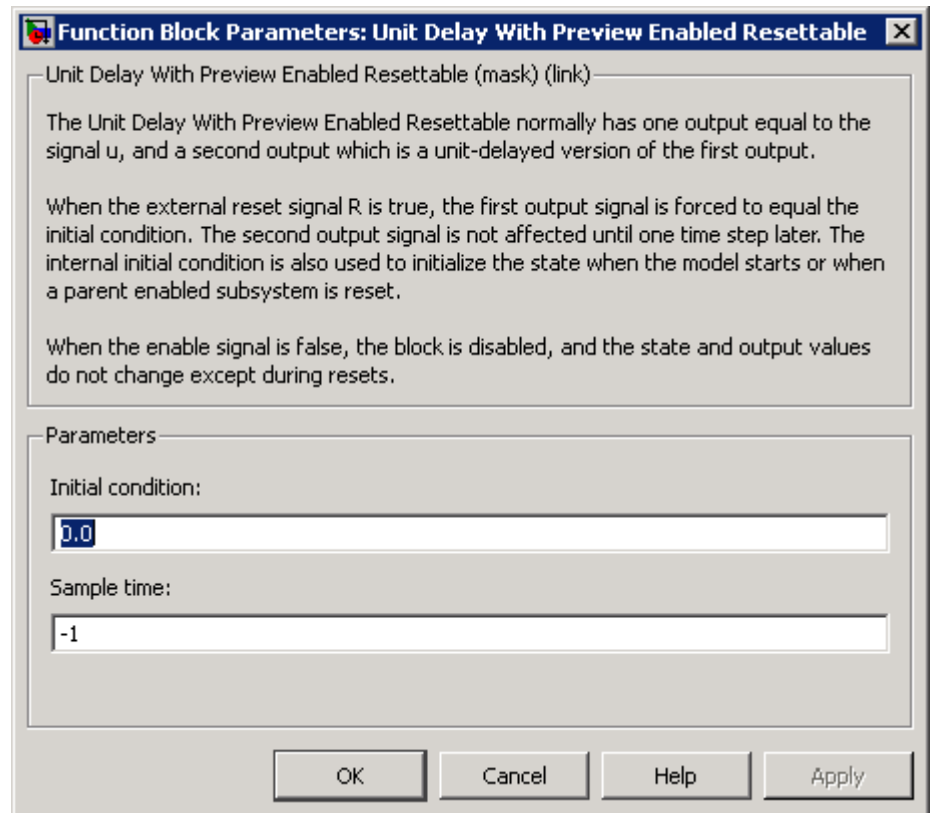
The **Sample time** parameter specifies the time between samples. To inherit the sample time, set this parameter to  $-1$ .

# Unit Delay With Preview Enabled Resetable

## Data Type Support

The Unit Delay With Preview Enabled Resetable block accepts input signals of any data type supported by Simulink software, including fixed-point and enumerated data types. The outputs are the same data type as the input  $u$ .

## Parameters and Dialog Box



### Initial condition

Specify the initial condition.

# Unit Delay With Preview Enabled Resettable

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## Sample time

Specify the time interval between samples. To inherit the sample time, set this parameter to -1. See “How to Specify the Sample Time” in the online documentation for more information.

## Characteristics

Direct Feedthrough	Yes, to first output port No, to second output port
Sample Time	Specified in the <b>Sample time</b> 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

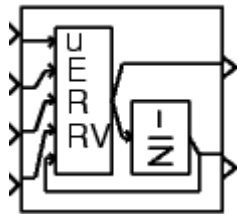
## Purpose

Output signal and signal delayed by one sample period, if external enable signal is on, with 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 a reset signal R.

The block has four input ports: one for the input signal  $u$ , one for the external enable signal  $E$ , one for the external reset signal  $R$ , and one for the external reset value  $RV$ .

When the enable signal  $E$  is on and the reset signal  $R$  is false, the first port outputs the signal and the second port outputs the signal delayed by one sample period.

When the enable signal  $E$  is on and the reset signal  $R$  is true, the first output signal is forced to equal the reset value  $RV$ . The second output signal is not affected until one time step later, at which time it is equal to the reset value  $RV$  at the previous time step. The internal **Initial condition** has a direct effect on the second output only when the model starts or when a parent enabled subsystem is reset.

When the enable signal is off, the block is disabled, and the state and output values do not change, except during resets.

The enable signal is on when  $E$  is not 0, and off when  $E$  is 0. The enable and reset actions are vectorized and support scalar expansion.

Having two outputs is useful for implementing recursive calculations where the result includes the most recent inputs. The second output can feed back into calculations of the block's inputs without causing an algebraic loop. Meanwhile, the first output shows the most up-to-date calculations.

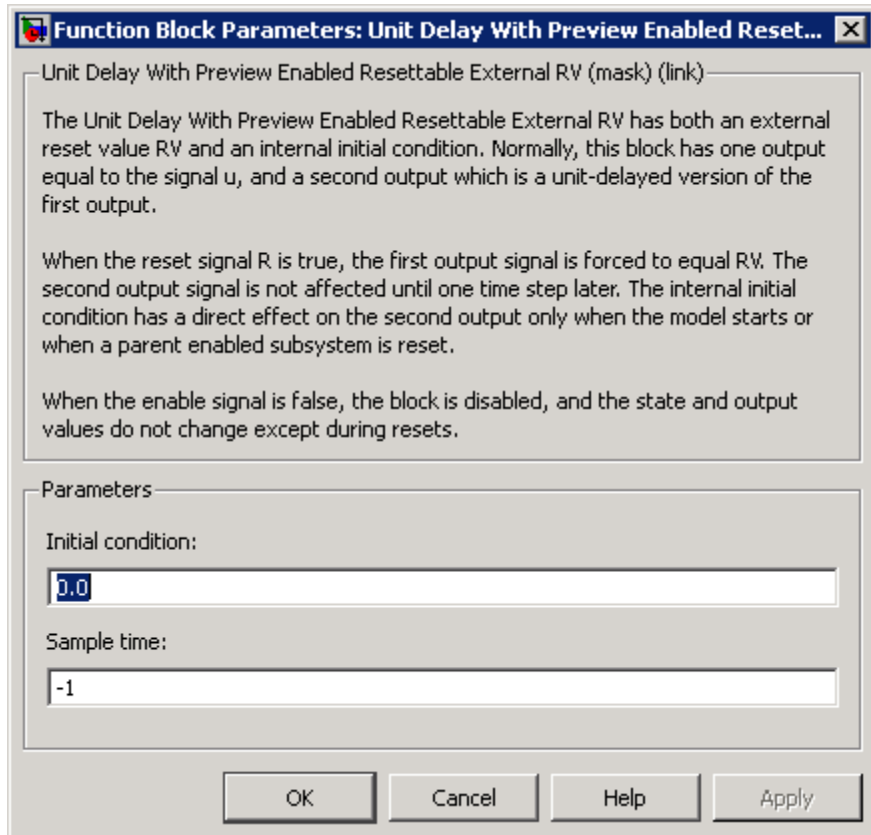
The **Sample time** parameter specifies the time between samples. To inherit the sample time, set this parameter to -1.

# Unit Delay With Preview Enabled Resettable External RV

## Data Type Support

The Unit Delay With Preview Enabled Resettable External RV block accepts input signals of any data type supported by Simulink software, including fixed-point and enumerated data types. The outputs are the same data type as the input  $u$ .

## Parameters and Dialog Box



### Initial condition

Specify the initial condition.

# Unit Delay With Preview Enabled Resettable External RV

## Sample time

Specify the time interval between samples. To inherit the sample time, set this parameter to -1. See “How to Specify the Sample Time” in the online documentation for more information.

## Characteristics

Direct Feedthrough	Yes, to first output port No, to second output port
Sample Time	Specified in the <b>Sample time</b> 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 Resettable, Unit Delay With Preview Resettable External RV

# Unit Delay With Preview Resettable

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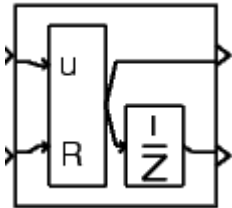
## Purpose

Output signal and signal delayed by one sample period, with external 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 a reset signal R.

The block has two input ports: one for the input signal  $u$  and one for the external reset signal R.

When the reset signal R is false, the first port outputs the signal and the second port outputs the signal delayed by one sample period.

When the reset signal R is true, the block resets the current state to the initial condition given by the **Initial condition** parameter. The first output signal is forced to equal the initial condition. The second output signal is not affected until one time step later.

This reset action is vectorized and supports scalar expansion.

Having two outputs is useful for implementing recursive calculations where the result includes the most recent inputs. The second output can feed back into calculations of the block's inputs without causing an algebraic loop. Meanwhile, the first output shows the most up-to-date calculations.

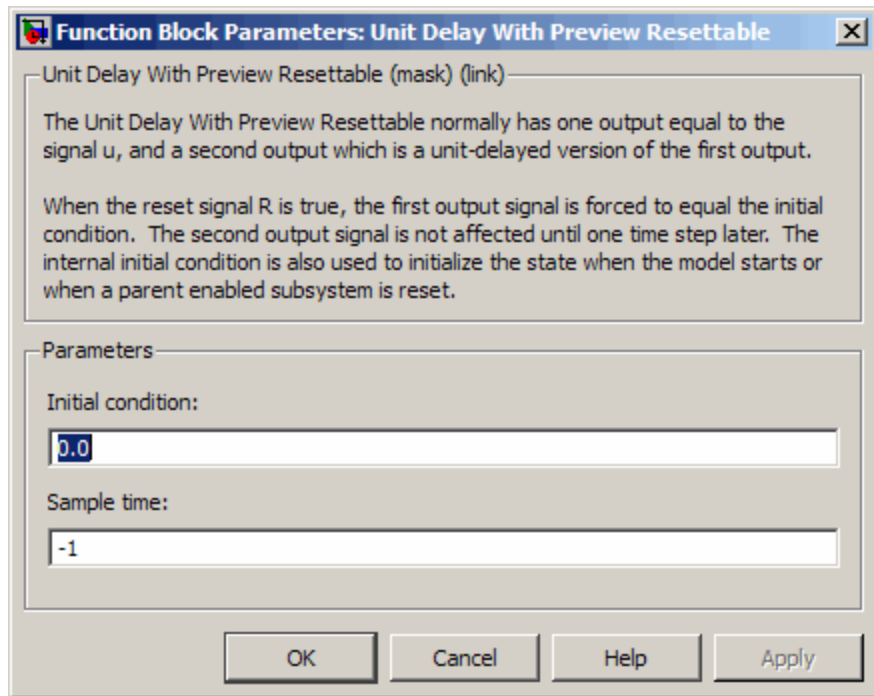
The **Sample time** parameter specifies the time between samples. To inherit the sample time, set this parameter to -1.

## Data Type Support

The Unit Delay With Preview Resettable block accepts input signals of any data type supported by Simulink software, including fixed-point and enumerated data types. The outputs are the same data type as the input  $u$ .

# 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 “How to Specify the Sample Time” in the online documentation for more information.

# Unit Delay With Preview Resettable

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<b>Characteristics</b>	Direct Feedthrough	Yes, to first output port No, to second output port
	Sample Time	Specified in the <b>Sample time</b> 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

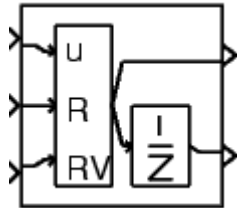
## Purpose

Output signal and signal delayed by one sample period, with 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 a reset signal R.

The block has three input ports: one for the input signal u, one for the external reset signal R, and one for the external reset value RV.

When the reset signal R is false, the first port outputs the signal and the second port outputs the signal delayed by one sample period.

When the reset signal R is true, the first output signal is forced to equal the reset value RV. The second output signal is not affected until one time step later, at which time it is equal to the reset value RV at the previous time step. The internal **Initial condition** has a direct effect on the second output only when the model starts or when a parent enabled subsystem is reset.

This reset action is vectorized and supports scalar expansion.

Having two outputs is useful for implementing recursive calculations where the result includes the most recent inputs. The second output can feed back into calculations of the block's inputs without causing an algebraic loop. Meanwhile, the first output shows the most up-to-date calculations.

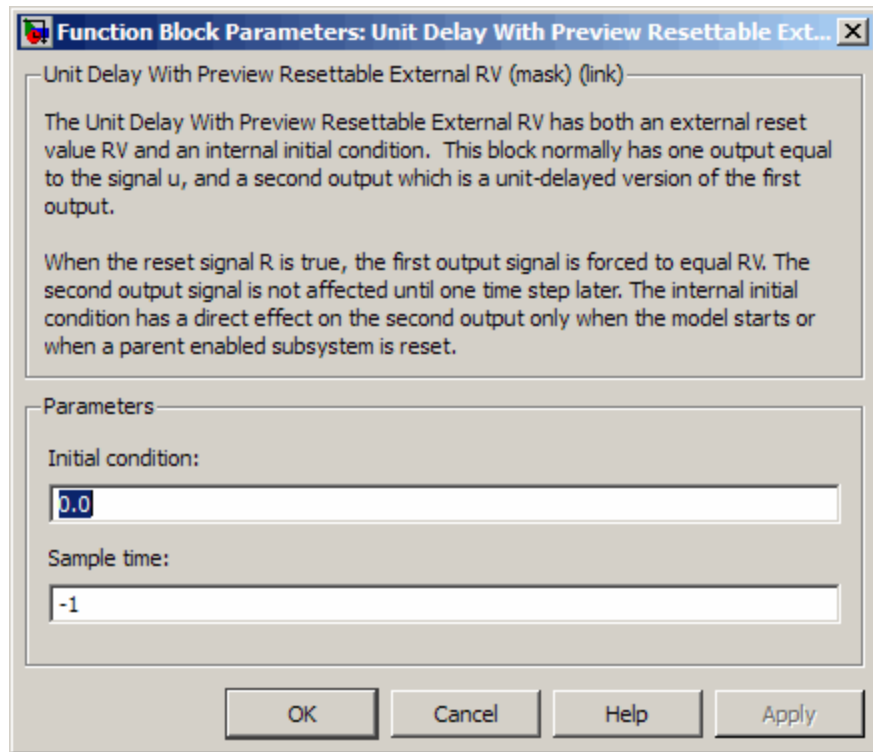
The **Sample time** parameter specifies the time between samples. To inherit the sample time, set this parameter to -1.

## Data Type Support

The Unit Delay With Preview Resettable External RV block accepts input signals of any data type supported by Simulink software, including fixed-point data types. The outputs are the same data type as the input u.

# Unit Delay With Preview Resetable 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 “How to Specify the Sample Time” in the online documentation for more information.



# Unit Delay With Preview Resettable External RV

---

## Characteristics

Direct Feedthrough	Yes, to first output port No, to second output port
Sample Time	Specified in the <b>Sample time</b> 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

# Variable Time Delay, Variable Transport Delay

**Purpose** Delay input by variable amount of time

**Library** Continuous

## Description

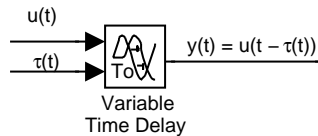


The Variable Transport Delay and Variable Time Delay appear as two blocks in the Simulink block library. However, they are actually the same built-in Simulink block with different settings of a **Select delay type** parameter. This parameter allows you to specify that the block operate in either of the following modes.

### Variable Time Delay

In this mode, the block has a data input a time delay input, and a data output. (See “How to Rotate a Block” in the Simulink documentation for a description of the port order for various block orientations.) 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

# Variable Time Delay, Variable Transport Delay

block outputs the signal at the time that corresponds to the current simulation time minus the delay time.

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 (top, or left) input at an earlier time equal to the current time minus a transportation delay

$$y(t) = u(t - t_d(t))$$

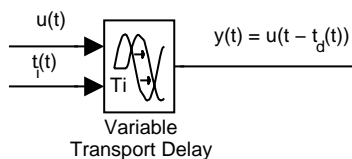
Simulink software finds the transportation delay,  $t_d(t)$ , by solving the following equation

$$\int_{t-t_d(t)}^t \frac{1}{t_i(\tau)} d\tau = 1$$

This equation involves an instantaneous time delay,  $t_i(t)$ , given by the block's time delay (bottom, or right) input.

# Variable Time Delay, 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

$$t_d(t) = \frac{L}{v_i(t)}$$

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.

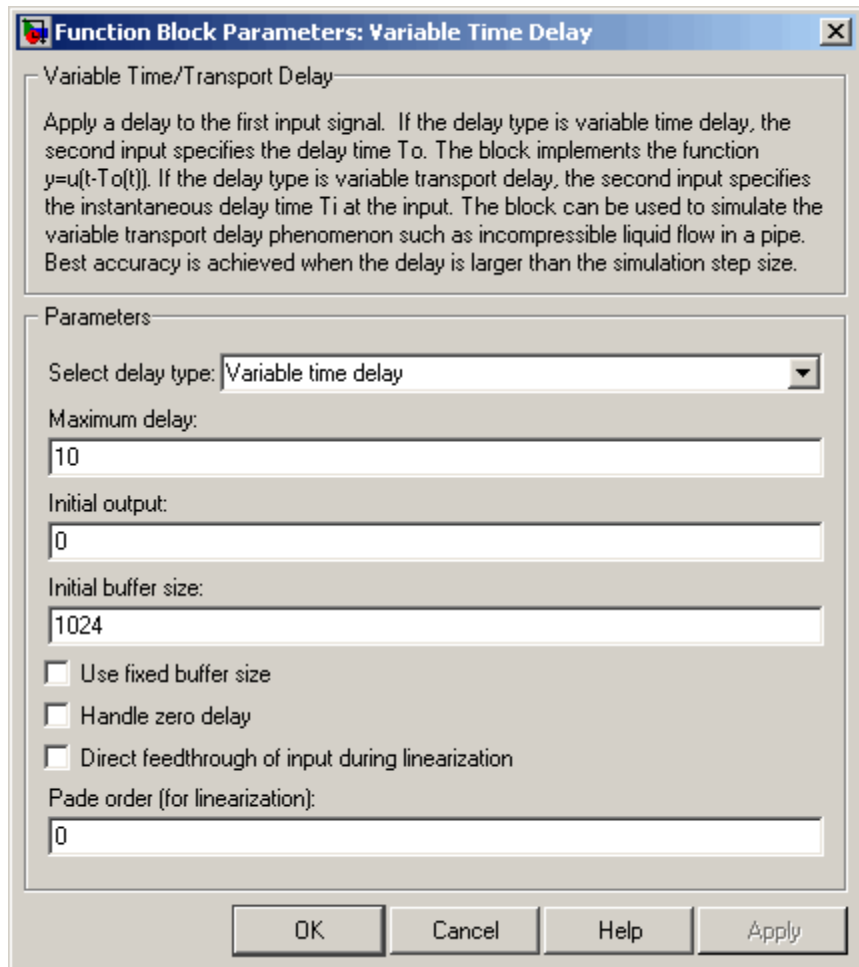
## Parameters and Dialog Box

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.

# Variable Time Delay, 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 software 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 software 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.

# Variable Time Delay, Variable Transport Delay

---

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.

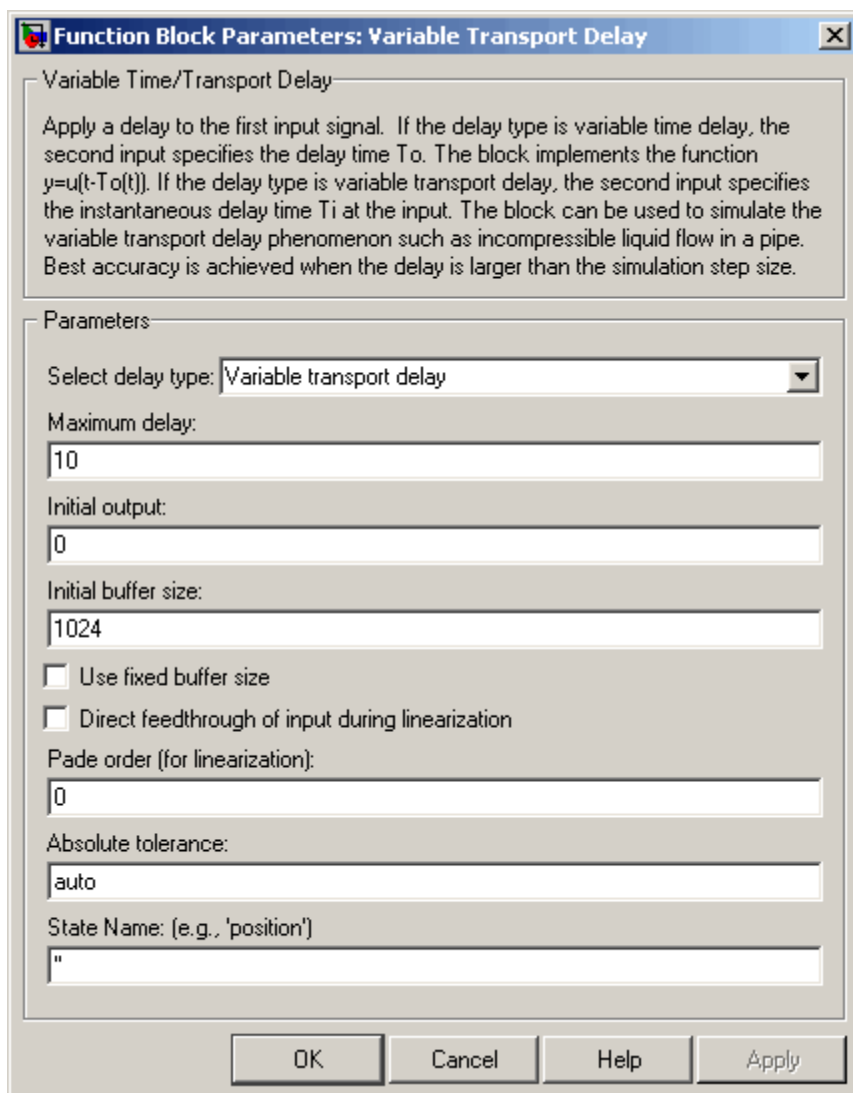
## **Pade order (for linearization)**

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.

## **Variable Transport Delay Parameters and Dialog Box**

The block's dialog box in Variable Transport Delay mode appears as follows.

# Variable Time Delay, Variable Transport Delay



This mode adds the following parameter.



# Variable Time Delay, Variable Transport Delay

## Absolute tolerance

Absolute tolerance used to solve the block's states. You can enter auto or a numeric value. If you enter auto, Simulink software determines the absolute tolerance (see "Absolute tolerance"). If you enter a numeric value, Simulink software 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.

## State Name

Use this to assign a unique name to each state. The state names apply only to the selected block. If left blank, no name is assigned.

To assign a name to a single state, enter the name between quotes, for example, 'velocity'.

To assign names to multiple states, enter a comma-delimited list surrounded by braces. For example, {'a', 'b', 'c'}. Each name must be unique.

The number of states must be evenly divided by the number of state names. There can be fewer names than the number of states, but there cannot be more names than states.

For example, you can specify two names in a system with four states. Simulink software will assign the first name to the first two states and the second name to the last two.

To assign state names with a variable that has been defined in the MATLAB workspace, enter the variable without quotes. A variable can be a string, cell, or structure.

## Characteristics

Direct Feedthrough	Yes, of the time delay (second) input
Sample Time	Continuous

# Variable Time Delay, Variable Transport Delay

---

Scalar Expansion	Yes, of input and all parameters except <b>Initial buffer size</b>
Dimensionalized	Yes
Zero Crossing	No

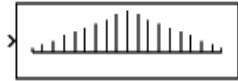
# Weighted Moving Average (Obsolete)

---

**Purpose** Implement weighted moving average (obsolete)

**Library** Discrete

## Description



---

**Note** The Weighted Moving Average block is obsolete. The MathWorks plans to remove this block in a future release. Use the Discrete FIR Filter block in new models. Consider replacing Weighted Moving Average with Discrete FIR Filter in existing models.

---

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. You can choose whether or not to specify the data type and scaling of the weights in the dialog with the **Gain data type** parameter.

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.

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.

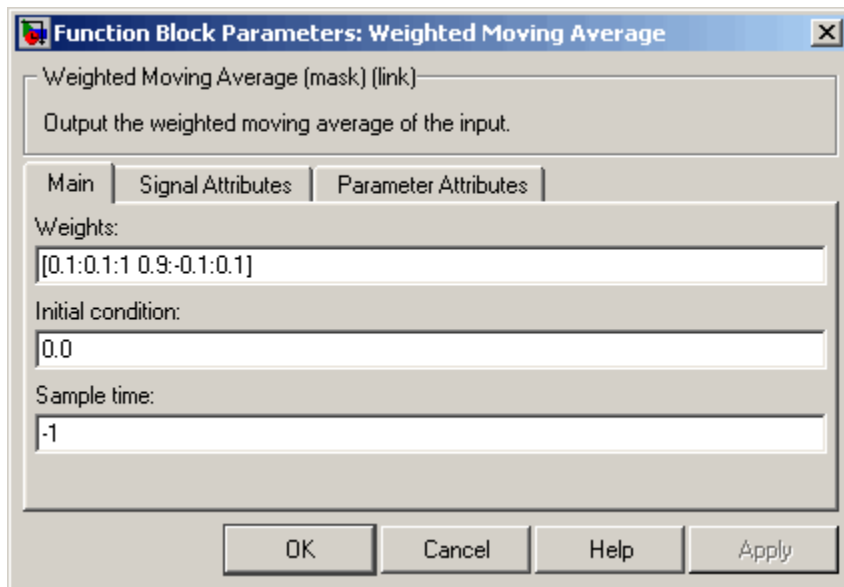
## Data Type Support

The Weighted Moving Average block supports all numeric data types supported by Simulink software, including fixed-point data types.

# Weighted Moving Average (Obsolete)

## Parameters and Dialog Box

The **Main** pane of the Weighted Moving Average block dialog box appears as follows:



### 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

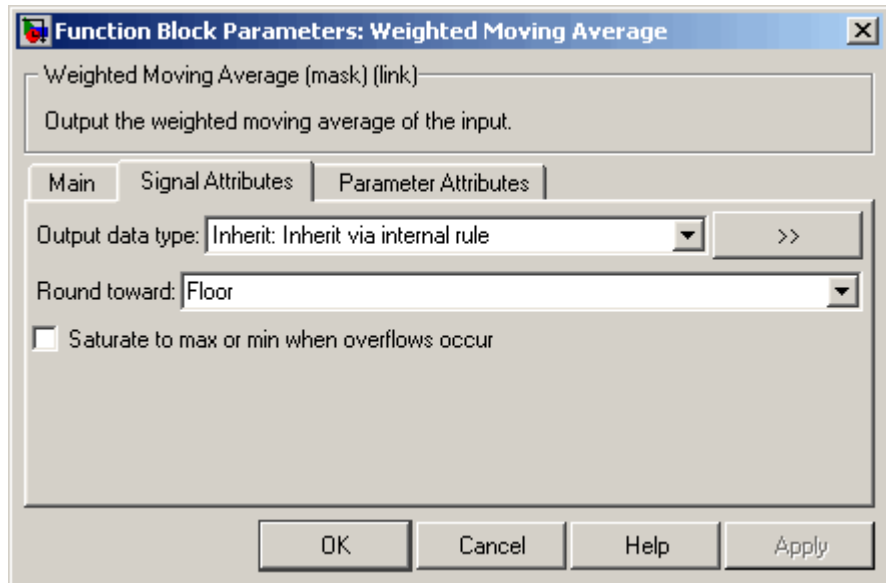
Specify the initial values for all times preceding the start time. The **Initial condition** parameter is converted from doubles to the input data type offline using round-to-nearest and saturation.

### Sample time

Specify the time interval between samples. To inherit the sample time, set this parameter to -1. See “How to Specify the Sample Time” in the online documentation for more information.

# Weighted Moving Average (Obsolete)


The **Signal Attributes** pane of the Weighted Moving Average block dialog box appears as follows:



## Output data type

Specify the output data type. You can set it to:

- A rule that inherits a data type, for example, `Inherit: Inherit via back propagation`
- The name of a data type object, for example, a `Simulink.NumericType` object
- An expression that evaluates to a data type, for example, `float('single')`

Click the **Show data type assistant** button  to display the **Data Type Assistant**, which helps you set the **Output data type** parameter.

# Weighted Moving Average (Obsolete)

---

See “Specifying Block Output Data Types” in *Simulink User’s Guide* for more information.

## Lock output scaling against changes by the autoscaling tool

Select to lock scaling of outputs. This parameter is visible only if you enter an expression for the **Output data type** parameter.

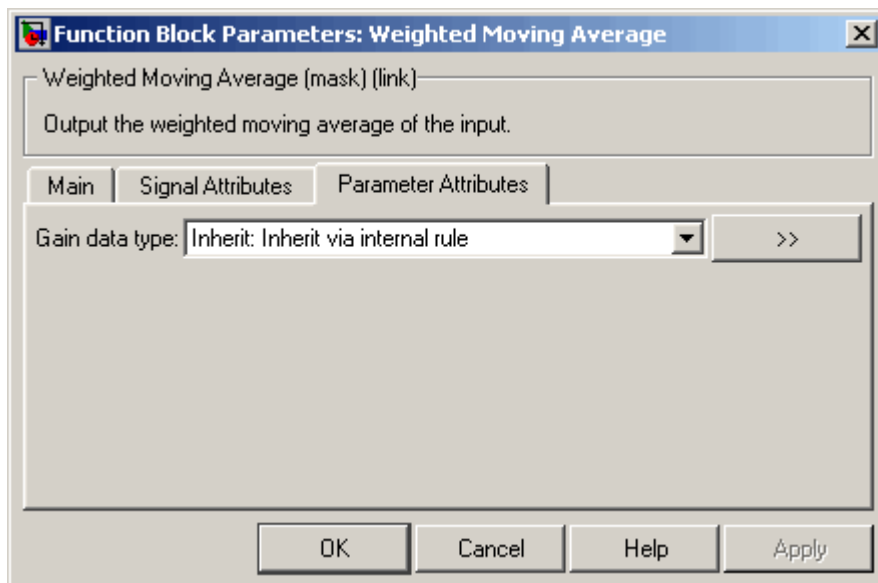
## Round toward

Rounding mode for the fixed-point output. For more information, see “Rounding” in the *Simulink Fixed Point User’s Guide*.

## Saturate to max or min when overflows occur

If selected, fixed-point overflows saturate.

The **Parameter Attributes** pane of the Weighted Moving Average block dialog appears as follows:

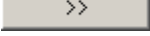


## Gain data type

Specify the data type of the **Weights** parameter. You can set it to:

# Weighted Moving Average (Obsolete)

- A rule that inherits a data type, for example, `Inherit: Inherit via internal rule`
- The name of a data type object, for example, a `Simulink.NumericType` object
- An expression that evaluates to a data type, for example, `fixdt(1,16,0)`

Click the **Show data type assistant** button  to display the **Data Type Assistant**, which helps you set the **Gain data type** parameter. (See “Using the Data Type Assistant” in *Simulink User’s Guide*.)

## 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

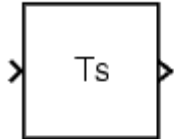
# Weighted Sample Time

---

**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.





**Purpose** Support calculations involving sample time

**Library** Math Operations

**Description** The Weighted Sample Time Math block adds, subtracts, multiplies, or divides its input signal,  $u$ , by a weighted sample time  $T_s$ . If the input signal is continuous,  $T_s$  is the sample time of the Simulink model. Otherwise,  $T_s$  is the sample time of the discrete input signal.

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,  $w$ , is 1, Simulink software refrains from displaying it in the equation on the block icon.

The block computes its output using the precedence rules for MATLAB operators (see “Operator Precedence” in the MATLAB documentation). For example, if the **Operation** parameter specifies  $+$ , the block calculates its output using the equation

$$u + (T_s * w)$$

In contrast, if the **Operation** parameter specifies  $/$ , the block calculates its output using the equation

$$(u / T_s) / w$$

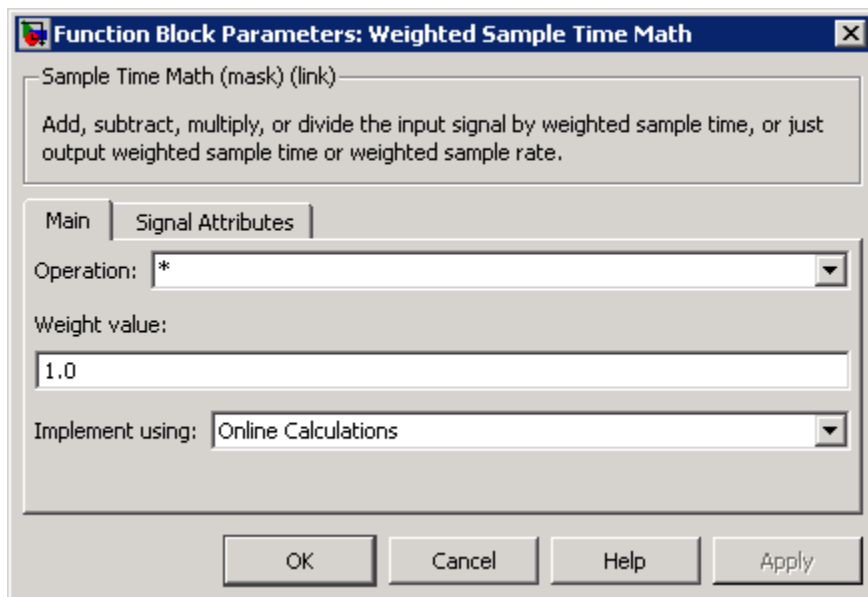
**Data Type Support** The Weighted Sample Time Math block accepts signals of any numeric data type supported by Simulink software, including fixed-point data types.

# Weighted Sample Time Math

---

## Parameters and Dialog Box

The **Main** pane of the Weighted Sample Time Math block dialog box appears as follows:



### Operation

Specify operation to use: +, -, \*, /, Ts Only, or 1/Ts Only.

### Weight value

Enter weight of sample time.

### Implement using

Specify online calculations or offline scaling adjustment. This parameter is visible only if you specify \* or / as the **Operation** parameter.

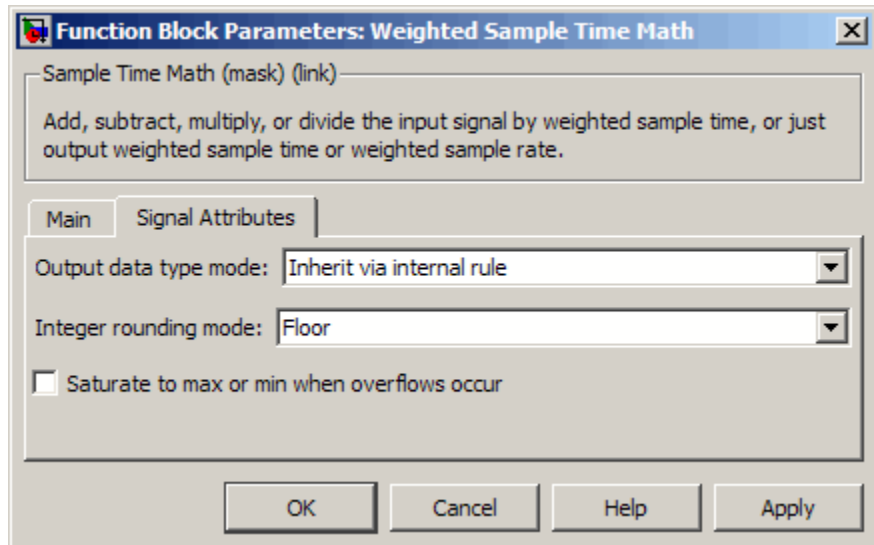
---

**Note** When the **Implement using** parameter is not visible, operations default to online calculations.

---

# Weighted Sample Time Math

The **Signal Attributes** pane of the Weighted Sample Time Math block dialog box appears as follows:



## Output data type mode

Specify whether the output data type mode is inherited by an internal rule or back propagation.

## Integer rounding mode

Select the rounding mode for fixed-point operations. For more information, see "Rounding" in the *Simulink Fixed Point User's Guide*.

## Saturate to max or min when overflows occur

If selected, fixed-point overflows saturate. This parameter is visible only if:

- The **Operation** parameter specifies + or -.
- The **Operation** parameter specifies \* or / and the **Implement using** parameter specifies Online Calculations.

# Weighted Sample Time Math

---

<b>Characteristics</b>	Direct Feedthrough	For all math operations options except Ts and 1/Ts
	Scalar Expansion	No, the weight is always a scalar

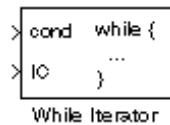
## Purpose

Repeatedly execute contents of subsystem at current time step while 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.

---

**Note** Placing a While Iterator block in a subsystem makes it an atomic subsystem if it is not already an atomic subsystem.

---

The output of a While Iterator subsystem can not be a function-call signal. Simulink software will display an error message if the simulation is run or the diagram updated.

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

# While Iterator

---

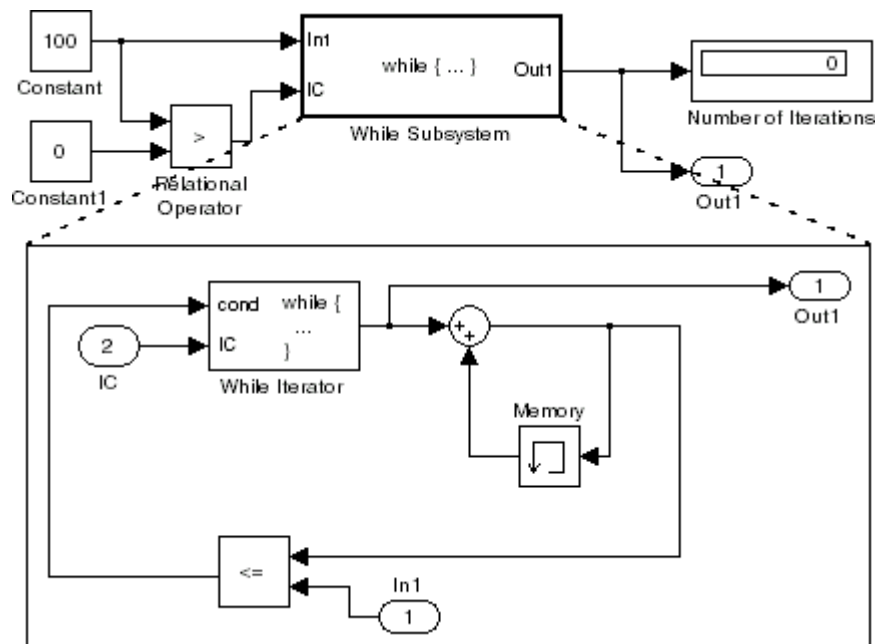
beginning of the time step, if the IC input is true, the iterator block executes the contents of the subsystem and then checks the while condition input. If the while condition input is true, the iterator executes the subsystem again. This process continues as long as the while condition input is true 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;
}
```

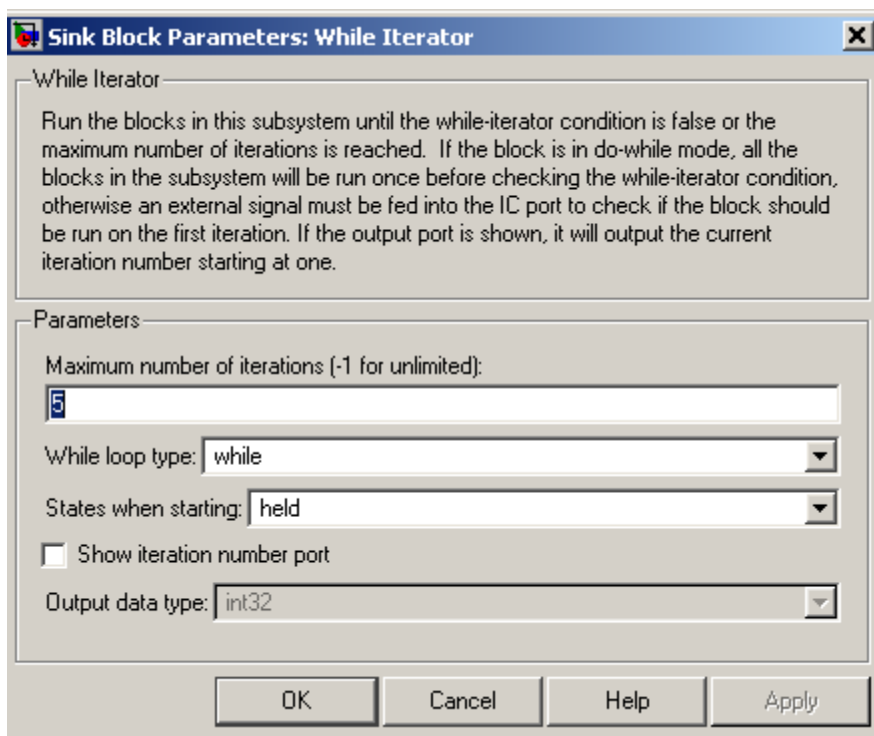
# While Iterator

## Data Type Support

Acceptable data inputs for the condition ports are any numeric data type supported by Simulink software, as well as any fixed-point type, that include a 0 value. For a discussion on the data types supported by Simulink software, 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



### 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 subsystem that executes repeatedly while condition is satisfied during 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.

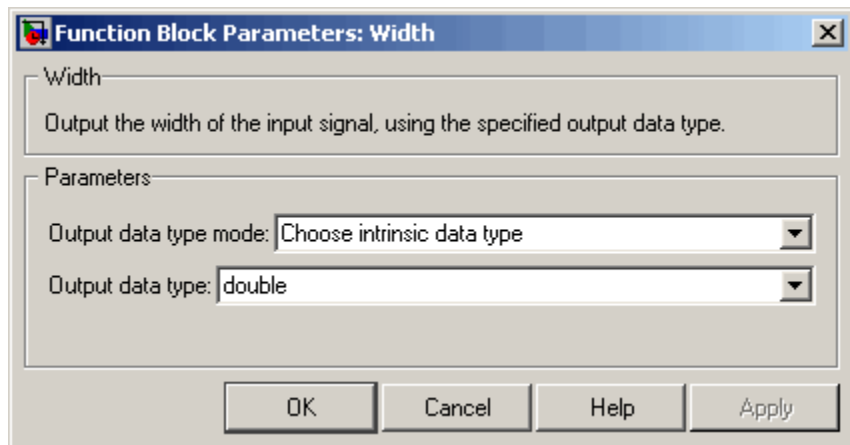
```
> In1  
while ( ... out1 >  
> It
```

See the While Iterator block and “Modeling Control Flow Logic” for more information.

When using simplified initialization mode, you cannot place any block needing elapsed time within an Iterator Subsystem. In simplified initialization mode, Iterator subsystems do not maintain elapsed time, so Simulink will report an error if any such block (such as the Discrete-Time Integrator block) is placed within the subsystem. For more information on simplified initialization modes, see “Underspecified initialization detection”.

<b>Purpose</b>	Output width of input vector
<b>Library</b>	Signal Attributes
<b>Description</b>	The Width block generates as output the width of its input vector.
<b>Data Type Support</b>	The Width block accepts real or complex signals of any data type supported by Simulink software, including fixed-point and enumerated data types. The Width block supports mixed-type signal vectors.

## Parameters and Dialog Box



---

**Note** The Width block ignores the **Data type override** setting of the Fixed-Point Tool.

---

### Output data type mode

Specify the output data type to be the same as the input, or inherit the data type by back propagation. 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 from the **Output data type mode** parameter. Choose a built in data type from the drop down list.

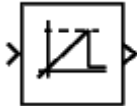
## Characteristics

Sample Time	Constant
Dimensionalized	Yes
Multidimensionalized	Yes

**Purpose** Set output to zero if input is above threshold

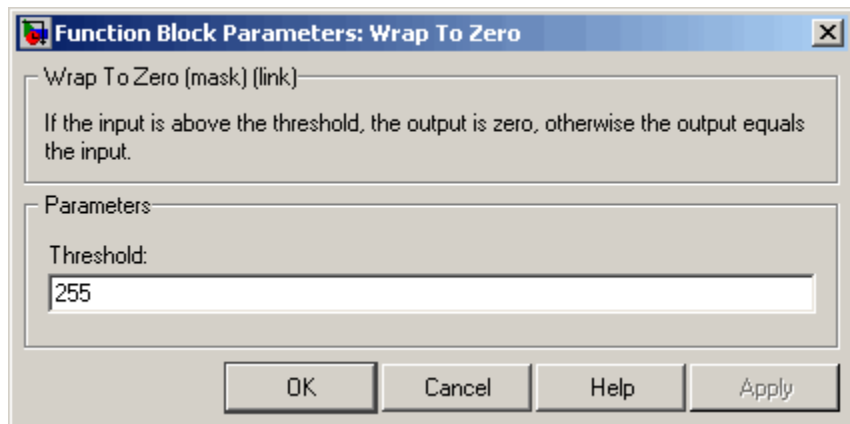
**Library** Discontinuities

**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 numeric data type supported by Simulink software, including fixed-point data types.

### Parameters and Dialog Box



### Threshold

When the input exceeds the threshold, the output is set to zero.

### Characteristics

Direct Feedthrough	Yes
Scalar Expansion	Yes
Multidimensionalized	Yes

# XY Graph

---

**Purpose** Display X-Y plot of signals using MATLAB figure window

**Library** Sinks

**Description** The XY Graph block displays an X-Y plot of its inputs in a MATLAB figure window.

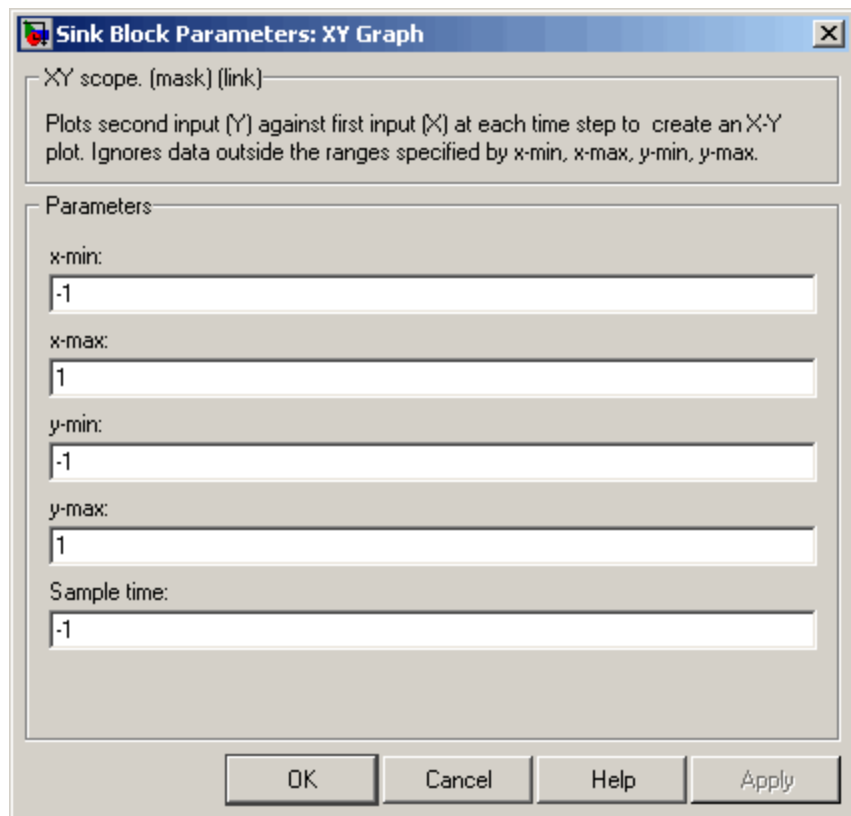


The block has two scalar inputs. The block plots data in the first input (the  $x$  direction) against data in the second input (the  $y$  direction). (See “How to Rotate a Block” in *Simulink User’s Guide* for a description of the port order for various block orientations.) This block is useful for examining limit cycles and other two-state data. Data outside the specified range is not displayed.

Simulink software opens a figure window for each XY Graph block in the model at the start of the simulation.

**Data Type Support** The XY Graph block accepts real signals of type double.

## Parameters and 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.

# XY Graph

---

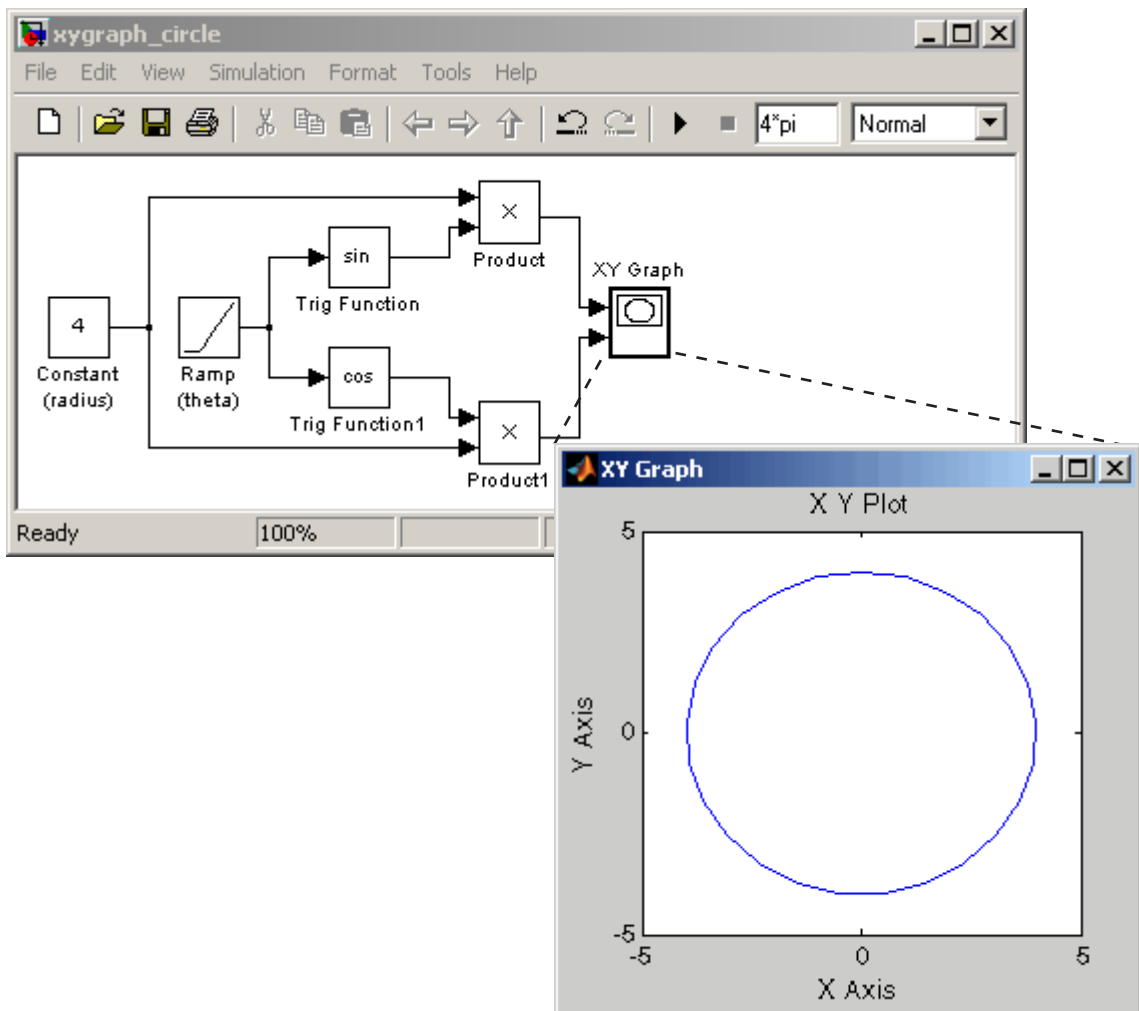
## Sample time

Specify the time interval between samples. To inherit the sample time, set this parameter to -1. See “How to Specify the Sample Time” in the Simulink documentation for more information.

## Examples

The following model computes the points that define a circle of radius 4, centered at the origin of the  $x$ - $y$  plane. The XY Graph block displays the circle.





## Characteristics

Sample Time	Specified in the <b>Sample time</b> parameter
States	0

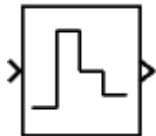
# Zero-Order Hold

---

**Purpose** Implement 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.

---

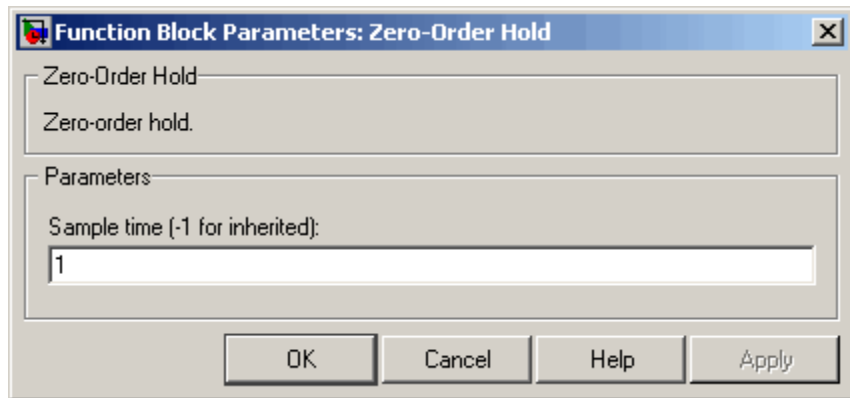
**Note** Do not use the Zero-Order Hold block to create a fast-to-slow transition between blocks operating at different sample rates. Instead, use the Rate Transition block.

---

**Data Type Support** The Zero-Order Hold block accepts real or complex signals of any data type supported by Simulink software, including fixed-point and enumerated data types.

For a discussion on the data types supported by Simulink software, 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 “How to Specify the Sample Time” in the online documentation for more information.

## Bus Support

The Zero-Order Hold block is a bus-capable block. The input can be a virtual or nonvirtual bus signal. No block-specific restrictions exist. All signals in a nonvirtual bus input to a Zero-Order Hold block must have the same sample time, even if the elements of the associated bus object specify inherited sample times. You can use a Rate Transition block to change the sample time of an individual signal, or of all signals in a bus. See Using Buses and Bus-Capable Blocks for more information.

## Characteristics

Bus-capable	Yes
Direct Feedthrough	Yes
Sample Time	Specified in the <b>Sample time</b> parameter
Scalar Expansion	No
Dimensionalized	Yes
Zero Crossing	No

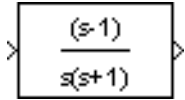
# Zero-Pole

---

**Purpose** Model system by 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

$$H(s) = K \frac{Z(s)}{P(s)} = K \frac{(s - Z(1))(s - Z(2)) \dots (s - Z(m))}{(s - P(1))(s - P(2)) \dots (s - P(n))}$$

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:

$$\frac{\text{gain}(s-3)(s-2)(s-1)}{(s-7)(s-5)(s-3)(s-1)}$$

- 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.

$$\frac{\text{gain}^*\text{zeros}(s)}{\text{poles}(s)}$$

### Specifying the Absolute Tolerance for the Block's States

By default, Simulink software 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

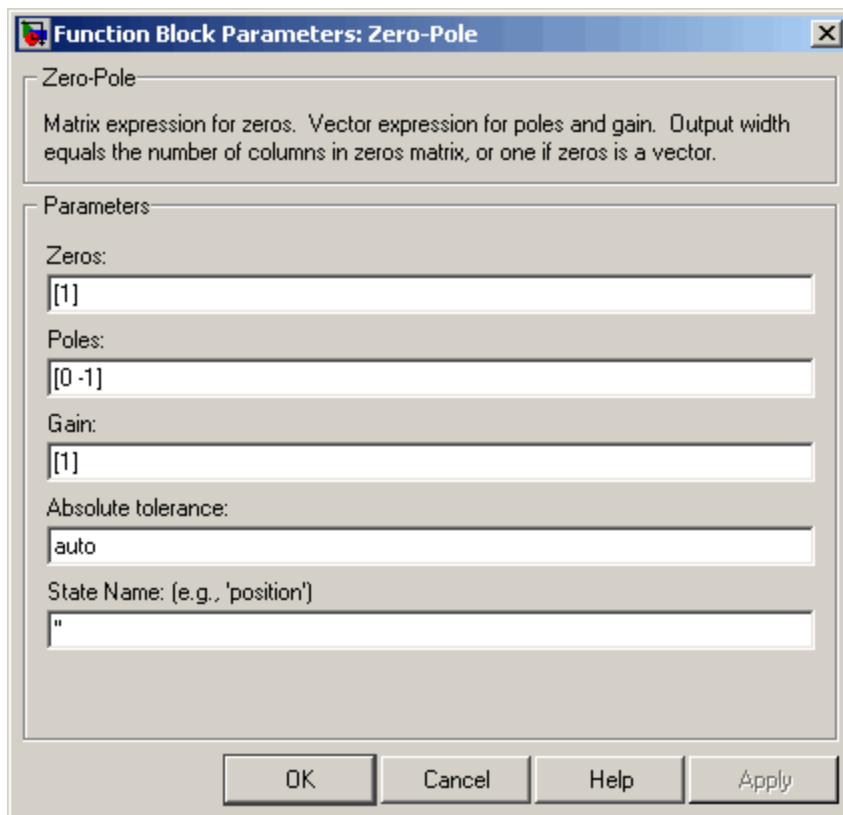
# Zero-Pole

the 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 software determines the absolute tolerance (see “Specifying Variable-Step Solver Error Tolerances”). If you enter a numeric value, Simulink software 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.

## **State Name**

Use this to assign a unique name to each state. The state names apply only to the selected block. If left blank, no name is assigned.

To assign a name to a single state, enter the name between quotes, for example, 'velocity'.

To assign names to multiple states, enter a comma-delimited list surrounded by braces. For example, {'a', 'b', 'c'}. Each name must be unique.

The number of states must be evenly divided by the number of state names. There can be fewer names than the number of states, but there cannot be more names than states.

For example, you can specify two names in a system with four states. Simulink software will assign the first name to the first two states and the second name to the last two.

To assign state names with a variable that has been defined in the MATLAB workspace, enter the variable without quotes. A variable can be a string, cell, or structure.

# Zero-Pole

---

<b>Characteristics</b>	Direct Feedthrough	Only if the lengths of the <b>Poles</b> and <b>Zeros</b> parameters are equal
	Sample Time	Continuous
	Scalar Expansion	No
	States	Length of <b>Poles</b> vector
	Dimensionalized	No
	Zero Crossing	No



# Function Reference

---

Model Construction (p. 3-2)	Model construction functions
Simulation (p. 3-6)	Simulation functions
Linearization and Trimming (p. 3-8)	Linearization and trimming functions
Data Type (p. 3-9)	Data type functions

## Model Construction

<code>addterms</code>	Add terminators to unconnected ports in model
<code>add_block</code>	Add block to Simulink system
<code>add_line</code>	Add line to Simulink system
<code>add_param</code>	Add parameter to Simulink system
<code>attachConfigSet</code>	Associate configuration set or configuration reference with model
<code>attachConfigSetCopy</code>	Copy configuration set or configuration reference and associate it with model
<code>bdclose</code>	Close any or all Simulink system windows unconditionally
<code>bdIsLoaded</code>	Whether block diagram is in memory
<code>bdroot</code>	Return name of top-level Simulink system
<code>closeDialog</code>	Close configuration parameters dialog
<code>close_system</code>	Close Simulink system window or block dialog box
<code>delete_block</code>	Delete block from Simulink system
<code>delete_line</code>	Delete line from Simulink system
<code>delete_param</code>	Delete system parameter added via <code>add_param</code> command
<code>detachConfigSet</code>	Dissociate configuration set or configuration reference from model
<code>disableimplicitsignalresolution</code>	Convert model to use only explicit signal resolution
<code>docblock</code>	Get or set editor invoked by Simulink DocBlock

<code>find mdlrefs</code>	Find Model blocks in model. Find models that Model blocks reference
<code>find_system</code>	Find systems, blocks, lines, ports, and annotations
<code>gcb</code>	Get pathname of current block
<code>gcbh</code>	Get handle of current block
<code>gcs</code>	Get pathname of current system
<code>getActiveConfigSet</code>	Get model's active configuration set or configuration reference
<code>getCallbackAnnotation</code>	Get information about annotation
<code>getConfigSet</code>	Get one of model's configuration sets or configuration references
<code>getConfigSets</code>	Get names of all of model's configuration sets or configuration references
<code>getfullname</code>	Get pathname of block or line
<code>get_param</code>	Get system and block parameter values
<code>legacy_code</code>	Use Legacy Code Tool
<code>libinfo</code>	Get information about library blocks referenced by model
<code>load_system</code>	Invisibly load Simulink model
<code>modeladvisor</code>	Open Model Advisor
<code>new_system</code>	Create empty Simulink system
<code>openDialog</code>	Open configuration parameters dialog
<code>open_system</code>	Open Simulink system window or block dialog box
<code>replace_block</code>	Replace blocks in Simulink model
<code>save_system</code>	Save Simulink system

<code>setActiveConfigSet</code>	Specify model's active configuration set or configuration reference
<code>set_param</code>	Set Simulink system and block parameters
<code>signalbuilder</code>	Create and access Signal Builder blocks
<code>simulink</code>	Open Simulink block library
<code>Simulink.BlockDiagram.addBus-ToVector</code>	Add Bus to Vector blocks to convert virtual bus signals into vector signals
<code>Simulink.BlockDiagram.copy-ContentsToSubSystem</code>	Copy contents of block diagram to empty subsystem
<code>Simulink.BlockDiagram.createSubSystem</code>	Create a subsystem containing a specified set of blocks
<code>Simulink.BlockDiagram.delete-Contents</code>	Delete contents of block diagram
<code>Simulink.Bus.cellToObject</code>	Convert cell array containing bus information to bus objects
<code>Simulink.Bus.createObject</code>	Create bus objects for blocks
<code>Simulink.Bus.objectToCell</code>	Convert bus objects to cell array containing bus information
<code>Simulink.Bus.save</code>	Save bus objects in M-file
<code>Simulink.SubSystem.convert-ToModelReference</code>	Convert atomic subsystem or function call subsystem to model reference
<code>Simulink.SubSystem.copyContents-ToBlockDiagram</code>	Copy contents of subsystem to empty block diagram
<code>Simulink.SubSystem.deleteContents</code>	Delete contents of subsystem
<code>slCharacterEncoding</code>	Change MATLAB character set encoding
<code>sldiscmdl</code>	Discretize Simulink model containing continuous blocks

---

<code>slIsFileChangedOnDisk</code>	Determine whether model has changed since it was loaded
<code>slmdliscui</code>	Open Model Discretizer GUI
<code>slreplace_mux</code>	Replace Mux blocks used to create buses with Bus Creator blocks
<code>slupdate</code>	Replace blocks from previous releases with latest versions
<code>view_mdrefs</code>	Display graph of model reference dependencies

## Simulation

<code>add_exec_event_listener</code>	Register listener for block method execution event
<code>model</code>	Execute particular phase of simulation of model
<code>sim</code>	Simulate dynamic system
<code>simget</code>	Get settings of model's simulation parameters
<code>simplot</code>	Plot simulation data in figure window
<code>simset</code>	Specify simulation options for simulations run via <code>sim</code> command
<code>Simulink.Block.getSampleTimes</code>	Return sample time information for a block
<code>Simulink.BlockDiagram.getInitialState</code>	Return initial state structure of block diagram
<code>Simulink.BlockDiagram.getSampleTimes</code>	Return all sample times associated with a model
<code>Simulink.BlockDiagram.getChecksum</code>	Return checksum of model
<code>Simulink.SubSystem.getChecksum</code>	Return checksum of subsystem
<code>slbuild</code>	Build standalone and model reference targets
<code>sldebug</code>	Start simulation in debug mode
<code>sldiagnostics</code>	Display diagnostic information about Simulink system
<code>unpack</code>	Extract signal logging objects from signal logs and write them into MATLAB workspace

---

<code>who</code>	List names of top-level data logging objects in Simulink data log
<code>whos</code>	List names and types of top-level data logging objects in Simulink data log

## Linearization and Trimming

`linmod`, `dlinmod`, `linmod2`,  
`linmodv5`

Extract continuous- or discrete-time linear state-space model of system around operating point

`trim`

Find trim point of dynamic system



## Data Type

<code>fixdt</code>	Create <code>Simulink.NumericType</code> object describing fixed-point or floating-point data type
<code>fixptbestexp</code>	Determine exponent that gives best precision fixed-point representation of value
<code>fixptbestprec</code>	Determine maximum precision available for fixed-point representation of value
<code>fixpt_evenspace_cleanup</code>	Modify lookup table input data to be evenly spaced
<code>fixpt_interp1</code>	Implement 1-D lookup table
<code>fixpt_look1_func_approx</code>	Optimize for fixed-point function, x values, or breakpoints that are generated for lookup table
<code>fixpt_look1_func_plot</code>	Plot function with x values generated by <code>fixpt_look1_func_approx</code> function
<code>fixpt_set_all</code>	Set property for every fixed-point block in subsystem
<code>float</code>	Create MATLAB structure describing floating-point data type
<code>fxptdlg</code>	Invoke Fixed-Point Tool
<code>num2fixpt</code>	Convert number to nearest value representable by specified fixed-point data type
<code>sfix</code>	Create MATLAB structure describing signed generalized fixed-point data type

<code>sfrac</code>	Create MATLAB structure describing signed fractional data type
<code>sint</code>	Create MATLAB structure describing signed integer data type
<code>tunablevars2parameterobjects</code>	Create Simulink parameter objects from tunable parameters
<code>ufix</code>	Create MATLAB structure describing unsigned generalized fixed-point data type
<code>ufrac</code>	Create MATLAB structure describing unsigned fractional data type
<code>uint</code>	Create MATLAB structure describing unsigned integer data type

# Functions — Alphabetical List

---

# add\_block

---

## Purpose

Add block to 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 8-83).

`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')
```

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`, `replace_block`, `set_param`

# add\_exec\_event\_listener

---

**Purpose** Register listener for 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 *Simulink User’s Guide* for more information). Simulink software invokes the registered listener whenever the specified event occurs during simulation of the model.

---

**Note** Simulink software 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 *Simulink User’s Guide*.)

`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.

# add\_line

---

## Purpose

Add line to 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.



## 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 parameter to 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. Simulink software saves these new parameters with the model file.

---

**Note** If you attempt to add a parameter that has the same name as an existing parameter of the system, Simulink software displays an error.

---

**Examples** This command

```
add_param('vdp','DemoName','VanDerPolEquation','EquationOrder','2')
```

adds the parameters `DemoName` and `EquationOrder` with string values `'VanDerPolEquation'` and `'2'` to the `vdp` system. Afterward, you can use the following command to retrieve the value of the `DemoName` parameter.

```
get_param('vdp','DemoName')
```

**See Also** `delete_param`, `get_param`, `set_param`

**Purpose** Add terminators to unconnected ports in 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`

# attachConfigSet

---

<b>Purpose</b>	Associate configuration set or configuration reference with model
<b>Syntax</b>	<code>attachConfigSet('model', configObj)</code> <code>attachConfigSet('model', configObj, allowRename)</code>
<b>Arguments</b>	<p><i>model</i> The name of an open model, or gcs to specify the current model</p> <p><i>configObj</i> A configuration set (<code>Simulink.ConfigSet</code>) or configuration reference (<code>Simulink.ConfigSetRef</code>)</p> <p><i>allowRename</i> Boolean that determines how Simulink software handles a name conflict</p>

**Description** `attachConfigSet` associates the configuration set or configuration reference (configuration object) specified by *configObj* with *model*.

You cannot attach a configuration object to a model if the configuration object is already attached to another model, or has the same name as another configuration object attached to the same model. The optional Boolean argument *allowRename* determines how Simulink software handles a name conflict between configuration objects. If *allowRename* is `false` and the configuration object specified by *configObj* has the same name as a configuration object already attached to *model*, Simulink software generates an error. If *allowRename* is `true` and a name conflict occurs, Simulink software provides a unique name for *configObj* before associating *configObj* with *model*.

**Example** The following example creates a copy of the current model's active configuration object and attaches it to the model, changing its name if necessary to be unique. The code is the same whether the object is a configuration set or configuration reference.

```
myConfigObj = getActiveConfigSet(gcs);  
copiedConfig = myConfigObj.copy;  
copiedConfig.Name = 'DevConfig';
```

```
attachConfigSet(gcs, copiedConfig, true);
```

## See Also

“Configuration Sets”, “Referencing Configuration Sets”

```
attachConfigSetCopy, closeDialog, detachConfigSet,  
getActiveConfigSet, getConfigSet, getConfigSets, openDialog,  
setActiveConfigSet
```

# attachConfigSetCopy

---

**Purpose** Copy configuration set or configuration reference and associate it with *model*

**Syntax**  
`myConfigObj = attachConfigSetCopy('model', configObj)`  
`myConfigObj = attachConfigSetCopy('model', configObj, allowRename)`

**Arguments**

*model*  
The name of an open model, or gcs to specify the current model

*configObj*  
A configuration set (Simulink.ConfigSet) or configuration reference (Simulink.ConfigSetRef)

*allowRename*  
Boolean that specifies how Simulink software handles a name conflict

**Description** `attachConfigSetCopy` copies the configuration set or configuration reference (configuration object) specified by *configObj* and associates the copy with *model*. Simulink software returns the copied configuration object as *newConfigObj*.

You cannot attach a configuration object to a model if the configuration object has the same name as another configuration object attached to the same model. The optional Boolean argument *allowRename* determines how Simulink software handles a name conflict between configuration objects. If *allowRename* is `false` and the configuration object specified by *configObj* has the same name as a configuration object already attached to *model*, Simulink software generates an error. If *allowRename* is `true` and a name conflict occurs, Simulink software provides a unique name for the copy of *configObj* before associating it with *model*.

**Example** The following example creates a copy of ModelA's active configuration object and attaches it to ModelB, changing the name if necessary to be unique. The code is the same whether the object is a configuration set or configuration reference.

```
myConfigObj = getActiveConfigSet('ModelA');  
newConfigObj = attachConfigSetCopy('ModelB', myConfigObj, true);
```

## See Also

“Configuration Sets”, “Referencing Configuration Sets”

attachConfigSet, closeDialog, detachConfigSet,  
getActiveConfigSet, getConfigSet, getConfigSets,  
openDialog, setActiveConfigSet

# bdclose

---

<b>Purpose</b>	Close any or all Simulink system windows unconditionally
<b>Syntax</b>	<code>bdclose</code> <code>bdclose('sys')</code> <code>bdclose('all')</code>
<b>Description</b>	<p><code>bdclose</code> 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.</p> <p><code>bdclose('sys')</code> closes the specified system window.</p> <p><code>bdclose('all')</code> closes all system windows.</p>
<b>Examples</b>	<p>This command closes the vdp system.</p> <pre>bdclose('vdp')</pre>
<b>See Also</b>	<code>close_system</code> , <code>new_system</code> , <code>open_system</code> , <code>save_system</code>



**Purpose** Whether block diagram is in memory

**Syntax** `isLoaded = bdIsLoaded(bdnames)`

**Description** `isLoaded = bdIsLoaded(bdnames)` returns whether or not a block diagram is in memory. `bdnames` can be a string or a cell array of strings. All strings must be valid block diagram names (which are the same as valid MATLAB variable names). It is an error to supply a path to a block or subsystem.

`isLoaded` is a logical array with one entry for each block diagram name. Examples:

**Examples** `bdIsLoaded('sf_car')`

returns a logical scalar.

`bdIsLoaded({'sf_car','vdp'})`

returns a 1\*2 logical array.

**See Also** `find_system`

# bdroot

---

<b>Purpose</b>	Return name of top-level Simulink system
<b>Syntax</b>	<code>bdroot</code> <code>bdroot('obj')</code>
<b>Description</b>	<code>bdroot</code> with no arguments returns the top-level system name. <code>bdroot('obj')</code> , where 'obj' is a system or block pathname, returns the name of the top-level system containing the specified object name.
<b>Examples</b>	This command returns the name of the top-level system that contains the current block.  <code>bdroot(gcb)</code>
<b>See Also</b>	<code>find_system</code> , <code>gcb</code>

## Purpose

Close Simulink system window or block dialog box

## Syntax

```
close_system
close_system('sys')
close_system('sys', saveflag)
close_system('sys', 'newname')
close_system('sys', 'newname', 'ErrorIfShadowed', true)
```

## 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` returns an error. The current system is defined in the description of the `gcs` command.

`close_system('sys')` closes the specified system, subsystem, or block window.

'*sys*' can be a string (which can be a system, a subsystem, or a full block pathname), a cell array of strings, a numeric handle, or an array of numeric handles. This command displays an error if '*sys*' is a MATLAB keyword, 'simulink', or more than 63 characters long.

`close_system('sys', saveflag)`, if *saveflag* is 1, saves the specified top-level system to a file with its current name, then closes the specified top-level system window and removes it from memory. If *saveflag* is 0, the system is closed without saving. A single *saveflag* can be supplied, in which case it is applied to all block diagrams. Alternatively, separate *saveflags* can be supplied for each block diagram, as a numeric array.

`close_system('sys', 'newname')` saves the specified top-level system to a file with the specified new name, then closes the system.

Additional arguments can be supplied when saving a block diagram. These are exactly the same as for `save_system`:

- `ErrorIfShadowed`: true or false (default: false)
- `BreakAllLinks`: true or false (default: false)
- `SaveAsVersion`: MATLAB version name (default: current)

# close\_system

---

- `OverwriteIfChangedOnDisk`: true or false (default: false)
- `SaveModelWorkspace`: true or false (default: false)

If you try to specify additional options when you are doing something other than saving a block diagram, they are ignored. You see a warning if you try to save when closing something other than a block diagram (e.g., a subsystem or a Block Properties dialog).

## Examples

This command closes the current system.

```
close_system
```

This command closes the `vdp` system, unless it has been modified, in which case it returns an error.

```
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', true)
```

All three of the following commands save and close `mymodel` (saved with the same name), and replace links to library blocks with copies of the library blocks in the saved file:

```
close_system('mymodel',1,'BreakAllLinks',true)
```

```
close_system('mymodel', 'mymodel', 'BreakAllLinks', true)
close_system('mymodel', [], 'BreakAllLinks', true)
```

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')
```

---

**Note** The `close_system` command cannot be used in a block or menu callback to close the root-level model. Attempting to close the root-level model in a block or menu callback results in an error and discontinues the callback's execution.

---

### See Also

`bdclose`, `gcs`, `new_system`, `open_system`, `save_system`

# closeDialog

---

<b>Purpose</b>	Close configuration parameters dialog
<b>Syntax</b>	<code>closeDialog(<i>configObj</i>)</code>
<b>Arguments</b>	<i>configObj</i> A configuration set ( <code>Simulink.ConfigSet</code> ) or configuration reference ( <code>Simulink.ConfigSetRef</code> )
<b>Description</b>	<code>closeDialog</code> closes an open configuration parameters dialog box. If <i>configObj</i> is a configuration set, the function closes the dialog box that displays the configuration set. If <i>configObj</i> is a configuration reference, the function closes the dialog box that displays the referenced configuration set, or generates an error if the reference does not specify a valid configuration set. If the dialog box is already closed, the function does nothing.
<b>Example</b>	<p>The following example closes a configuration parameters dialog box that shows the current parameters for the current model. The parameter values derive from the active configuration set or configuration reference (configuration object). The code is the same in either case; the only difference is which type of configuration object is currently active.</p> <pre>myConfigObj = getActiveConfigSet(gcs); closeDialog(myConfigObj);</pre>
<b>See Also</b>	“Configuration Sets”, “Referencing Configuration Sets” <code>attachConfigSet</code> , <code>attachConfigSetCopy</code> , <code>detachConfigSet</code> , <code>getActiveConfigSet</code> , <code>getConfigSet</code> , <code>getConfigSets</code> , <code>openDialog</code> , <code>setActiveConfigSet</code>

**Purpose** Delete block from 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`, `replace_block`

# delete\_line

---

**Purpose** Delete line from 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`



**Purpose** Delete system parameter added via 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', 'DemoName', 'VanDerPolEquation', 'EquationOrder', '2')
delete_param('vdp', 'DemoName')
```

adds the parameters DemoName and EquationOrder to the vdp system, then deletes DemoName from the system.

**See Also** add\_param

# detachConfigSet

---

**Purpose** Dissociate configuration set or configuration reference from model

**Syntax** `detachConfigSet('model', 'configObjName')`

**Arguments**

*model*  
The name of an open model, or gcs to specify the current model

*configObjName*  
The name of a configuration set (Simulink.ConfigSet) or configuration reference (Simulink.ConfigSetRef)

**Description** `detachConfigSet` detaches the configuration set or configuration reference (configuration object) specified by '*configObjName*' from *model*. If no such configuration object is attached to the model, an error occurs.

**Examples** The following example detaches the configuration object named DevConfig from the current model. The code is the same whether DevConfig is a configuration set or configuration reference.

```
detachConfigSet(gcs, 'DevConfig');
```

**See Also** “Configuration Sets”, “Referencing Configuration Sets”  
`attachConfigSet`, `attachConfigSetCopy`, `closeDialog`,  
`getActiveConfigSet`, `getConfigSet`, `getConfigSets`, `openDialog`,  
`setActiveConfigSet`

<b>Purpose</b>	Convert model to use only explicit signal resolution
<b>Syntax</b>	<pre>[retVal] = disableimplicitsignalresolution(model) [retVal] = disableimplicitsignalresolution(model, displayOnly)</pre>
<b>Arguments</b>	<p><i>model</i> Model name or handle.</p> <p><i>displayOnly</i> Boolean specifying whether to change the model or just generate a report. Default: false; the function changes the model.</p>
<b>Return</b>	<p><i>retVal</i> A MATLAB structure containing:</p> <ul style="list-style-type: none"><li>• <b>Signals:</b> Handles to ports with signal names that resolve to signal objects</li><li>• <b>States:</b> Handles to blocks with states that resolve to signal objects.</li></ul>
<b>Description</b>	<p><code>disableimplicitsignalresolution</code> inputs a model, reports all signals and states that implicitly resolve to signal objects, and optionally converts the model to resolve only signals and states that explicitly require it. The report and any changes are limited to the model itself; they do not include blocks that are library links. Before executing this function, ensure that all relevant Simulink data objects are defined in the base workspace. The function ignores any data objects that are defined elsewhere.</p> <p>If <i>displayOnly</i> is true, the function scans <i>model</i>, returns a structure of handles to signals and states that resolve implicitly to signal objects, and leaves the model unchanged. If <i>displayOnly</i> is false (the default), the function returns the same list and also performs the following operations on <i>model</i>:</p>

# disableimplicitsignalresolution

---

- Search the model for all output ports and block states that resolve to Simulink signal objects.
- Modify these ports and blocks to enforce signal object resolution in the future.
- Set the model's `SignalResolutionControl` parameter to 'UseLocalSettings' (GUI: **Explicit Only**).
- If any Stateflow output data resolves to a Simulink signal object:
  - Turn off hierarchical scoping of signal objects from within the Stateflow chart.
  - Explicitly label the output signal of the Stateflow chart.
  - Enforce signal object resolution for this signal in the future.

---

**Note** The changes made by `disableimplicitsignalresolution` permanently change the model. Be sure to back up the model before calling the function with `displayOnly` defaulted or specified as `false`.

---

## See Also

“Signal Properties Dialog Box”

“Data Validity Diagnostics Overview”

`Simulink.Signal`

**Purpose**

Get or set editor invoked by Simulink DocBlock

**Syntax**

```
docblock('setEditorHTML', editCmd)
docblock('setEditorDOC', editCmd)
docblock('setEditorTXT', editCmd)
editCmd = docblock('getEditorHTML')
editCmd = docblock('getEditorDOC')
editCmd = docblock('getEditorTXT')
```

**Description**

`docblock('setEditorHTML', editCmd)` sets the HTML editor invoked by the DocBlock. The *editCmd* string specifies a command, executed at the MATLAB prompt, which launches a custom HTML editor. By default, the DocBlock invokes Microsoft Word (if available) as the HTML editor; otherwise, it opens HTML documents using the editor you specified on the **Editor/Debugger Preferences** pane of the Preferences dialog box.

`docblock('setEditorDOC', editCmd)` sets the Rich Text Format (RTF) editor invoked by the DocBlock. The *editCmd* string specifies a command, executed at the MATLAB prompt, which launches a custom RTF editor. By default, the DocBlock invokes Microsoft Word (if available) as the RTF editor; otherwise, it opens RTF documents using the editor you specified on the **Editor/Debugger Preferences** pane of the Preferences dialog box.

`docblock('setEditorTXT', editCmd)` sets the text editor invoked by the DocBlock. The *editCmd* string specifies a command, executed at the MATLAB prompt, which launches a custom text editor. By default, the DocBlock invokes the editor you specified on the **Editor/Debugger Preferences** pane of the Preferences dialog box.

`editCmd = docblock('getEditorHTML')` returns the value of the current command used to invoke an HTML editor when double-clicking the DocBlock.

`editCmd = docblock('getEditorDOC')` returns the value of the current command used to invoke a RTF editor when double-clicking the DocBlock.

`editCmd = docblock('getEditorTXT')` returns the value of the current command used to invoke a text editor when double-clicking the DocBlock.

---

**Note** Use the "%<FileName>" token in the *editCmd* string to represent the full pathname to the document. Use the empty string '' as the *editCmd* to reset the DocBlock to its default editor for a particular document type.

---

## Examples

This command specifies Microsoft Notepad as the DocBlock editor for RTF documents.

```
docblock('setEditorRTF','system(''notepad "%<FileName>"');')
```

This command resets the DocBlock to use its default editor for RTF documents.

```
docblock('setEditorRTF','')
```

This command specifies Mozilla Composer as the HTML editor for the DocBlock.

```
docblock('setEditorHTML','system(''/usr/local/bin/mozilla ...  
-edit "%<FileName>" &'');')
```

**Purpose** Find Model blocks in model. Find models that Model blocks reference

**Syntax**

```
[refMdlS, mdlBlks] = find_mdrefs('modelName')  
[refMdlS, mdlBlks] = find_mdrefs('modelName', true)  
[refMdlS, mdlBlks] = find_mdrefs('modelName', false)
```

**Description** [refMdlS, mdlBlks] = find\_mdrefs('modelName') or find\_mdrefs('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\_mdrefs(modelName, false) finds only the Model blocks and models directly referenced by 'modelName'.

## Examples

Open the sldemo\_mdref\_basic demo. Then execute

```
>> [r, b] = find_mdrefs('sldemo_mdref_basic')
```

```
r =  
    'sldemo_mdref_counter'  
    'sldemo_mdref_basic'
```

```
b =  
    'sldemo_mdref_basic/CounterA'  
    'sldemo_mdref_basic/CounterB'  
    'sldemo_mdref_basic/CounterC'
```

# find\_mdrefs

---

## **See Also**

`view_mdrefs`



**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 8, "Model and Block Parameters" for a list of model and block parameters.

You can specify any of the following search constraints.

# find\_system

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'.

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')
```

# find\_system

---

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, <code>.*a\$</code> 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 <code>'\\'</code> matches any string containing a <code>\</code> character.
[ ]	Matches any one of a specified set of characters. For example, <code>f[oa]r</code> matches 'for' and 'far'. Some characters have special meaning within brackets. A hyphen (-) indicates a range of characters to match. For example, <code>[a-zA-Z1-9]</code> matches any alphanumeric character. A circumflex (^) indicates characters that should not produce a match. For example, <code>f[^i]r</code> matches 'far' and 'for' but not 'fir'.
\w	Matches a word character. (This is a shorthand expression for <code>[a-zA-Z0-9_]</code> .) For example, <code>^\w</code> matches 'mu' but not '&mu'.
\d	Matches any digit (shorthand for <code>[0-9]</code> ). For example, <code>\d+</code> matches any integer.
\D	Matches any nondigit (shorthand for <code>[^0-9]</code> ).
\s	Matches a white space (shorthand for <code>[ \t\r\n\f]</code> ).
\S	Matches a non white-space (shorthand for <code>[^ \t\r\n\f]</code> ).
\<WORD\>	Matches WORD exactly, where WORD is a string of characters separated by white space from other words. For example, <code>\&lt;to\&gt;</code> 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.

## find\_system

---

For example, the following command finds all the inport and output blocks in the `clutch` model demo provided with Simulink software.

```
find_system('clutch', 'regexp', 'on', 'blocktype', 'port')
```

### **See Also**

`get_param`, `set_param`

**Purpose**

Create Simulink.NumericType object describing 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.

# fixdt

---

## **See Also**

float, sfix, sfrac, sint, ufix, ufrac, uint



**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  $2^{-12}$ , 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 software 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 software 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.

## fixpt\_evenspace\_cleanup

---

Input	Value	Example
xdata_original	Input lookup data	0:0.005:1
xdt	Input data type	sfix(16)
xscale	Input scaling	2 <sup>-12</sup>

### See Also

fixdt, fixpt\_interp1, fixpt\_look1\_func\_approx, sfix, ufix

**Purpose** Implement 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')
```

# fixpt\_interp1

---

**See Also**

fixpt\_look1\_func\_approx, fixpt\_look1\_func\_plot

## Purpose

Optimize for fixed-point function, x values, or breakpoints that are generated for 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 <code>funcstr</code> is the function for which breakpoints are approximated.

# fixpt\_look1\_func\_approx

---

Input	Value
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 User’s Guide* 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.

# fixpt\_look1\_func\_approx

<b>Parameter</b>	<b>Even Power of 2 Spaced Data</b>	<b>Evenly Spaced Data</b>	<b>Unevenly Spaced Data</b>
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.

## 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.

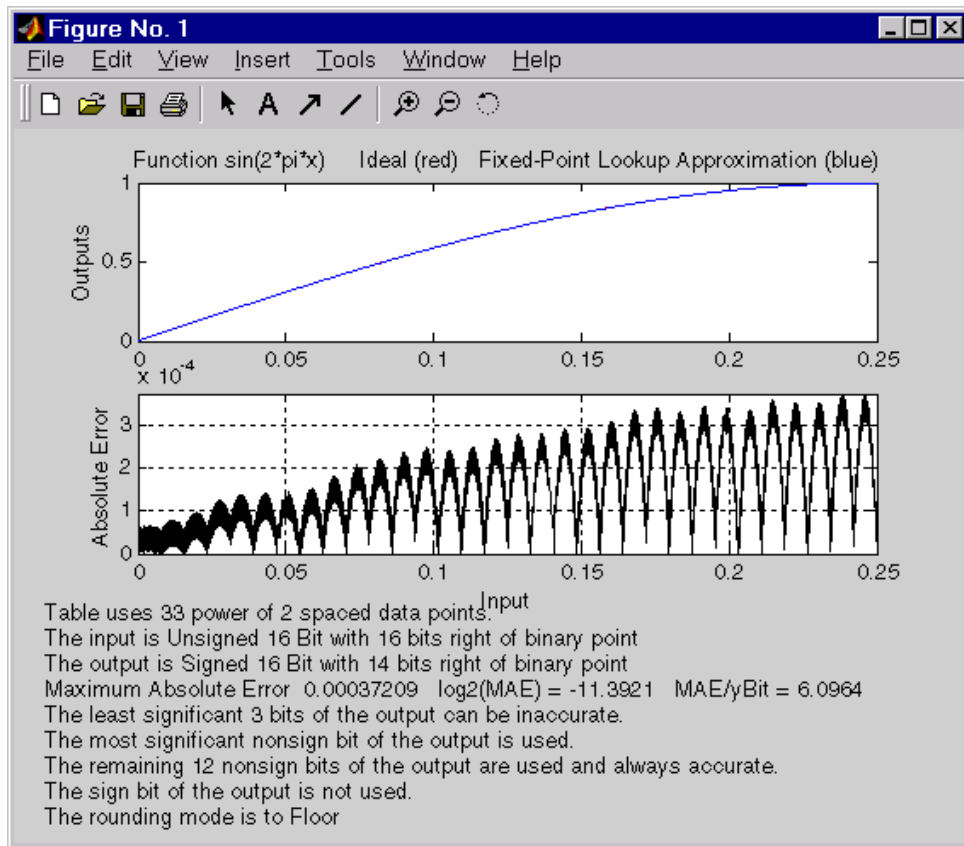
You can then plot the ideal function, the approximation, and the errors by typing

```
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.

# fixpt\_look1\_func\_approx



The lookup table requires 33 points to achieve a maximum absolute error of  $2^{-11.3922}$ .

**See Also** `fixpt_look1_func_plot`

**Purpose** Plot function with x values generated by `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 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
<code>xdata</code>	x values for the lookup table
<code>ydata</code>	y values for the lookup table
<code>'funcstr'</code>	Function of x
<code>xmin</code>	Minimum input of interest
<code>xmax</code>	Maximum input of interest
<code>xdt</code>	Data type of x
<code>xscale</code>	Scaling for the x values
<code>ydt</code>	Data type of y
<code>yscale</code>	Scaling for the y values
<code>rndmeth</code>	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

## fixpt\_look1\_func\_plot

---

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 User’s Guide* 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`

- Purpose** Set property for every fixed-point block in 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')
```

# fixptbestexp

---

**Purpose** Determine exponent that gives best precision fixed-point representation of 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  $2^{\text{fixptbestexp}(4/3, 16, 1)}$ .

## See Also

`fixptbestprec`

# fixptbestprec

---

**Purpose** Determine maximum precision available for fixed-point representation of 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 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 expression that you specify for the **Output data type** parameter in a block mask. 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 Tool. 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 the Simulink Fixed Point documentation.

## See Also

`fixptbestexp`

# float

---

**Purpose** Create MATLAB structure describing 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`

**Purpose** Edit print frames for Simulink and Stateflow block diagrams

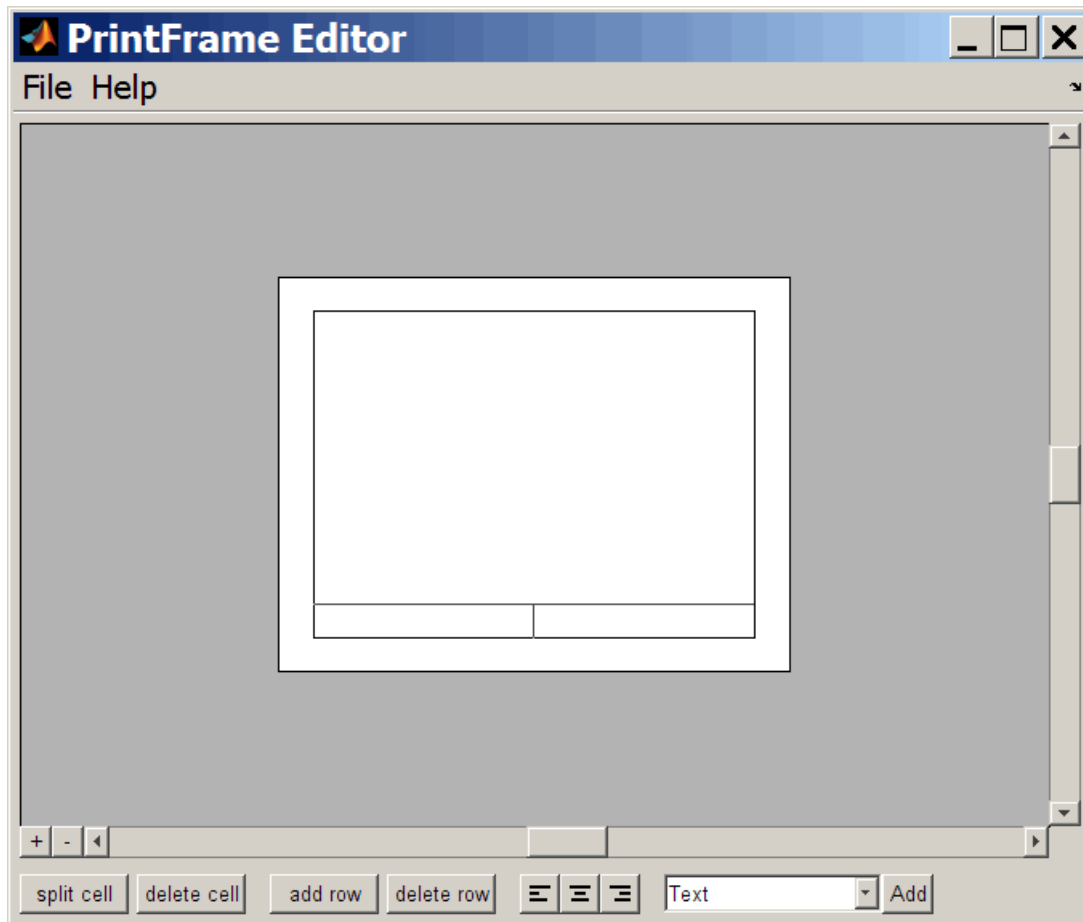
**Syntax** `frameedit`  
`frameedit filename`

**Description** `frameedit` starts the PrintFrame Editor, a graphical user interface you use to create borders for Simulink and Stateflow block diagrams. With no argument, `frameedit` opens the **PrintFrame Editor** window with a new file.

`frameedit filename` opens the **PrintFrame Editor** window with the specified filename, where `filename` is a figure file (`.fig`) previously created and saved using `frameedit`.

## Remarks

This illustrates the main features of the PrintFrame Editor.



## Closing the PrintFrame Editor

To close the **PrintFrame Editor** window, click the close box in the upper right corner, or select **Close** from the **File** menu.

### **Printing Simulink Block Diagrams with Print Frames**

Select **Print** from the Simulink **File** menu. Check the **Frame** box and supply the filename for the print frame you want to use. Click **OK** in the **Print** dialog box.

### **Getting Help for the PrintFrame Editor**

For further instructions on using the PrintFrame Editor, select **PrintFrame Editor Help** from the **Help** menu in the PrintFrame Editor.

**Purpose** Invoke Fixed-Point Tool

**Syntax** `fxptdlg('modelName')`

**Description** `fxptdlg('modelName')` launches the Fixed-Point Tool for the Simulink model specified by `modelName`. You can also access this tool by the following methods:

- From the Simulink **Tools** menu, select **Fixed-Point > Fixed-Point Tool**.
- From a subsystem context (right-click) menu, select **Fixed-Point > Fixed-Point Tool**.

In conjunction with Simulink Fixed Point software, the Fixed-Point Tool provides convenient access to:

- Model and subsystem parameters that control the signal logging, logging mode, and data type override, namely, `MinMaxOverflowArchiveMode`, `MinMaxOverflowLogging`, and `DataTypeOverride` (see “Model Parameters” on page 8-2)
- Plotting capabilities that enable you to plot data that resides in the MATLAB workspace, namely, simulation results associated with Scope, To Workspace, and root-level Outport blocks, in addition to logged signal data (see “Logging Signals” in the *Simulink User’s Guide*)
- An interactive autoscaling feature that proposes fixed-point scaling for appropriately configured objects in your model, and then allows you to selectively accept and apply the scaling proposals

You can launch the Fixed-Point Tool for any system or subsystem, and the tool controls the object selected in its **Model Hierarchy** pane. If Simulink Fixed Point software is installed, the Fixed-Point Tool **Contents** pane displays the name, data type, design minimum and maximum values, minimum and maximum simulation values, and scaling of each model object that logs fixed-point data. Additionally, if



a signal saturates or overflows, the tool displays the number of times saturation or overflow occurred. You can display an object's dialog box by right-clicking the appropriate entry in the **Contents** pane and selecting **Properties**.

---

**Note** The Fixed-Point Tool works only for models that simulate in Normal mode. The tool does not work when you simulate your model in Accelerator or Rapid Accelerator mode (see “Accelerating Models” in *Simulink User's Guide*).

---

Most of the functionality in the Fixed-Point Tool is for use with the Simulink Fixed Point software. However, even if you do not have Simulink Fixed Point software, you can use data type override to simulate a model that specifies fixed-point data types. In this mode, the Simulink software replaces fixed-point data types with floating-point data types 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 software.

To simulate a model without using Simulink Fixed Point:

- 1** From the Simulink **Tools** menu, select **Fixed-Point > Fixed-Point Tool**.

The Fixed-Point Tool appears.

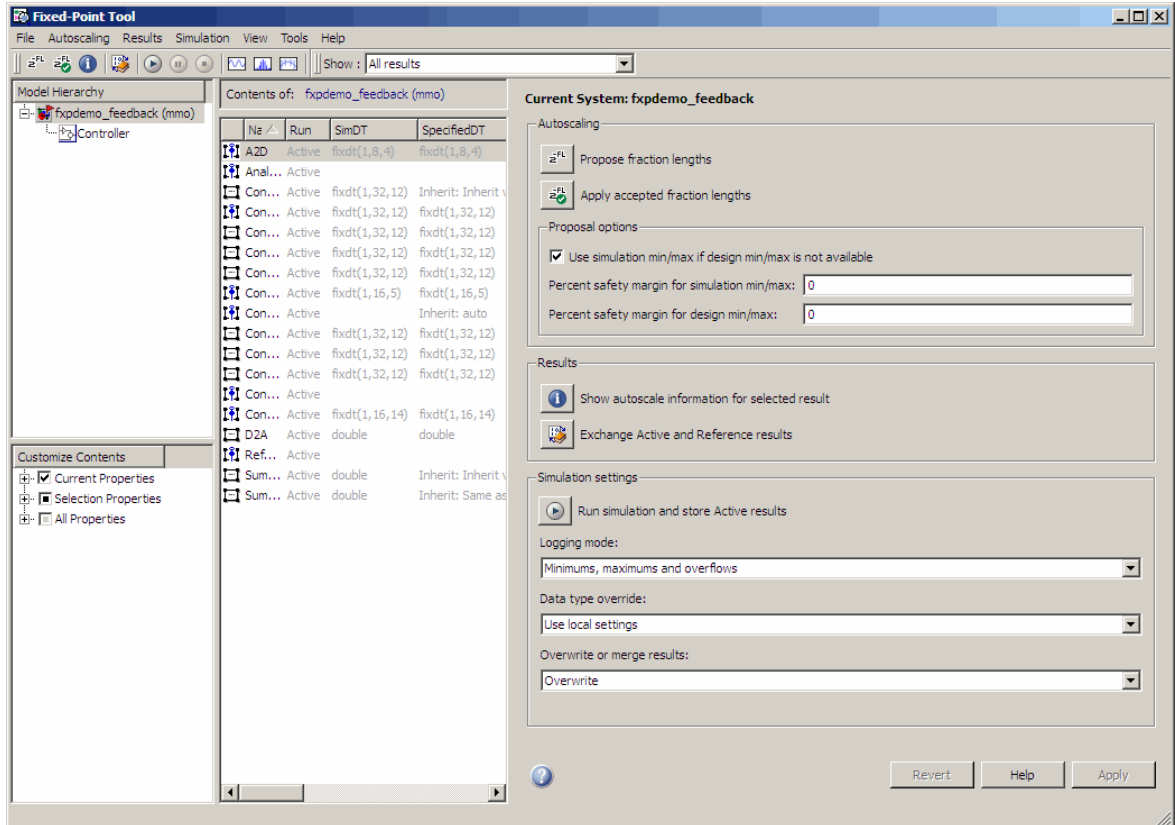
- 2** Set the **Logging mode** parameter to Force off.
- 3** Set the **Data type override** parameter to True doubles or True singles.

---

**Note** If a parameter in your model specifies a `fi` object, you can prevent the checkout of a Fixed-Point Toolbox license by setting the `fipref.DataTypeOverride` property to `TrueDoubles`. See the Fixed-Point Toolbox documentation for more information.

---

## Parameters and Dialog Box



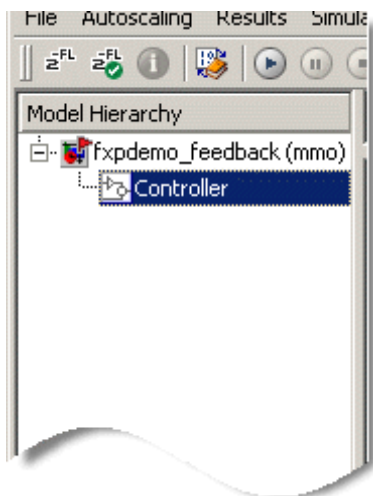
The Fixed-Point Tool includes the following components:

- **Model Hierarchy** pane (see “Model Hierarchy Pane” on page 4-66)
- **Contents** pane (see “Contents Pane” on page 4-67)

- **Dialog** pane (see “Dialog Pane” on page 4-74)
- **Main** toolbar (see “Main Toolbar” on page 4-88)

## Model Hierarchy Pane

The **Model Hierarchy** pane displays a tree-structured view of the Simulink model hierarchy. The first node in the pane represents a Simulink model. Expanding the root node displays subnodes that represent the model’s subsystems, Embedded MATLAB Function blocks, Stateflow charts, and referenced models.



The Fixed-Point Tool’s **Contents** pane displays elements that comprise the object selected in the **Model Hierarchy** pane. The **Dialog** pane provides parameters for specifying the selected object’s data type override and logging mode. Objects that control the **Logging mode** parameter display a red flag on their icons, while those that control the **Data type override** parameter display a green flag. The **Model Hierarchy** pane indicates the value of these parameters by displaying the following abbreviations next to the object name:

| Abbreviation              | Parameter Value                  |
|---------------------------|----------------------------------|
| <b>Logging mode</b>       |                                  |
| mmo                       | Minimums, maximums and overflows |
| o                         | Overflows only                   |
| fo                        | Force off                        |
| <b>Data type override</b> |                                  |
| scl                       | Scaled doubles                   |
| dbl                       | True doubles                     |
| sgl                       | True singles                     |
| fo                        | Force off                        |

See “Dialog Pane” on page 4-74 for more information about these parameters.

### Contents Pane

The **Contents** pane displays a tabular view of objects that log fixed-point data in the system or subsystem selected in the **Model Hierarchy** pane. The table rows correspond to model objects, such as blocks, block parameters, and Stateflow data. The table columns correspond to attributes of those objects, such as the data type, design minimum and maximum values, and simulation minimum and maximum values.

Contents of: `fxpdemo_feedback (mmo)`

| Name                                | Run    | SimDT          | SpecifiedDT                        | Pr |
|-------------------------------------|--------|----------------|------------------------------------|----|
| A2D                                 | Active | fixdt(1,8,4)   | fixdt(1,8,4)                       |    |
| Analog Plant                        | Active |                |                                    |    |
| Controller/Combine Terms            | Active |                | fixdt(1,32,12)                     |    |
| Controller/Combine Terms : Accu...  | Active | fixdt(1,32,12) | Inherit: Inherit via internal rule |    |
| Controller/Combine Terms : Output   | Active | fixdt(1,32,12) | fixdt(1,32,12)                     |    |
| Controller/Denominator Terms : A... | Active | fixdt(1,32,12) | fixdt(1,32,12)                     |    |
| Controller/Denominator Terms : O... | Active | fixdt(1,32,12) | fixdt(1,32,12)                     |    |
| Controller/Denominator Terms : P... | Active | fixdt(1,32,12) | fixdt(1,32,12)                     |    |
| Controller/Down Cast                | Active | fixdt(1,16,5)  | fixdt(1,16,5)                      |    |
| Controller/In1                      | Active |                | Inherit: auto                      |    |
| Controller/Numerator Terms : Acc... | Active | fixdt(1,32,12) | fixdt(1,32,12)                     |    |
| Controller/Numerator Terms : O...   | Active | fixdt(1,32,12) | fixdt(1,32,12)                     |    |
| Controller/Numerator Terms : P...   | Active | fixdt(1,32,12) | fixdt(1,32,12)                     |    |

**Note** The **Contents** pane displays information only after you simulate a system or propose fraction lengths.

The **Contents** pane displays columns that correspond to the following properties and controls:

| Column Label       | Description                                                                                                                 |
|--------------------|-----------------------------------------------------------------------------------------------------------------------------|
| <b>Name</b>        | Identifies path and name of block.                                                                                          |
| <b>Run</b>         | Indicates whether the Fixed-Point Tool stores results as an active or a reference run.                                      |
| <b>SimDT</b>       | Data type the block uses during simulation.                                                                                 |
| <b>SpecifiedDT</b> | Data type the block specifies in its parameter dialog box, for example, the value of its <b>Output data type</b> parameter. |

| <b>Column Label</b>  | <b>Description</b>                                                                                                            |
|----------------------|-------------------------------------------------------------------------------------------------------------------------------|
| <b>ProposedDT</b>    | Data type that the Fixed-Point Tool proposes.                                                                                 |
| <b>Accept</b>        | Check box that enables you to selectively accept the Fixed-Point Tool's scaling proposal.                                     |
| <b>DesignMin</b>     | Minimum value the block specifies in its parameter dialog box, for example, the value of its <b>Output minimum</b> parameter. |
| <b>SimMin</b>        | Minimum value that occurs during simulation.                                                                                  |
| <b>ProposedMin</b>   | Minimum value that results from the data type the Fixed-Point Tool proposes.                                                  |
| <b>DesignMax</b>     | Maximum value the block specifies in its parameter dialog box, for example, the value of its <b>Output maximum</b> parameter. |
| <b>SimMax</b>        | Maximum value that occurs during simulation.                                                                                  |
| <b>ProposedMax</b>   | Maximum value that results from the data type the Fixed-Point Tool proposes.                                                  |
| <b>OverflowWraps</b> | Number of overflows that wrap during simulation.                                                                              |
| <b>Saturations</b>   | Number of overflows that saturate during simulation.                                                                          |
| <b>DTGroup</b>       | Identification tag associated with objects that share data types.                                                             |
| <b>DivByZero</b>     | Number of divide-by-zero instances that occur during simulation.                                                              |
| <b>LogSignal</b>     | Check box that allows you to enable or disable signal logging for an object.                                                  |

| Column Label            | Description                                                                                                                                                                                                                                                                                                                                                                                  |
|-------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>InitValueMin</b>     | <p>Minimum initial value for a signal or parameter. Some model objects provide parameters that allow you to specify the initial values of their signals. For example, the Constant block includes a <b>Constant value</b> that initializes the block output signal.</p> <hr/> <p><b>Note</b> The Fixed-Point Tool uses this parameter when it proposes scaling.</p>                          |
| <b>InitValueMax</b>     | <p>Maximum initial value for a signal or parameter. Some model objects provide parameters that allow you to specify the initial values of their signals. For example, the Constant block includes a <b>Constant value</b> that initializes the block output signal.</p> <hr/> <p><b>Note</b> The Fixed-Point Tool uses this parameter when it proposes scaling.</p>                          |
| <b>ModelRequiredMin</b> | <p>Minimum value of a parameter used during simulation. For example, the Lookup Table (n-D) uses the <b>Breakpoints</b> and <b>Table data</b> parameters to perform its lookup operation and generate output. In this example, the block uses more than one parameter so the Fixed-Point Tool sets <b>ModelRequiredMin</b> to the minimum of the minimum values of all these parameters.</p> |



| Column Label            | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|-------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                         | <hr/> <p><b>Note</b> The Fixed-Point Tool uses this parameter when it proposes scaling.</p> <hr/>                                                                                                                                                                                                                                                                                                                                                                                              |
| <b>ModelRequiredMax</b> | <p>Maximum value of a parameter used during simulation. For example, the Lookup Table (n-D) uses the <b>Breakpoints</b> and <b>Table data</b> parameters to perform its lookup operation and generate output. In this example, the block uses more than one parameter so the Fixed-Point Tool sets <b>ModelRequiredMax</b> to the maximum of the maximum values of all these parameters.</p> <hr/> <p><b>Note</b> The Fixed-Point Tool uses this parameter when it proposes scaling.</p> <hr/> |

The following topics describe ways in which you can customize the **Contents** pane:

- “Changing Column Order and Width”
- “Sorting Rows by Column”
- “Hiding Columns”

### Changing Column Order and Width

You can alter the order and width of columns that appear in the **Contents** pane as follows:

- To move a column, click and drag the head of a column to a new location among the column headers.

- To make a column wider or narrower, click and drag the right edge of a column header. If you double-click the right edge of a column header, the column width changes to fit its contents.

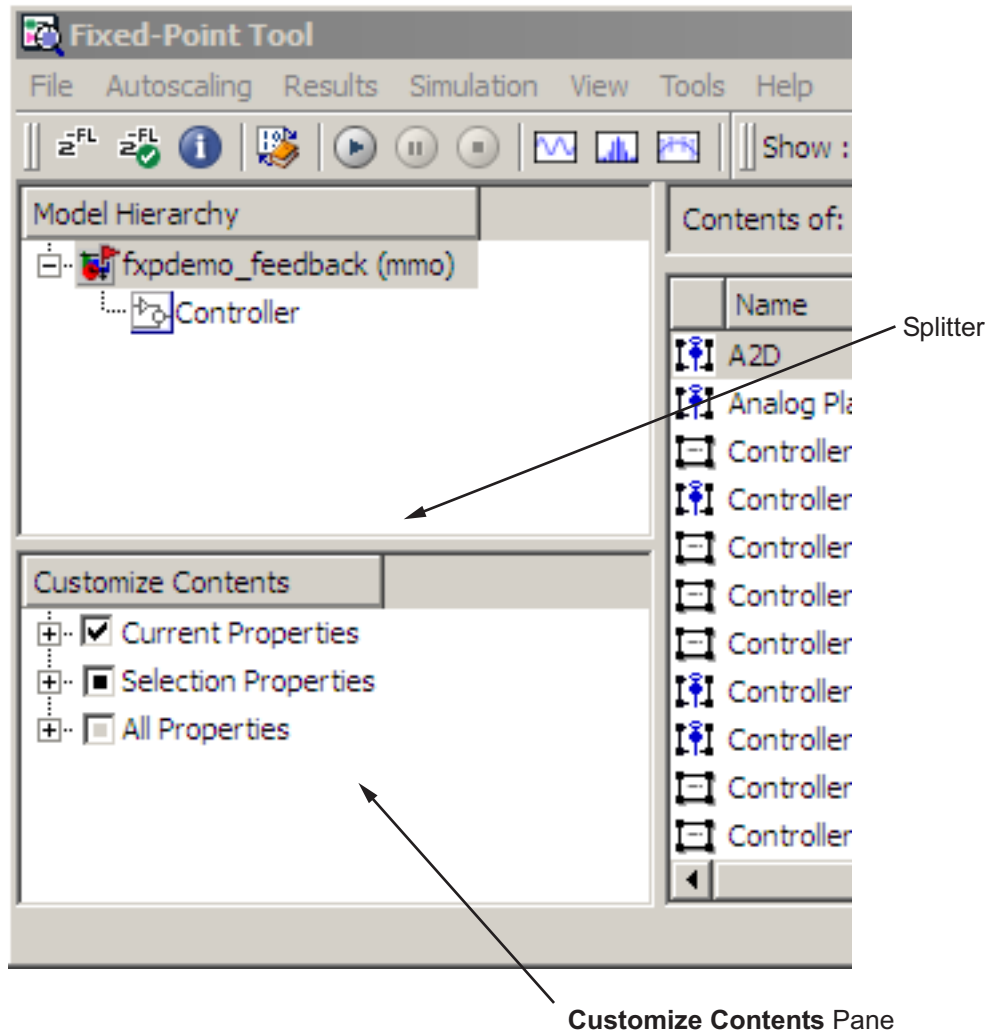
### **Sorting Rows by Column**

By default, the **Contents** pane displays its contents in ascending order of the **Name** column. You can alter the order in which the **Contents** pane displays its rows as follows:

- To sort all the rows in ascending order of another column, click the head of that column.
- To change the order from ascending to descending, simply click again on the head of that column.

### **Hiding Columns**

You can select the properties that the **Contents** pane displays or hides by using the **Customize Contents** pane. When visible, the pane appears in the lower-left corner of the Fixed-Point Tool window.



- To access the **Customize Contents** pane, from the Fixed-Point Tool **View** menu, select **Customize Contents**. A splitter divides the **Customize Contents** pane from the **Model Hierarchy** pane

above it. Drag the splitter up or down to adjust the relative size of the two panes.


- To hide properties from the **Contents** pane, in the **Customize Contents** pane, expand the **Current Properties** node and uncheck the properties that you do not want to appear.
- To display additional properties in the **Contents** pane, in the **Customize Contents** pane, expand the **All Properties** node and select the desired properties.


## **Dialog Pane**

Use the **Dialog** pane to view and change properties associated with the object selected in the **Model Hierarchy** pane.

**Current System: fxpdemo\_feedback**

Autoscaling

 Propose fraction lengths

 Apply accepted fraction lengths


Proposal options


Use simulation min/max if design min/max is not available

Percent safety margin for simulation min/max:


Percent safety margin for design min/max:

Results

 Show autoscale information for selected result

 Exchange Active and Reference results

Simulation settings

 Run simulation and store Active results

Logging mode:

Data type override:

Overwrite or merge results:

### Tips

From the Fixed-Point Tool **View** menu, you can select **Dialog View** to hide the **Dialog** pane, making more room for displaying results.

## Propose fraction lengths

Collect range data and proposes fraction lengths for model objects.

### Action

Use this button to perform the first phase of the autoscaling procedure, in which the Fixed-Point Tool collects range data for model objects—either from design minimum and maximum values the objects specify explicitly, or from logged minimum and maximum values that occur during simulation. Based on these values, the tool proposes fraction lengths for blocks whose:

- **Lock output scaling against changes by the autoscaling tool** parameter is cleared.
- Data type specifies a generalized fixed-point number.

The Fixed-Point Tool lists its scaling proposals in the **Contents** pane. The tool alerts you to potential scaling issues for each object in the list by displaying a green, yellow, or red icon, as shown here:



The proposed scaling poses no issues for this object.



The proposed scaling poses potential issues for this object. Open the Autoscale Information dialog box to review these issues.



The proposed scaling will introduce data type errors if applied to this object. Open the Autoscale Information dialog box for details about how to resolve these issues.

### Command-Line Alternative

No command line alternative available.

**Apply accepted fraction lengths**

Apply scaling proposals.

**Action**

Use this button to perform the second phase of the autoscaling procedure, in which the Fixed-Point Tool applies the scaling proposals to the objects whose **Accept** check box in the **Contents** pane is selected.

**Command-Line Alternative**

No command line alternative available.

## Use simulation min/max if design min/max are not available

Propose fraction lengths based on simulation minimum and maximum values if no design minimum and maximum values are available.

### Settings

Default: On



On

Proposes fraction lengths based on simulation minimum and maximum values, but only for blocks that do not specify design minimum or maximum values using, for example, **Output minimum** and **Output maximum** parameters.



Off

Ignores simulation minimum and maximum values when proposing fraction lengths.

### Dependency

This parameter enables **Percent safety margin for simulation min/max**.

### Command-Line Alternative

No command line alternative available.



### **Percent safety margin for simulation min/max**

Specify multiplication safety factor for simulation minimum and maximum values.

#### **Settings**

**Default:** 0

The simulation minimum and maximum values are multiplied by the factor designated by this parameter, allowing you to specify a range different from that obtained from the simulation run. 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.

#### **Dependencies**

This parameter is enabled by **Use simulation min/max if design min/max are not available**.

Before performing autoscaling, you must either specify design minimum and maximum values or run a simulation to collect simulation minimum and maximum data. To learn how to do this, see “Tutorial: Feedback Controller” in the Simulink Fixed Point documentation.

#### **Command-Line Alternative**

No command line alternative available.

## **Percent safety margin for design min/max**

Specify multiplication safety factor for design minimum and maximum values.

### **Settings**

**Default:** 0

The design minimum and maximum values are multiplied by the factor designated by this parameter. 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.

### **Dependency**

Before performing autoscaling, you must either specify design minimum and maximum values or run a simulation to collect simulation minimum and maximum data. To learn how to do this, see “Tutorial: Feedback Controller” in the Simulink Fixed Point documentation.

### **Command-Line Alternative**

No command line alternative available.

**Show autoscale information for selected result**

Display the Autoscale Information dialog box for object selected in the **Contents** pane.

**Action**

Use this option to:

- Determine why a fraction length cannot be proposed, for example, fraction lengths cannot be proposed for Library Links or Mask Subsystems.
- Provide access to showing blocks with shared data types.
- Obtain more information on the proposal for the selected result.

**Command-Line Alternative**

No command line alternative available.

## **Exchange Active and Reference results**

Swap results between active and reference run.

### **Action**

Use this button to swap the results that the Fixed-Point Tool stores as an active run with those that it stores as a reference run.

### **Command-Line Alternative**

No command-line alternative available.

## **Run simulation and store Active results**

Simulate model and store results.

### **Action**

Simulates the model and stores the results as active run, denoted by the Active label in the **Run** column of the **Contents** pane.

### **Tips**

Using the **Run simulation and store Active results** button is the same as simulating the model using the **Start simulation** button in the Model Editor.

### **Command-Line Alternative**

Command: sim

## Logging mode

Control which objects log data during simulation.

## Settings

**Default:** Use local settings

Use local settings

Logs data according to the value of this parameter set for each subsystem. Otherwise, settings for parent systems always override those of child systems.

Minimums, maximums and overflows

Logs minimum value, maximum value, and overflow data for all blocks in the current system or subsystem during simulation.

Overflows only

Logs only overflow data for all blocks in the current system or subsystem.

Force off

Does not log data 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.

## Dependencies

The value of this parameter for parent systems controls logging for all child subsystems, unless Use local settings is selected.

## Command-Line Alternative

**Parameter:** 'MinMaxOverflowLogging'

**Type:** string

**Value:** 'UseLocalSettings' | 'MinMaxAndOverflow' | 'OverflowOnly' | 'ForceOff'

**Default:** 'UseLocalSettings'

**Data type override**

Control data type override of objects that allow you to specify data types in their dialog boxes.

**Settings**

**Default:** Use local settings

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**

Overrides data types according to the setting of this parameter for each subsystem. Otherwise, settings for parent systems override those of child systems.

**Scaled doubles**

Overrides the output data type of all blocks in the current system or subsystem with doubles; however, the scaling and bias specified in the mask of each block is maintained.

**True doubles**

Overrides the output data type of all blocks in the current system or subsystem with double-precision. The overridden values have no scaling or bias.

**True singles**

Overrides the output data type of all blocks in the current system or subsystem with single-precision. 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.

**Tips**

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.

## Dependencies

- The following Simulink blocks allow you to set data types in their block masks, but ignore the **Data type override** setting:
  - Probe
  - Trigger
  - Width
- The Embedded MATLAB Function block ignores the **Data type override** parameter if it specifies Scaled doubles.

## Command-Line Alternative

**Parameter:** 'DataTypeOverride'

**Type:** string

**Value:** 'UseLocalSettings' | 'ScaledDoubles' | 'TrueDoubles'  
| 'TrueSingles' | 'ForceOff'

**Default:** 'UseLocalSettings'



### **Overwrite or merge results**

Control how simulation results are stored.

#### **Settings**

**Default:** Overwrite

#### Overwrite

Clears all existing simulation results from the **Contents** pane before displaying new simulation results.

#### Merge

Merges new simulation results with existing simulation results in the **Contents** pane.

#### **Command-Line Alternative**

**Parameter:** 'MinMaxOverflowArchiveMode'

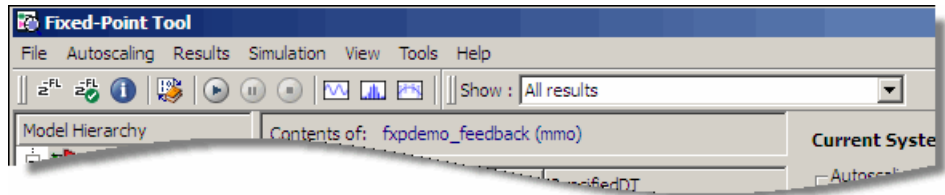
**Type:** string

**Value:** 'Overwrite' | 'Merge'

**Default:** 'Overwrite'

## Main Toolbar

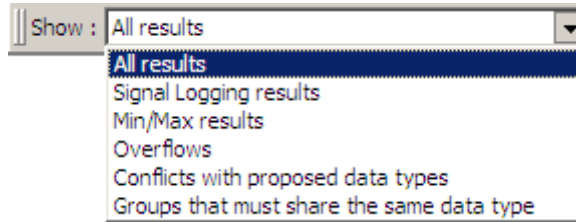
The Fixed-Point Tool's main toolbar appears near the top of the Fixed-Point Tool window under the Fixed-Point Tool's menu.



The toolbar contains the following buttons that execute commonly used Fixed-Point Tool commands:

| Button | Usage                                             |
|--------|---------------------------------------------------|
|        | Propose fraction lengths.                         |
|        | Apply accepted fraction lengths.                  |
|        | Display autoscale information.                    |
|        | Exchange active results with reference results.   |
|        | Simulate a model and store results as active run. |
|        | Pause a simulation.                               |
|        | Stop a simulation.                                |
|        | Create a time series plot.                        |
|        | Create a histogram plot.                          |
|        | Create a time series difference (A-R) plot.       |

The toolbar also contains the results filter:



The results filter specifies the type of results to display in the **Contents** pane. The **Contents** pane displays information only after you simulate a system or propose fraction lengths. If there are no results that satisfy a particular filter option, the list will be blank.


Options include:

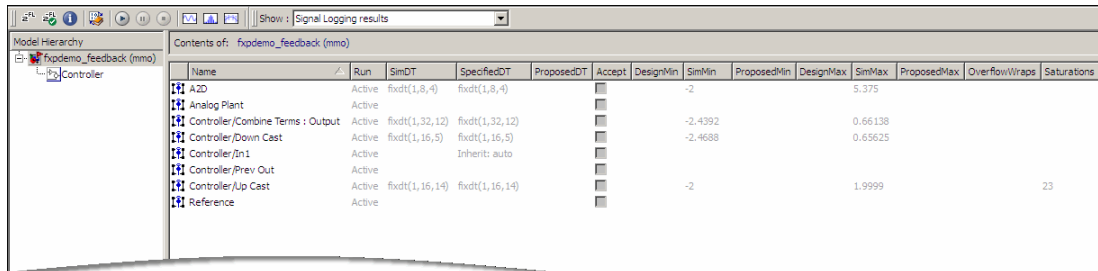
- All results

Displays all results for the selected tree node.

| Name                                          | Run    | SimDT  | SpecifiedDT     | ProposedDT | Accept                   | DesignMin | SimMin  | ProposedMin | DesignMax | SimMax | ProposedMax | Overflow/Wraps |
|-----------------------------------------------|--------|--------|-----------------|------------|--------------------------|-----------|---------|-------------|-----------|--------|-------------|----------------|
| Controller/Combine Terms : Output             | Active | double | fixdt(1,32,12)  |            | <input type="checkbox"/> |           | -2.4135 |             |           | 4.327  |             |                |
| Controller/Up Cast                            | Active | double | fixdt(1,16,14)  |            | <input type="checkbox"/> |           | -2      |             |           | 4      |             |                |
| Controller/Combine Terms : Accumulator        | Active | double | Inherit: Inh... |            | <input type="checkbox"/> |           | -6.4754 |             |           | 4.327  |             |                |
| Controller/Denominator Terms : Accumulator    | Active | double | fixdt(1,32,12)  |            | <input type="checkbox"/> |           | -8.5166 |             |           | 5.3965 |             |                |
| Controller/Denominator Terms : Output         | Active | double | fixdt(1,32,12)  |            | <input type="checkbox"/> |           | -6.4754 |             |           | 3.4877 |             |                |
| Controller/Denominator Terms : Product output | Active | double | fixdt(1,32,12)  |            | <input type="checkbox"/> |           | -8.5166 |             |           | 5.3965 |             |                |
| Controller/Numerator Terms : Accumulator      | Active | double | fixdt(1,32,12)  |            | <input type="checkbox"/> |           | -5.6773 |             |           | 5.7005 |             |                |
| Controller/Numerator Terms : Output           | Active | double | fixdt(1,32,12)  |            | <input type="checkbox"/> |           | -3.3674 |             |           | 3.544  |             |                |
| Controller/Numerator Terms : Product output   | Active | double | fixdt(1,32,12)  |            | <input type="checkbox"/> |           | -5.6773 |             |           | 5.7005 |             |                |
| D2A                                           | Active | double | double          |            | <input type="checkbox"/> |           | -2.4135 |             |           | 4.327  |             |                |
| Sum 1 : Accumulator                           | Active | double | Inherit: Inh... |            | <input type="checkbox"/> |           | -2.171  |             |           | 4      |             |                |
| A2D                                           | Active | double | fixdt(1,8,4)    |            | <input type="checkbox"/> |           | -2      |             |           | 4      |             |                |
| Controller/In1                                | Active | double | Inherit: auto   |            | <input type="checkbox"/> |           |         |             |           |        |             |                |
| Controller/Down Cast                          | Active | double | fixdt(1,16,5)   |            | <input type="checkbox"/> |           | -2.4135 |             |           | 4.327  |             |                |
| Controller/Prev Out                           | Active |        |                 |            | <input type="checkbox"/> |           |         |             |           |        |             |                |
| Analog Plant                                  | Active |        |                 |            | <input type="checkbox"/> |           |         |             |           |        |             |                |
| Reference                                     | Active |        |                 |            | <input type="checkbox"/> |           |         |             |           |        |             |                |
| Sum 1 : Output                                | Active | double | Inherit: Sam... |            | <input type="checkbox"/> |           | -2      |             |           | 4      |             |                |

- Signal Logging results

For the selected tree node, displays blocks whose output ports have logged signal data. The Fixed-Point tool marks these blocks with the logged signal icon .




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**Note** You can plot simulation results associated with logged signal data. For more information, see “Plot Interface” on page 4-93.

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- Min/Max results

For the selected tree node, displays blocks that record design Min/Max, simulation Min/Max, and overflow data.

**Prerequisites:** Logging mode should not be set to Force Off.

Contents of: Fixdemo\_feedback (mmo)

| Name                                 | Run    | SimDT          | SpecifiedDT        | ProposedDT | Accept | DesignMin | SimMin | ProposedMin | DesignMax | SimMax | ProposedMax | OverflowWraps | Saturations |
|--------------------------------------|--------|----------------|--------------------|------------|--------|-----------|--------|-------------|-----------|--------|-------------|---------------|-------------|
| A2D                                  | Active | fixdt(1,8,4)   | fixdt(1,8,4)       |            |        | -2        |        |             |           |        |             |               | 5.375       |
| Controller/Combine Terms : Accum...  | Active | fixdt(1,32,12) | Inherit: Inheri... |            |        | -2.4392   |        |             |           |        |             |               | 3.5059      |
| Controller/Combine Terms : Output    | Active | fixdt(1,32,12) | fixdt(1,32,12)     |            |        | -2.4392   |        |             |           |        |             |               | 0.66138     |
| Controller/Denominator Terms : A...  | Active | fixdt(1,32,12) | fixdt(1,32,12)     |            |        | -3.0791   |        |             |           |        |             |               | 4.8591      |
| Controller/Denominator Terms : O...  | Active | fixdt(1,32,12) | fixdt(1,32,12)     |            |        | -0.70093  |        |             |           |        |             |               | 3.5059      |
| Controller/Denominator Terms : Pr... | Active | fixdt(1,32,12) | fixdt(1,32,12)     |            |        | -3.0791   |        |             |           |        |             |               | 4.8591      |
| Controller/Down Cast                 | Active | fixdt(1,16,5)  | fixdt(1,16,5)      |            |        | -2.4688   |        |             |           |        |             |               | 0.65625     |
| Controller/Numerator Terms : Acc...  | Active | fixdt(1,32,12) | fixdt(1,32,12)     |            |        | -2.8503   |        |             |           |        |             |               | 2.8501      |
| Controller/Numerator Terms : Output  | Active | fixdt(1,32,12) | fixdt(1,32,12)     |            |        | -1.772    |        |             |           |        |             |               | 1.6936      |
| Controller/Numerator Terms : Pro...  | Active | fixdt(1,32,12) | fixdt(1,32,12)     |            |        | -2.8503   |        |             |           |        |             |               | 2.8501      |
| Controller/Up Cast                   | Active | fixdt(1,16,14) | fixdt(1,16,14)     |            |        | -2        |        |             |           |        |             |               | 1.9999      |
| D2A                                  | Active | double         | double             |            |        | -2.4688   |        |             |           |        |             |               | 0.65625     |
| Sum1 : Accumulator                   | Active | double         | Inherit: Inheri... |            |        | -3.8431   |        |             |           |        |             |               | 5.3839      |
| Sum1 : Output                        | Active | double         | Inherit: Same...   |            |        | -2        |        |             |           |        |             |               | 5.3839      |

- Overflows

For the selected tree node, displays blocks that have non-zero overflows recorded. If a block has its **Saturate on integer overflow** option selected, overflow information appears in the **Saturations** column, otherwise it appears in the **OverflowWraps** column.

Contents of: Fixdemo\_feedback (mmo)



| Name               | Run    | SimDT          | SpecifiedDT    | ProposedDT | Accept | DesignMin | SimMin | ProposedMin | DesignMax | SimMax | ProposedMax | OverflowWraps | Saturations |
|--------------------|--------|----------------|----------------|------------|--------|-----------|--------|-------------|-----------|--------|-------------|---------------|-------------|
| Controller/Up Cast | Active | fixdt(1,16,14) | fixdt(1,16,14) |            |        | -2        |        |             |           | 1.9999 |             | 23            |             |

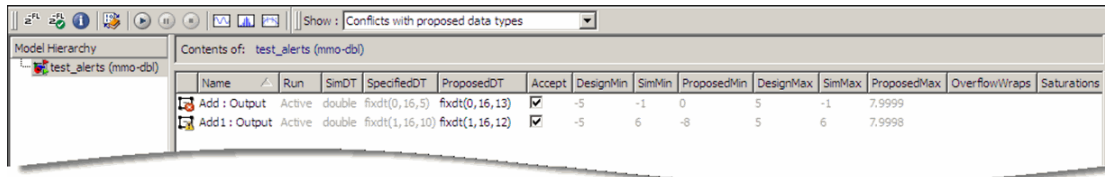
- Conflicts with proposed data types

For the selected tree node, displays results that have potential scaling issues.

**Prerequisites:** This information is available only after you propose fraction lengths.

The Fixed-Point Tool marks these results with a yellow or red icon, as shown here:

-  The proposed scaling poses potential issues for this object. Open the Autoscale Information dialog box to review these issues.
-  The proposed scaling will introduce data type errors if applied to this object. Open the Autoscale Information dialog box for details about how to resolve these issues.



Model Hierarchy: test\_alerts (mmo-db)

Contents of: test\_alerts (mmo-db)

| Name          | Run    | SimDT  | SpecifiedDT    | ProposedDT     | Accept                              | DesignMin | SimMin | ProposedMin | DesignMax | SimMax | ProposedMax | OverflowWraps | Saturations |
|---------------|--------|--------|----------------|----------------|-------------------------------------|-----------|--------|-------------|-----------|--------|-------------|---------------|-------------|
| Add : Output  | Active | double | fixdt(0,16,5)  | fixdt(0,16,13) | <input checked="" type="checkbox"/> | -5        | -1     | 0           | 5         | -1     | 7.9999      |               |             |
| Add1 : Output | Active | double | fixdt(1,16,10) | fixdt(1,16,12) | <input checked="" type="checkbox"/> | -5        | 6      | -8          | 5         | 6      | 7.9998      |               |             |

- Groups that must share the same data type

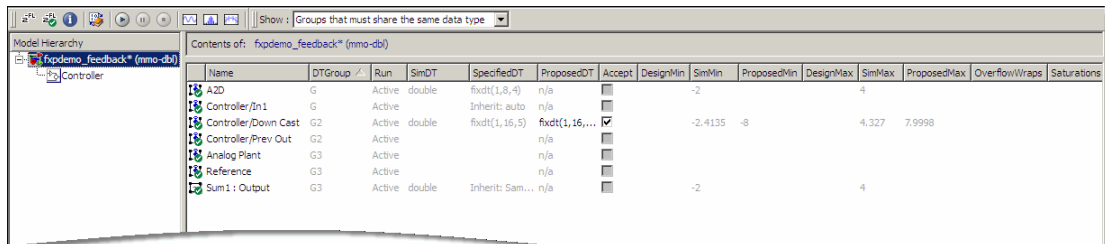
For the selected tree node, displays blocks that must share the same data type because of data type propagation rules.

**Prerequisites:** This information is available only after you propose fraction lengths.

The Fixed-Point Tool allocates an identification tag to blocks that must share the same data type. This identification tag is displayed in the **DTGroup** column as follows:

- If the selected tree node is the model root

All results for the model are listed. The **DTGroup** column is sorted by default so that you can easily view all blocks in a group.

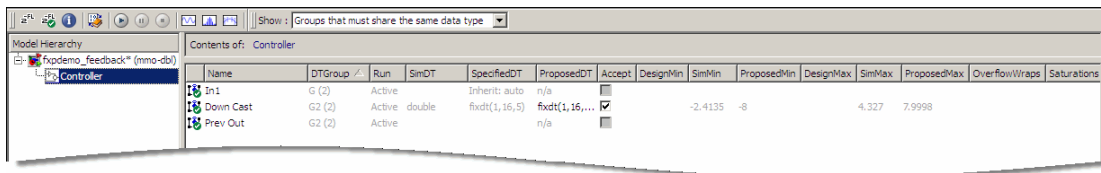


Model Hierarchy: fxdemo\_feedback\* (mmo-db)

Contents of: fxdemo\_feedback\* (mmo-db)

| Name                 | DTGroup | Run    | SimDT  | SpecifiedDT     | ProposedDT     | Accept                              | DesignMin | SimMin  | ProposedMin | DesignMax | SimMax | ProposedMax | OverflowWraps | Saturations |
|----------------------|---------|--------|--------|-----------------|----------------|-------------------------------------|-----------|---------|-------------|-----------|--------|-------------|---------------|-------------|
| A2D                  | G       | Active | double | fixdt(1,8,4)    | n/a            | <input type="checkbox"/>            |           | -2      |             |           | 4      |             |               |             |
| Controller/In1       | G       | Active | double | Inherit: auto   | n/a            | <input type="checkbox"/>            |           |         |             |           |        |             |               |             |
| Controller/Down Cast | G2      | Active | double | fixdt(1,16,5)   | fixdt(1,16,... | <input checked="" type="checkbox"/> |           | -2.4135 | -8          | 4.327     | 7.9998 |             |               |             |
| Controller/Prev Out  | G2      | Active | double |                 |                | <input type="checkbox"/>            |           |         |             |           |        |             |               |             |
| Analog Plant         | G3      | Active | double |                 |                | <input type="checkbox"/>            |           |         |             |           |        |             |               |             |
| Reference            | G3      | Active | double |                 |                | <input type="checkbox"/>            |           |         |             |           |        |             |               |             |
| Sum1 : Output        | G3      | Active | double | Inherit: Sam... | n/a            | <input type="checkbox"/>            |           | -2      |             |           | 4      |             |               |             |

- If the selected tree node is a subsystem
  - The identification tags have a suffix that indicates the total number of results in each group. For example, G2 (2) means group G2 has 2 members. This information enables you to see how many members of a group belong to the selected subsystem and which groups share data types across subsystem boundaries.




## Plot Interface

The Fixed-Point Tool provides plotting capabilities that enable you to plot signals for graphical analysis. The tool can access signal data that resides in the MATLAB workspace, allowing you to plot simulation results associated with

- Scope blocks whose **Save data to workspace** parameter is selected
- To Workspace blocks
- Root-level Outport blocks, when the **Output** check box on the **Data Import/Export** pane of the Configuration Parameters dialog box is selected
- Logged signal data (see “Logging Signals” in the *Simulink User’s Guide*)

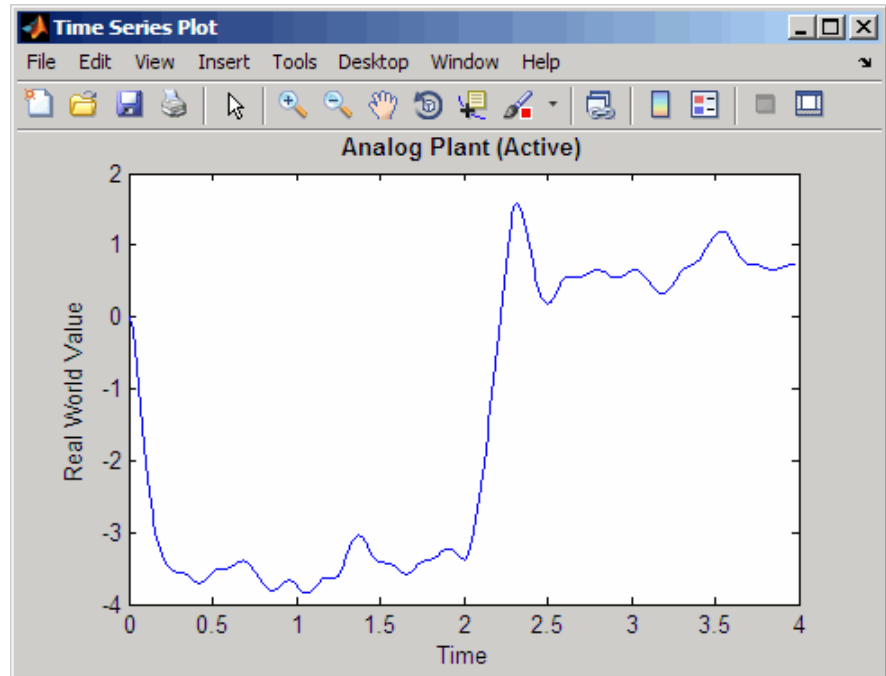
---

**Tip** The **Contents** pane of the Fixed-Point Tool displays an antenna icon  next to items that you can plot.

---

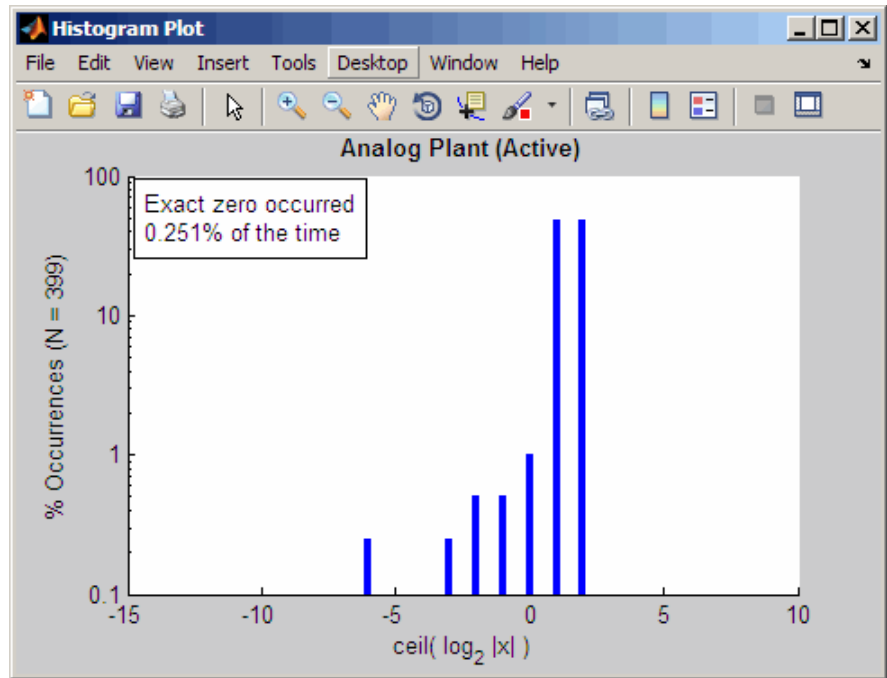
You can create the following types of plots using the Fixed-Point Tool’s interface:

- Time series plot — Plots data as a function of time.

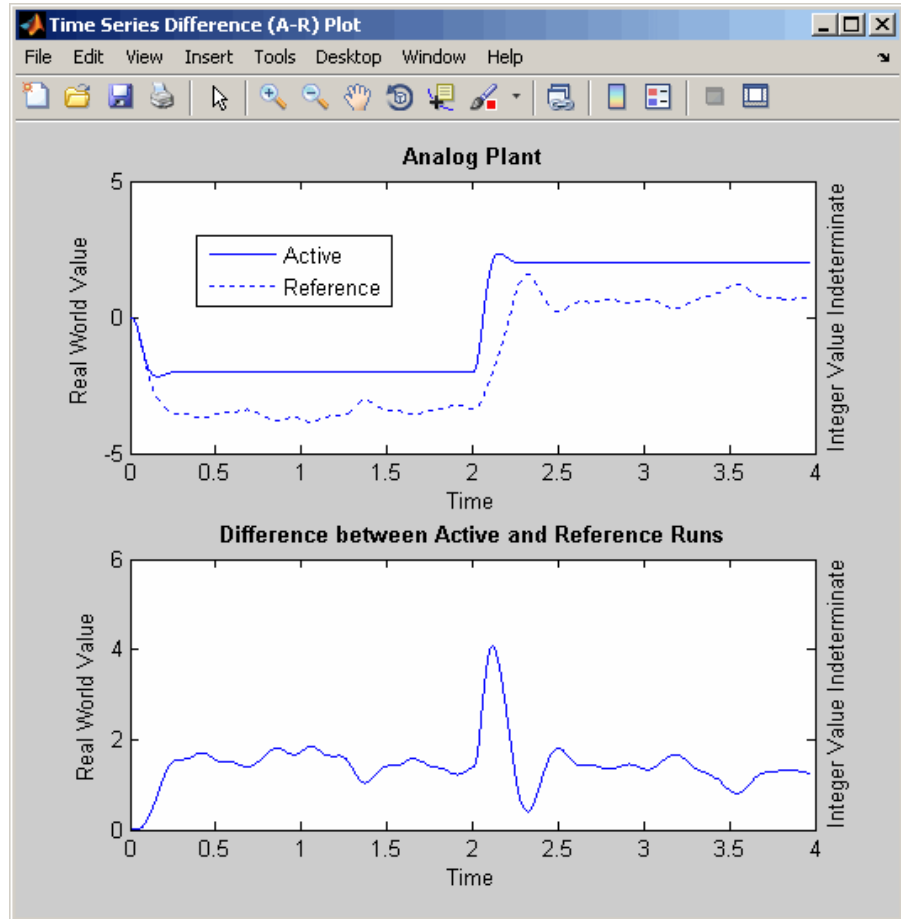




- Histogram plot — Plots the number of data values that occur at each bit.



- Time series difference (A-R) plot — Plots both the active and reference versions of a signal on the upper axes, and plots the difference between the active and reference versions of that signal on the lower axes.



## Signal Logging Options

The Fixed-Point Tool provides options that allow you to control signal logging in a model (see “Logging Signals” in the *Simulink User’s Guide*). Using these options, you can enable or disable logging for multiple signals simultaneously, based on signal attributes such as:

- The location of signals in a model hierarchy
- Whether or not signals have names

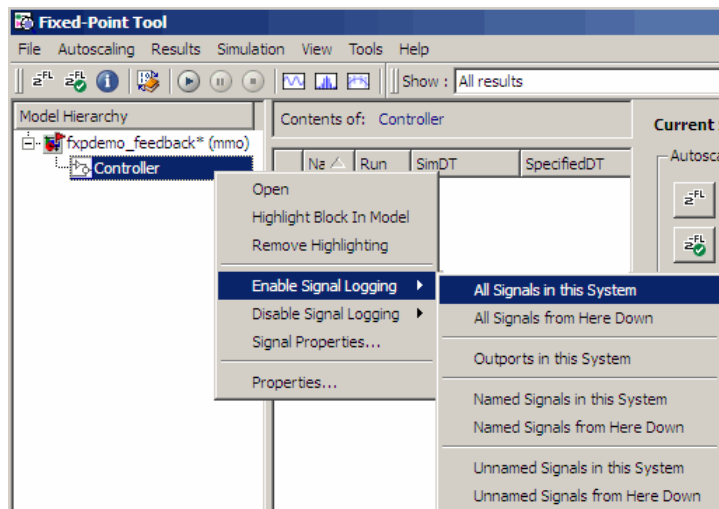
To access the signal logging options in the Fixed-Point Tool:

- 1 In the **Model Hierarchy** pane, right-click a node that represents either a model or a subsystem.

The Fixed-Point Tool displays a context menu for the selected node.

- 2 In the context menu, select either **Enable Signal Logging** or **Disable Signal Logging**.

The Fixed-Point Tool displays a submenu that lists a variety of signal logging options.



---

**Note** You can now control the signal logging of a Simulink subsystem, that is placed inside of a Stateflow Chart, from the subsystem parent node.

---

Choose from the following signal logging options:

| Select...                      | To Enable or Disable Signal Logging for...                                                                  |
|--------------------------------|-------------------------------------------------------------------------------------------------------------|
| All Signals in this System     | All signals in the selected system                                                                          |
| All Signals from Here Down     | All signals in the selected system and its subsystems                                                       |
| Outputs in this System         | All Output blocks in the selected system                                                                    |
| Named Signals in this System   | All signals in the selected system, whose <b>Signal name</b> parameter specifies a value                    |
| Named Signals from Here Down   | All signals in the selected system and its subsystems, whose <b>Signal name</b> parameter specifies a value |
| Unnamed Signals in this System | All signals in the selected system, whose <b>Signal name</b> parameter is empty                             |
| Unnamed Signals from Here Down | All signals in the selected system and its subsystems, whose <b>Signal name</b> parameter is empty          |

---

**Note** The Fixed-Point Tool does not control signal logging for referenced models or subsystems with library links. It ignores these objects when enabling or disabling signal logging in a model hierarchy.

---

**Examples**

To learn how to use the tool, see “Fixed-Point Tool” in the Simulink Fixed Point documentation.

**See Also**

`autofixexp`

**Purpose** Get pathname of 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 handle of 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

**Purpose** Get pathname of 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 system and block parameter values

**Syntax**

```
get_param('obj', 'parameter')  
get_param( { objects }, 'parameter')  
get_param(handle, 'parameter')  
get_param(0, '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(0, '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 8, “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 in *Simulink User's Guide*.

```
blks = find_system(gcs, 'Type', 'block');
listblks = get_param(blks, 'BlockType')

listblks =

    'SubSystem'
    'Inport'
    'Constant'
    'Gain'
    'Sum'
    'Output'
```

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 =
    SineType: [1x1 struct]
    TimeSource: [1x1 struct]
    Amplitude: [1x1 struct]
    Bias: [1x1 struct]
    Frequency: [1x1 struct]
    Phase: [1x1 struct]
    Samples: [1x1 struct]
    Offset: [1x1 struct]
    SampleTime: [1x1 struct]
    VectorParamsID: [1x1 struct]
```

**See Also**      `find_system`, `set_param`

# getActiveConfigSet

---

|                    |                                                                                                                                                                                                                                                                                                                |
|--------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Purpose</b>     | Get model's active configuration set or configuration reference                                                                                                                                                                                                                                                |
| <b>Syntax</b>      | <code>myConfigObj = getActiveConfigSet('model')</code>                                                                                                                                                                                                                                                         |
| <b>Arguments</b>   | <i>model</i><br>The name of an open model, or gcs to specify the current model                                                                                                                                                                                                                                 |
| <b>Description</b> | <code>getActiveConfigSet</code> returns the configuration set or configuration reference (configuration object) that is the active configuration object of ' <i>model</i> '.                                                                                                                                   |
| <b>Example</b>     | The following example returns the active configuration object of the current model. The code is the same whether the object is a configuration set or configuration reference.<br><br><pre>myConfigObj = getActiveConfigSet(gcs);</pre>                                                                        |
| <b>See Also</b>    | “Configuration Sets”, “Referencing Configuration Sets”<br><code>attachConfigSet</code> , <code>attachConfigSetCopy</code> , <code>closeDialog</code> ,<br><code>detachConfigSet</code> , <code>getConfigSet</code> , <code>getConfigSets</code> , <code>openDialog</code> ,<br><code>setActiveConfigSet</code> |

|                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|--------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Purpose</b>     | Get information about annotation                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| <b>Syntax</b>      | <code>getCallbackAnnotation</code>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| <b>Description</b> | <code>getCallbackAnnotation</code> is intended to be invoked by annotation callback functions. If it is invoked from an annotation callback function, it returns an instance of <code>Simulink.Annotation</code> 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., <code>[]</code> . |

# getConfigSet

---

|                    |                                                                                                                                                                                                                                                                             |
|--------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Purpose</b>     | Get one of model's configuration sets or configuration references                                                                                                                                                                                                           |
| <b>Syntax</b>      | <pre>myConfigObj = getConfigSet('model', 'configObjName')</pre>                                                                                                                                                                                                             |
| <b>Arguments</b>   | <p><i>model</i><br/>The name of an open model, or gcs to specify the current model</p> <p><i>configObjName</i><br/>The name of a configuration set (Simulink.ConfigSet) or configuration reference (Simulink.ConfigSetRef)</p>                                              |
| <b>Description</b> | getConfigSet returns the configuration set or configuration reference (configuration object) that is attached to <i>model</i> and is named <i>configObjName</i> . If no such object exists, an error occurs.                                                                |
| <b>Example</b>     | <p>The following example returns the configuration object that is named DevConfig and attached to the current model. The code is the same whether DevConfig is a configuration set or configuration reference.</p> <pre>myConfigObj = getConfigSet(gcs, 'DevConfig');</pre> |
| <b>See Also</b>    | “Configuration Sets”, “Referencing Configuration Sets”<br>attachConfigSet, attachConfigSetCopy, closeDialog,<br>detachConfigSet, getActiveConfigSet, getConfigSets, openDialog,<br>setActiveConfigSet                                                                       |

**Purpose** Get names of all of model's configuration sets or configuration references

**Syntax** `myConfigObjNames = getConfigSets('model')`

**Arguments** `model`  
The name of an open model, or `gcs` to specify the current model

**Description** `getConfigSets` returns a cell array of strings specifying the names of all configuration sets and configuration references (configuration objects) attached to `'model'`.

**Example** The following example obtains the names of the configuration objects attached to the current model.

```
myConfigObjNames = getConfigSets(gcs)
```

**See Also** “Configuration Sets”, “Referencing Configuration Sets”  
`attachConfigSet`, `attachConfigSetCopy`, `closeDialog`,  
`detachConfigSet`, `getActiveConfigSet`, `getConfigSet`, `openDialog`,  
`setActiveConfigSet`

# getfullname

---

**Purpose** Get pathname of block or line

**Syntax** path=getfullname(handle)

**Description** path=getfullname(handle) returns the full pathname of the block or line specified by handle.

**Examples** getfullname(gcb) returns the pathname of the block currently selected in the model editor's window.

The following code returns the pathname of the line currently selected in the model editor's window.

```
line = find_system(gcs, 'SearchDepth', 1, 'FindAll', 'on', ...
    'Type', 'line', 'Selected', 'on');
path = getfullname(line);
```

**See Also** gcb, find\_system



**Purpose**

Use Legacy Code Tool

**Syntax**

```
legacy_code('help')
specs = legacy_code('initialize')
legacy_code('sfcn_cmex_generate', specs)
legacy_code('compile', specs, compilerOptions)
legacy_code('generate_for_sim', specs, modelName)
legacy_code('slblock_generate', specs, modelName)
legacy_code('sfcn_tlc_generate', specs)
legacy_code('rtwmakecfg_generate', specs)
legacy_code('backward_compatibility')
```

**Arguments**

*specs*

A structure with the following fields:

**Name the S-function**

**SFunctionName** (Required) — A string specifying a name for the S-function to be generated by the Legacy Code Tool.

**Define Legacy Code Tool Function Specifications**

- **InitializeConditionsFcnSpec** — A nonempty string specifying a reentrant function that the S-function calls to initialize and reset states. You must declare this function by using tokens that Simulink software can interpret as explained in “Declaring Legacy Code Tool Function Specifications”.
- **OutputFcnSpec** — A nonempty string specifying the function that the S-function calls at each time step. You must declare this function by using tokens that Simulink software can interpret as explained in “Declaring Legacy Code Tool Function Specifications”.
- **StartFcnSpec** — A string specifying the function that the S-function calls when it begins execution. This function can access S-function parameter arguments only. You must declare this function by using tokens that Simulink software can

interpret as explained in “Declaring Legacy Code Tool Function Specifications”.

- **TerminateFcnSpec** — A string specifying the function that the S-function calls when it terminates execution. This function can access S-function parameter arguments only. You must declare this function by using tokens that Simulink software can interpret as explained in “Declaring Legacy Code Tool Function Specifications”.

## **Define Compilation Resources**

- **HeaderFiles** — A cell array of strings specifying the file names of header files required for compilation.
- **SourceFiles** — A cell array of strings specifying source files required for compilation. You can specify the source files using absolute or relative path names.
- **HostLibFiles** — A cell array of strings specifying library files required for host compilation. You can specify the library files using absolute or relative path names.
- **TargetLibFiles** — A cell array of strings specifying library files required for target (that is, standalone) compilation. You can specify the library files using absolute or relative path names.
- **IncPaths** — A cell array of strings specifying directories containing header files. You can specify the directories using absolute or relative path names.
- **SrcPaths** — A cell array of strings specifying directories containing source files. You can specify the directories using absolute or relative path names.
- **LibPaths** — A cell array of strings specifying directories containing host and target library files. You can specify the directories using absolute or relative path names.

## **Specify a Sample Time**

`SampleTime` — One of the following:

- `'inherited'` (default) — Sample time is inherited from the source block.
- `'parameterized'` — Sample time is represented as a tunable parameter. Generated code can access the parameter by calling MEX API functions, such as `mxGetPr` or `mxGetData`.
- `Fixed` — Sample time that you explicitly specify. For information on how to specify sample time, see “How to Specify the Sample Time”.

If you specify this field, you must specify it last.

## Define S-Function Options

`Options` — A structure that controls S-function options. The structure's fields include:

- `isMacro` — A logical value specifying whether the legacy code is a C macro. By default, the value is false (0).
- `isVolatile` — A logical value specifying the setting of the S-function `SS_OPTION_NONVOLATILE` option. By default, the value is true (1).
- `canBeCalledConditionally` — A logical value specifying the setting of the S-function `SS_OPTION_CAN_BE_CALLED_CONDITIONALLY` option. By default, the value is true (1).
- `useTlcWithAccel` — A logical value specifying the setting of the S-function `SS_OPTION_USE_TLC_WITH_ACCELERATOR` option. By default, the value is true (1).
- `language` — A string specifying either `'C'` or `'C++'` as the target language of the S-function that Legacy Code Tool will produce. By default, the value is `'C'`.

---

**Note** The Legacy Code Tool can interface with C++ functions, but not C++ objects. For a work around, see “Legacy Code Tool Limitations” in the Simulink documentation.

---

- `singleCPPMexFile` — A logical value that, if true (1), specifies that generated code:
  - Requires you to generate and manage an inlined S-function as only one file (.cpp) instead of two (.c and .t1c).
  - Maintains model code style (level of parentheses usage and preservation of operand order in expressions and condition expressions in if statements) as specified by model configuration parameters.

By default, the value is false (0).

---

**Limitations** You cannot set the `singleCPPMexFile` field to true (1) if

- `Options.language='C++'`
  - You use one of the following Simulink objects with the `IsAlias` property set to true (1):
    - `Simulink.Bus`
    - `Simulink.AliasType`
    - `Simulink.NumericType`
  - The Legacy Code Tool function specification includes a `void*` or `void**` to represent scalar work data for a state argument
  - - `HeaderFiles` field of the Legacy Code Tool structure specifies multiple header files
-

*modelName*

The name of a Simulink model into which Legacy Code Tool is to insert the masked S-function block generated when you specify `legacy_code` with the action string `'slblock_generate'`. If you omit this argument, the block appears in an empty model editor window.

**Description**

The `legacy_code` function creates a MATLAB structure for registering the specification for existing C or C++ code and the S-function being generated. In addition, the function can generate, compile and link, and create a masked block for the specified S-function. Other options include generating

- A TLC file for simulation in Accelerator mode or code generation
- An `rtwmakecfg.m` file that you can customize to specify dependent source and header files that reside in a different directory than that of the generated S-function

`legacy_code('help')` displays instructions for using Legacy Code Tool.

`specs = legacy_code('initialize')` initializes the Legacy Code Tool data structure, `specs`, which registers characteristics of existing C or C++ code and properties of the S-function that the Legacy Code Tool generates.

`legacy_code('sfcn_cmex_generate', specs)` generates an S-function source file as specified by the Legacy Code Tool data structure, `specs`.

`legacy_code('compile', specs, compilerOptions)` compiles and links the S-function generated by the Legacy Code Tool based on the data structure, `specs`, and any compiler options that you might specify. The following examples show how to specify no options, one option, and multiple options:

```
legacy_code('compile', s);  
legacy_code('compile', s, '-DCOMPILER_VALUE1=1');  
legacy_code('compile', s, ...
```

```
{'-DCOMPILER_VALUE1=1', '-DCOMPILER_VALUE2=2', ...  
'-DCOMPILER_VALUE3=3'});
```

`legacy_code('generate_for_sim', specs, modelName)` generates, compiles, and links the S-function in a single step. The function also generates a TLC file for accelerated simulations, if the `Options.useTlcWithAccel` field of the Legacy Code Tool data structure is set to 1.

`legacy_code('slblock_generate', specs, modelName)` generates a masked S-Function block for the S-function generated by the Legacy Code Tool based on the data structure, *specs*. The block appears in the Simulink model specified by *modelName*. If you omit *modelName*, the block appears in an empty model editor window.

`legacy_code('sfcn_tlc_generate', specs)` generates a TLC file for the S-function generated by the Legacy Code Tool based on the data structure, *specs*. This option is relevant if you want to

- Force Accelerator mode in Simulink software to use the TLC inlining code of the generated S-function. See the description of the `ssSetOptions SimStruct` function and `SS_OPTION_USE_TLC_WITH_ACCELERATOR` S-function option for more information.
- Use Real-Time Workshop software to generate code from your Simulink model. See “Automating the Generation of Files for Fully Inlined S-Functions Using Legacy Code Tool” for more information.

`legacy_code('rtwmakecfg_generate', specs)` generates an `rtwmakecfg.m` file for the S-function generated by the Legacy Code Tool based on the data structure, *specs*. This option is relevant only if you use Real-Time Workshop software to generate code from your Simulink model. See “Using the `rtwmakecfg.m` API to Customize Generated Makefiles” and “Automating the Generation of Files for Fully Inlined S-Functions Using Legacy Code Tool” in the Real-Time Workshop documentation for more information.

`legacy_code('backward_compatibility')` automatically updates syntax for using Legacy Code Tool, as made available from MATLAB Central in releases before R2006b, to the supported syntax described in this reference page and in “Integrating Existing C Functions into Simulink Models with the Legacy Code Tool” in *Writing S-Functions*.

## See Also

- “Integrating Existing C Functions into Simulink Models with the Legacy Code Tool” in the Writing S-Functions documentation
- “Automating the Generation of Files for Fully Inlined S-Functions Using Legacy Code Tool” in the Real-Time Workshop documentation

# libinfo

---

**Purpose** Get information about library blocks referenced by 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.



## Purpose

Extract continuous- or discrete-time linear state-space model of system around operating point

## Syntax

```
argout = linmod('sys');  
argout = linmod('sys',x,u);  
argout = linmod('sys', x, u, para);  
argout = linmod('sys', x, u, 'v5');  
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);  
argout = linmod2('sys', x, u, para);  
  
argout = linmodv5('sys');  
argout = linmodv5('sys',x,u);  
argout = linmodv5('sys', x, u, para);  
argout = linmod('sys', x, u, para, xpert, upert);
```

## Arguments

|                                   |                                                                                                                                                                                                                                                                                                                                              |
|-----------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <code>sys</code>                  | The name of the Simulink system from which the linear model is to be extracted.                                                                                                                                                                                                                                                              |
| <code>x</code> and <code>u</code> | The state and the input vectors. If specified, they set the operating point at which the linear model is to be extracted. When a model has model references using the Model block, you must use the Simulink structure format to specify <code>x</code> . To extract the <code>x</code> structure from the model, use the following command: |

```
x = Simulink.BlockDiagram.getInitialState('sys');
```

# linmod, dlinmod, linmod2, linmodv5

---

You can then change the operating point values within this structure by editing `x.signals.values`.

|                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|-------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <code>Ts</code>   | Sample time of the discrete-time linearized model                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| <code>'v5'</code> | An optional argument that invokes the perturbation algorithm created prior to MATLAB 5.3. Invoking this optional argument is equivalent to calling <code>linmodv5</code> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| <code>para</code> | A three-element vector of optional arguments: <ul style="list-style-type: none"><li>• <code>para(1)</code> — 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 <code>'v5'</code> flag. The default value is <code>1e-05</code>.</li><li>• <code>para(2)</code> — Linearization time. For blocks that are functions of time, this parameter can be set with a nonnegative value of <code>t</code> giving the time at which Simulink software evaluates the blocks when linearizing a model. The default value is <code>0</code>.</li><li>• <code>para(3)</code> — Set <code>para(3)=1</code> to remove extra states associated with blocks that have no path from input to output. The default value is <code>0</code>.</li></ul> |

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 = Simulink.BlockDiagram.getInitialState('sys');
```

You can then change the perturbation values within this structure by editing `xpert.signals.values`.

The perturbation input arguments are only available when invoking the perturbation algorithm created prior to MATLAB 5.3, either by calling `linmodv5` or specifying the 'v5' input argument to `linmod`.

*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_struct = linmod('sys', x, u)` returns a structure that contains the linearized model,

# linmod, dlinmod, linmod2, linmodv5

---

including state names, input and output names, and information about the operating point.

## 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. `linmodv5` computes a linear state space model using the full model perturbation algorithm created prior to MATLAB 5.3.

`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 software 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  $T_s$  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  $T_s$  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  $T_s$ , provided that

- $T_s$  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  $A_d$  provides an indication of the stability of the system. The system is stable if  $T_s > 0$  and the eigenvalues are within the unit circle, as determined by this statement:

$$\text{all}(\text{abs}(\text{eig}(A_d))) < 1$$

Likewise, the system is stable if  $T_s = 0$  and the eigenvalues are in the left half plane, as determined by this statement:

$$\text{all}(\text{real}(\text{eig}(A_d))) < 0$$

When the system is unstable and the sample time is not an integer multiple of the other sampling times, `dlinmod` produces  $A_d$  and  $B_d$  matrices, which can be complex. The eigenvalues of the  $A_d$  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.

# linmod, dlinmod, linmod2, linmodv5

---

## 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.

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 *i*th row is the block name associated with the *i*th 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 *Simulink User’s Guide*.

**Purpose** Invisibly load 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`

# model

---

**Purpose** Execute particular phase of simulation of 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 software 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 states and outputs of a model, 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

|                  |                                                                                                                                                                                                                                                                                                                                                                                                                |
|------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <code>sys</code> | Vector of model size data: <ul style="list-style-type: none"><li>• <code>sys(1)</code> = number of continuous states</li><li>• <code>sys(2)</code> = number of discrete states</li><li>• <code>sys(3)</code> = number of outputs</li><li>• <code>sys(4)</code> = number of inputs</li><li>• <code>sys(5)</code> = reserved</li><li>• <code>sys(6)</code> = direct-feedthrough flag (1 = yes, 0 = no)</li></ul> |
|------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|



|                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|----------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                      | <ul style="list-style-type: none"> <li>• <code>sys(7)</code> = number of sample times (= number of rows in <code>ts</code>)</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                 |
| <code>x0</code>      | Vector containing the initial conditions of the system's states                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| <code>str</code>     | Vector of names of the blocks associated with the model's states. The state names and initial conditions appear in the same order in <code>str</code> and <code>x0</code> , respectively.                                                                                                                                                                                                                                                                                                                                              |
| <code>ts</code>      | An $m$ -by-2 matrix containing the sample time (period, offset) information                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| <code>outputs</code> | Outputs of the model at time step <code>t</code> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| <code>derivs</code>  | Derivatives of the continuous states of the model at time <code>t</code> .                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| <code>dstates</code> | Discrete states of the model at time <code>t</code> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| <code>t</code>       | Time step                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| <code>x</code>       | State vector                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| <code>u</code>       | Inputs                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| <code>flag</code>    | <p>String that indicates the simulation phase to be executed:</p> <ul style="list-style-type: none"> <li>• <code>'sizes'</code> executes the size computation phase of the simulation. This phase determines the sizes of the model's inputs, outputs, state vector, etc.</li> <li>• <code>'compile'</code> executes the compilation phase of the simulation. The compilation phase propagates signal and sample time attributes.</li> <li>• <code>'update'</code> computes the next values of the model's discrete states.</li> </ul> |

## Examples

This command executes the compilation phase of the VDP model that comes with Simulink software.

```
vdp([], [], [], 'compile')
```

The following command terminates the simulation in the previous example.

```
vdp([], [], [], 'term')
```

- '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 software to terminate simulation of the model.

---

**Note** You must always terminate simulation of the model by invoking the model command with the 'term' command. Simulink software does not let you close the model until you have terminated the simulation.

---

## See Also

sim

|                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|--------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Purpose</b>     | Open Model Advisor                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <b>Syntax</b>      | <code>modeladvisor('model')</code>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <b>Arguments</b>   | <i>model</i><br>A string specifying the name or handle to the model or subsystem.                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| <b>Description</b> | <code>modeladvisor(model)</code> opens the Model Advisor on the model or subsystem specified by <i>model</i> . If the specified model or subsystem is not open, this command opens it.                                                                                                                                                                                                                                                                                                                                  |
| <b>Examples</b>    | <p>The command</p> <pre>modeladvisor('vdp')</pre> <p>opens the Model Advisor on the vdp demo model.</p> <p>The command</p> <pre>modeladvisor('f14/Aircraft Dynamics Model')</pre> <p>opens the Model Advisor on the Aircraft Dynamics Model subsystem of the f14 demo model.</p> <p>The command</p> <pre>modeladvisor(gcs)</pre> <p>opens the Model Advisor on the currently selected subsystem.</p> <p>The command</p> <pre>modeladvisor(bdroot)</pre> <p>opens the Model Advisor on the currently selected model.</p> |
| <b>See Also</b>    | “Consulting the Model Advisor”                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |

# new\_system

---

**Purpose** Create 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 8, “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')
```

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`

# num2fixpt

---

**Purpose** Convert number to nearest value representable by 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:

|                            |                                                                                                                                                                                                                                                                            |
|----------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <code>OrigValue</code>     | Value to be converted to a fixed-point representation. Must be specified using a <code>double</code> data type.                                                                                                                                                            |
| <code>FixPtDataType</code> | The fixed-point data type used to convert <code>OrigValue</code> .                                                                                                                                                                                                         |
| <code>FixPtScaling</code>  | Scaling of the output in either <code>Slope</code> or <code>[Slope Bias]</code> format. If <code>FixPtDataType</code> does not specify a generalized fixed-point data type using the <code>sfix</code> or <code>ufix</code> command, <code>FixPtScaling</code> 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 =
```

```
9.500000000000000
```

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 =
```

```
9.750000000000000
```

## num2fixpt

---

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)
```

```
ans =
```

```
9.87500000000000
```

eliminates the quantization error entirely.

### See Also

`fixptbestexp`, `fixptbestprec`



**Purpose** Open Simulink system window or 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', 'destsys', 'replace')
open_system('sys', 'destsys', '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 opened system (for example, engine/Combustion). On UNIX systems, the fully qualified pathname of a model can start with a tilde (~), signifying your home directory.

---

**Note** If you use the `open_system` command to open a subsystem without first opening or loading the top level model, Simulink gives an error. Use `load_system` to load a model before you use `open_system` to open a subsystem in that model.

---

`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

---

`open_system('blk', 'OpenFcn')` runs this block's open function.

`open_system('sys', 'destsys', 'replace')` replaces the window of the previously opened system `destsys` with the window of the subsystem `sys` opened by this command. The location of the new window is determined by the location of the destination system `destsys` while the size of the window will match that used by `sys`.

`open_system('sys', 'destsys', 'reuse')` reuses the window of the previously opened system `destsys` to display the contents of the subsystem `sys` opened by this command. In this case, `sys` will be scaled to fit within the window size determined by the destination system `destsys`.

---

**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') 'Model'])
```

---

## 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');
```

This command opens f14 into the f14/Controller window using reuse mode.

```
open_system('f14', 'f14/Controller', 'reuse');
```

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.

This command opens `f14` and `vdp` with a vectorized operation.

```
open_system( { 'f14', 'vdp' } );
```

Open a subsystem after loading a model.

```
load_system('f14');  
open_system('f14/Controller');
```

## See Also

`close_system`, `load_system`, `new_system`, `save_system`

# openDialog

---

|                    |                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|--------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Purpose</b>     | Open configuration parameters dialog                                                                                                                                                                                                                                                                                                                                                                                                          |
| <b>Syntax</b>      | <code>openDialog(<i>configObj</i>)</code>                                                                                                                                                                                                                                                                                                                                                                                                     |
| <b>Arguments</b>   | <i>configObj</i><br>A configuration set ( <code>Simulink.ConfigSet</code> ) or configuration reference ( <code>Simulink.ConfigSetRef</code> )                                                                                                                                                                                                                                                                                                 |
| <b>Description</b> | <code>openDialog</code> opens a configuration parameters dialog box. If <i>configObj</i> is a configuration set, the dialog box displays the configuration set. If <i>configObj</i> is a configuration reference, the dialog box displays the referenced configuration set, or generates an error if the reference does not specify a valid configuration set. If the dialog box is already open, its window becomes selected.                |
| <b>Example</b>     | The following example opens a configuration parameters dialog box that shows the current parameters for the current model. The parameter values derive from the active configuration set or configuration reference (configuration object). The code is the same in either case; the only difference is which type of configuration object is currently active.<br><pre>myConfigObj = getActiveConfigSet(gcs); openDialog(myConfigObj);</pre> |
| <b>See Also</b>    | “Configuration Sets”, “Referencing Configuration Sets”<br><code>attachConfigSet</code> , <code>attachConfigSetCopy</code> , <code>closeDialog</code> , <code>detachConfigSet</code> , <code>getActiveConfigSet</code> , <code>getConfigSet</code> , <code>getConfigSets</code> , <code>setActiveConfigSet</code>                                                                                                                              |

## Purpose

Replace blocks in Simulink model

## Syntax

```
replace_block('sys', 'old_blk', 'new_blk')  
replace_block('sys', 'Parameter', 'value', ..., 'blk')
```

## Description

`replace_block('sys', 'old_blk', 'new_blk')` replaces all blocks in 'sys' having the block or mask type 'old\_blk' with 'new\_blk'.

- If 'new\_blk' is a Simulink built-in block, only the block name is necessary.
- If 'old\_blk' or 'new\_blk' is in another system, its full block pathname is required.
- If 'noprompt' is omitted, Simulink software 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. For information on block parameters, see Chapter 8, “Model and Block Parameters”

---

**Note** Because it may be difficult to undo the changes this command makes, it is a good idea to save your Simulink model 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 software lists the matching blocks in a dialog box before making the replacement.

# replace\_block

---

```
RepNames = replace_block('f14','Gain','Integrator')
```

This command replaces all blocks in the Unlocked subsystem in the clutch system having a Gain of 'bv' with the Integrator block. Simulink software 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')
```

This command replaces the Small\_Wheel subsystem in the wheel\_analysis model with the Large\_Wheel subsystem from the wheels library.

```
replace_block('wheel_analysis','Name','Small_Wheel','wheels/Large_Wheel')
```

## See Also

find\_system, set\_param

**Purpose**

Save Simulink system

**Syntax**

```
save_system
save_system('sys')
save_system('sys', 'newname')
save_system('sys', 'newname', 'BreakAllLinks', true)
save_system('sys', 'newname', 'BreakUserLinks', true)
save_system('sys', 'newname', 'SaveModelWorkspace', true)
save_system('sys', 'newname', 'ErrorIfShadowed', true)
save_system('sys', 'newname', 'SaveAsVersion', 'version')
save_system('sys', 'newname', 'OverWriteIfChangedOnDisk', true)
save_system('sys', 'exported_file_name', 'ExportToXML', true)
save_system('sys', 'newname', 'SaveModelWorkspace', true,
    'BreakUserLinks', true, 'OverwriteIfChangedOnDisk', true)
```

**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. `'sys'` can be a string, a cell array of strings, a numeric handle, or an array of numeric handles.

`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 software saves the system in the working directory, or a fully qualified pathname. On UNIX systems, the fully qualified pathname can start with a tilde (~), signifying your home directory.

`'newname'` can be empty ([]) , in which case the current name is used. If `'sys'` refers to more than one block diagram, `'newname'` must be a cell array of new names.

This command displays an error if you enter any of the following as the new model name:

- A MATLAB keyword

## save\_system

---

- 'simulink'
- More than 63 characters

Additional arguments must be supplied as name-value pairs, in any order. Allowed names are:

- **ErrorIfShadowed:** true or false (default: false)  
Generates an error if the specified new name already exists on the MATLAB path or workspace.
- **BreakAllLinks:** true or false (default: false)  
Replaces links to library blocks with copies of the library blocks in the saved file. The 'BreakAllLinks' option affects any linked block, including user-defined and Simulink library blocks.



---

**Note**

The 'BreakAllLinks' option can result in compatibility issues when upgrading to newer versions of Simulink software. For example:

- Any masks on top of library links to Simulink S-functions will not upgrade to the new version of the S-function.
- Any library links to masked subsystems in a Simulink library will not upgrade to the new subsystem behavior.
- Any broken links prevent the automatic library forwarding mechanism from upgrading the link.

If you have saved a model with broken links, use the `Check model`, `local libraries`, and `referenced models` for known upgrade issues option in the Model Advisor to scan the model for out-of-date blocks. You can then use the `slupdate` command to upgrade the Simulink blocks to their current versions. Subsequently running the Model Advisor lists any remaining third-party library and optional Simulink blockset blocks that are still out of date and need to be manually upgraded.

---

- `BreakUserLinks`: true or false (default: false)

Replaces links to user-defined library blocks with copies of the library blocks in the saved file.

- `SaveAsVersion`: MATLAB version name (default: current)

Saves the system in a form that can be loaded by a specified version of Simulink software. Valid values include: R12, R12P1, R13, R13SP1, R14, R14SP1, R14SP2, R14SP3, R2006A, R2006B, R2007A, R2007B and R2008A. These version names are not case sensitive. If the system to be saved contains blocks not supported by the specified Simulink software 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

---

- `OverwriteIfChangedOnDisk`: true or false (default: false)

If the file has changed on disk since the model was loaded, `save_system` displays an error to prevent the changes on disk from being overwritten. This error appears only if the **Saving the model** option in the **Model File Change Notification** section of the Simulink Preferences dialog is selected.

To save the model regardless of whether the file has been changed on disk supply the `OverwriteIfChangedOnDisk` option with value true.

- `SaveModelWorkspace`: true or false (default: false)

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.

- `ExportToXML`: true or false (default: false)

Exports the specified block diagram to a file in a simple XML format. The full name of the file, including an extension, should be specified. The block diagram in memory is not changed and no callbacks are executed. The `ExportToXML` option should not be used in conjunction with any other `save_system` options.

The same options are applied to all the block diagrams that are saved.

`save_system` returns the full name of the file that was saved, as a string. If multiple files were saved, the return value is a cell array of strings.

`save_system` can save only entire block diagrams, but the utility function `Simulink.SubSystem.copyContentsToBlockDiagram` can be used to copy the contents of a subsystem into a new block diagram, which can then be saved using `save_system`.

If you set the `UpdateHistory` property of the model to `UpdateHistoryWhenSave`, you see the following behavior:

- When you save interactively, you see a dialog prompting for a comment to include in the model history.

- When you save using `save_system`, you are not prompted for a comment. `save_system` reuses the previous comment, unless you set 'ModifiedComment' before saving, as follows:

```
set_param(mymodel, 'ModifiedComment', mycomment)
```

## Examples

This command saves the current system.

```
save_system
```

This command saves the vdp system with the name `vdp`.

```
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 another directory.

```
save_system('vdp', 'C:\TMP\vdp.mdl')
```

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', 'BreakAllLinks', true)
```

Both of these commands save the current model (with its current name), and break any library links in it:

```
save_system('mymodel', 'mymodel', 'BreakAllLinks', true)  
save_system('mymodel', [], 'BreakAllLinks', true)
```

This command saves the current model with a new name, but displays an error (instead of saving) if something with this name already exists on the MATLAB path:

```
save_system('mymodel', 'mynewmodel', 'ErrorIfShadowed', true)
```

## save\_system

---

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', true)
```

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', 'SaveAsVersion', 'R13SP1')
```

This command saves the current model with a new name, saves the model workspace, breaks any library links, and overwrites if the file has changed on disk:

```
save_system('mymodel', 'mynewmodel', 'SaveModelWorkspace',  
true, 'BreakAllLinks', true, 'OverwriteIfChangedOnDisk', true)
```

This command returns the full path name of the file that was saved, as a string. If multiple files were saved, the return value is a cell array of strings.

```
filename = save_system('mymodel')
```

### See Also

close\_system, new\_system, open\_system

|                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|--------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Purpose</b>     | Set Simulink system and block parameters                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| <b>Syntax</b>      | <code>set_param('obj', 'parameter1', value1, 'parameter2', value2, ...)</code>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <b>Description</b> | <p><code>set_param('obj', 'parameter1', value1, 'parameter2', value2, ...)</code>, where 'obj' specifies a model or block, sets the specified parameters to the specified values. Case is ignored for parameter names. Value strings are case sensitive.</p> <p>Most block parameter values must be specified as strings. Two exceptions are the <code>Position</code> and <code>UserData</code> parameters, common to all blocks. All parameters that correspond to dialog box entries have string values. Model and block parameters are listed in Chapter 8, “Model and Block Parameters”.</p> <p>You can change block parameter values in the workspace and update the block diagram with these changes. To do this:</p> <ol style="list-style-type: none"><li>1 Use <code>set_param</code> to make the changes at the command prompt.</li><li>2 Make the model window the current window.</li><li>3 Select <b>Edit &gt; Update Diagram</b>.</li></ol> <p>When you set multiple parameters on the same model or block, use a single <code>set_param</code> command with multiple pairs of arguments, rather than multiple <code>set_param</code> commands. This technique is more efficient because using a single call requires evaluating parameters only once, and can prevent dependency errors because the call sets all parameter values before checking the legality of the results.</p> |
| <b>Examples</b>    | <p>This command sets the <code>Solver</code> and <code>StopTime</code> parameters of the <code>vdp</code> system.</p> <pre>set_param('vdp', 'Solver', 'ode15s', 'StopTime', '3000')</pre>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |

## set\_param

---

This command sets the Gain parameter of the Mu block 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” in the Simulink User’s Guide).

```
set_param('mymodel/Compute', 'OpenFcn', 'my_open_fcn')
```

### See Also

find\_system, get\_param

|                    |                                                                                                                                                                                                                                                                                                                                                     |
|--------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Purpose</b>     | Specify model's active configuration set or configuration reference                                                                                                                                                                                                                                                                                 |
| <b>Syntax</b>      | <code>setActiveConfigSet('model', 'configObjName')</code>                                                                                                                                                                                                                                                                                           |
| <b>Arguments</b>   | <p><i>model</i><br/>The name of an open model, or gcs to specify the current model</p> <p><i>configObjName</i><br/>The name of a configuration set (Simulink.ConfigSet) or configuration reference (Simulink.ConfigSetRef)</p>                                                                                                                      |
| <b>Description</b> | <code>setActiveConfigSet</code> specifies the active configuration set or configuration reference (configuration object) of <i>model</i> to be the configuration object specified by <i>configObjName</i> . If no such configuration object is attached to the model, an error occurs. The previously active configuration object becomes inactive. |
| <b>Example</b>     | <p>The following example makes DevConfig the active configuration object of the current model. The code is the same whether DevConfig is a configuration set or configuration reference.</p> <pre>setActiveConfigSet(gcs, 'DevConfig');</pre>                                                                                                       |
| <b>See Also</b>    | “Configuration Sets”, “Referencing Configuration Sets”<br><code>attachConfigSet</code> , <code>attachConfigSetCopy</code> , <code>closeDialog</code> , <code>detachConfigSet</code> , <code>getActiveConfigSet</code> , <code>getConfigSet</code> , <code>getConfigSets</code> , <code>openDialog</code>                                            |

**Purpose** Create MATLAB structure describing signed generalized fixed-point data type

**Syntax** `a = sfix(TotalBits)`

**Description** `sfix(TotalBits)` returns a MATLAB structure that describes the data type of a signed generalized fixed-point number with a word size given by `TotalBits`.

`sfix` is automatically called when a signed generalized fixed-point data type is specified in a block dialog box.

---

**Note** A 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 signed generalized fixed-point data type:

```
a = sfix(16)
a =
    Class: 'FIX'
    IsSigned: 1
    MantBits: 16
```

**See Also** `fixdt`, `float`, `sfrac`, `sint`, `ufix`, `ufrac`, `uint`



**Purpose**

Create MATLAB structure describing signed fractional data type

**Syntax**

```
a = sfrac(TotalBits)
a = sfrac(TotalBits, GuardBits)
```

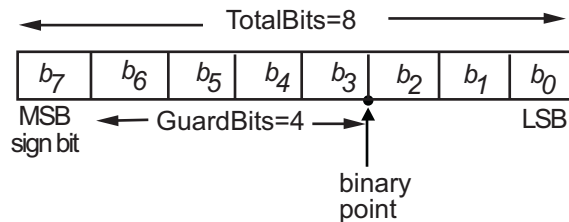
**Description**

`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 binary point.

`sfrac` is automatically called when a signed fractional data type is specified in a block dialog box.

The most significant (leftmost) bit is the sign bit. 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 and to right of the sign bit. For example, the structure for an 8-bit signed fractional data type with 4 guard bits is:

**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  $(1 - 2^{(1-8)}) \cdot 2^4 = 15.875$ :

```
a = sfrac(8,4)
a =
    Class: 'FRAC'
    IsSigned: 1
```

# sfrac

---

MantBits: 8  
GuardBits: 4

## See Also

fixdt, float, sfix, sint, ufix, ufrac, uint

## 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(path, 'create', time, data, siglabels,
    grouplabels)
block = signalbuilder(path, 'create', time, data, siglabels,
    grouplabels, vis)
block = signalbuilder(path, 'create', time, data, siglabels,
    grouplabels, vis, pos)

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)

signalbuilder(block, 'print', [])
signalbuilder(block, 'print', config, printArgs)
figh = signalbuilder(block, 'print', config, 'figure')
```

## Description

Use the `signalbuilder` command to interact programmatically with Signal Builder blocks.

- “Create and Access Signal Builder Blocks” on page 4-154
- “Get/Set Methods for Specific Signals and Groups” on page 4-155
- “Query and Set the Active Group” on page 4-156

- “Print Signal Groups” on page 4-156

## Create and Access Signal Builder Blocks

`[time, data] = signalbuilder(block)` returns the time (x-coordinate) and amplitude (y-coordinate) data of the Signal Builder block, *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.

`[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. The preceding table describes the allowable formats of *time* and *data*. 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(path, 'create', time, data, siglabels, grouplabels)` creates a new Signal Builder block at *path* using the specified values. If *path* is empty, the function creates a block in a new model, which has a default name. If *data* is a cell array and *time* is a vector, the *time* values are duplicated for each element of *data*. Each vector within *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(path, 'create', time, data, siglabels, grouplabels, vis)` creates a new Signal Builder block and sets the visible signals in each group based on the values of the matrix *vis*. This matrix must be the same size as the cell array, *data*.

`block = signalbuilder(path, 'create', time, data, siglabels, grouplabels, vis, pos)` creates a new Signal Builder block and sets the block position to *pos*.

`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.

---

**Note** The `signalbuilder` function does not allow you to alter and delete data in the same invocation.

---

## 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`.

## Print Signal Groups

`signalbuilder(block, 'print', [])` prints the currently active signal group.

`signalbuilder(block, 'print', config, printArgs)` prints the currently active signal group or the signal group that `config` specifies. The argument `config` is a structure that allows you to customize the printed appearance of a signal group. The `config` structure may contain any of the following fields:

| Field                       | Description                                                                                    | Example Value      |
|-----------------------------|------------------------------------------------------------------------------------------------|--------------------|
| <code>groupIndex</code>     | Scalar specifying index of signal group to print                                               | 2                  |
| <code>timeRange</code>      | Two-element vector specifying the time range to print (must not exceed the block's time range) | [3 6]              |
| <code>visibleSignals</code> | Vector specifying index of signals to print                                                    | [1 2]              |
| <code>yLimits</code>        | Cell array specifying limits for each signal's <i>y</i> -axis                                  | {[-1 1],<br>[0 1]} |

| Field     | Description                                                                                                                                   | Example Value |
|-----------|-----------------------------------------------------------------------------------------------------------------------------------------------|---------------|
| extent    | Two-element vector of the form:<br><br>[width, height]<br><br>specifying the dimensions (in pixels) of the area in which to print the signals | [500 300]     |
| showTitle | Logical value specifying whether to print a title; true (1) prints the title                                                                  | false         |

The optional argument *printArgs* allows you to configure print options (see `print` in the MATLAB Function Reference).

`figh = signalbuilder(block, 'print', config, 'figure')` prints the currently active signal group or the signal group that *config* specifies to a new hidden figure handle, *figh*.

## Examples

### Example 1

The following command creates a new Signal Builder block in a new model editor window:

```
block = signalbuilder([], 'create', [0 5], {[2 2];[0 2]});
```

The Signal Builder block contains two signals in one group. To alter the second signal in the group, use the `set` keyword as follows:

```
signalbuilder(block, 'set', 2, 1, [0 5], [2 0])
```

To delete the first signal from the group, enter the following command:

```
signalbuilder(block, 'set', 1, 1, [], [])
```

To add a new signal in a new group, use the `append` keyword as follows:

```
signalbuilder(block, 'append', [0 2.5 5], [0 2 0]);
```

## Example 2

The following command creates a new Signal Builder block in a new model editor window:

```
block = signalbuilder([], 'create', [0 2], {[0 1],[1 0]});
```

The Signal Builder block has two groups, each of which contains a signal. To delete the second group, simply delete its signal with the following command:

```
signalbuilder(block, 'set', 1, 2, [], [])
```

## Example 3

The following command creates a new Signal Builder block in a new model editor window:

```
block = signalbuilder([], 'create', [0 1], ...  
    {[0 0],[1 1];[1 0],[0 1];[1 1],[0 0]});
```

The Signal Builder block has two groups, each of which contains three signals.



**Purpose**

Simulate dynamic system

**Syntax**

```
sim(model,timespan,options,ut);  
[t,x,y] = sim(model,timespan,options,ut);  
[t,x,y1, y2, ..., yn] = sim(model,timespan,options,ut);
```

**Description**

The `sim` command causes the specified Simulink model to be executed. The model is executed with the data passed to the `sim` command, which may include parameter values specified in an `options` structure. The values in the structure override the values shown for block diagram parameters in the Configuration Parameters dialog box, and the structure may set additional parameters that are not otherwise available (such as `DstWorkspace`). The parameters in an `options` structure are useful for setting conditions for a specific simulation run.

Use the `simset` command to create an `options` structure for use by the `sim` command. The `simset` command inputs name-value pairs and sets each named parameter to the value indicated. You do not need to specify values for all block diagram parameters that `simset` accepts. In most cases, an unspecified parameter defaults to the block diagram value that is current when `sim` executes the model, but some exceptions exist. See the `simset` command documentation for details.

---

**Note** If you use an `options` structure, check the `simset` documentation to determine the values used by the `sim` command for the parameters that you do not specify.

---

With one exception, the default workspace for a simulation executed by the `sim` command is the MATLAB workspace. The exception is that the default workspace for To Workspace blocks is the workspace of the function that invoked the `sim` command.

## Superseding the Base Workspace

When you run a simulation interactively, Simulink tries to resolve any symbols used in the model to appropriate workspace items, as described in “Resolving Symbols” and “Hierarchical Symbol Resolution”, and it writes any exported or logged data to the MATLAB base workspace, as described in “Importing and Exporting Data” and “Logging Signals”.

When you use the `sim` command to run a simulation programmatically, you have two options that do not exist with interactive simulation: you can specify a workspace other than the MATLAB base workspace as the last workspace searched in hierarchical symbol resolution, and a workspace other than the MATLAB base workspace as the destination for any data logged or exported during simulation.

Most simulation is interactive, so most Simulink documentation does not mention these possibilities: it unconditionally describes the MATLAB base workspace as the final workspace searched during hierarchical symbol resolution, and the workspace to which any exported or logged data is written.

To supersede the base workspace for symbol resolution, data output, or both, provide an `options` structure to the `sim` command and set one or both of the following two structure fields:

- `SrcWorkspace` — Specifies which workspace is searched last during hierarchical symbol resolution.
- `DstWorkspace` — Specifies which workspace is the destination of any logged or exported data.

Each of these fields can take any of these three values:

- `base` — Use the base workspace, just as it would be used if no `options` structure had been provided.
- `current` — Supersede the base workspace with the workspace of the function that called the `sim` command.

- `parent` — Supersede the base workspace with the workspace of the function that called the function that called the `sim` command.

---

**Note** When you create a new `options` structure, the default value for `SrcWorkspace` is `base`, but the default for `DstWorkspace` is `current`, which can cause unexpected behavior if you inadvertently accept it. See the `simset` documentation for a complete list of all `options` structure fields and their default values.

---

If you execute the `sim` command without providing an `options` structure, hierarchical resolution, data logging, and data export occur exactly as they do for interactive simulation. When you supersede the base workspace, the change is effective only for the duration of the `sim` command. After the command completes, the base workspace is accessible just as it was previously. You cannot supersede the base workspace for a sequence of programmatic simulations by setting a global state: each execution of the `sim` command must specify its own `SrcWorkspace` or `DstWorkspace` as needed.

#### **Limitation with Referenced Model Accelerator Mode**

When the `sim` command executes a referenced model in Accelerator mode, the source workspace is always the MATLAB base workspace (`SrcWorkspace` is `base`) even if a `simset` `options` structure specifies some other source workspace.

#### **Parallel Processing with `sim`**

Simulink fully supports calling `sim` directly from `parfor` to perform simultaneous simulations in rapid accelerator mode, provided the up-to-date check is 'off'. For other methods of simulation, `sim` is not fully compatible with the `parfor` function. For more information, see “Running Parallel Simulations”

## 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 Output block, in port number order. If any Output block has a vector input, its output takes the appropriate number of columns.                                                                                                                                                                                                                                                                        |
| y <sub>1</sub> , . . . , y <sub>n</sub> | Each y <sub>i</sub> returns the output of the corresponding root-level Output 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:<br><br>tFinal to specify the stop time. The start time is 0.<br><br>[tStart tFinal] to specify the start and stop times.<br><br>[tStart OutputTimes tFinal] to specify the start and stop times and time points to be returned in t. Generally, t includes more time points. OutputTimes is equivalent to specifying <b>Configuration Parameters &gt; Data Import/Export &gt; Output options &gt; Produce specified output only</b> . |

|         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|---------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| options | Optional simulation parameters specified as a structure created by the <code>simset</code> command (see <code>simset</code> ).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| ut      | <p>Optional external inputs. UT can be:</p> <ul style="list-style-type: none"> <li>• A MATLAB function (expressed as a string) that specifies the input:<br/> <math display="block">\text{'sin(t)'}</math> at each simulation time step.</li> <li>• A table of input values versus time for all input ports:<br/> <math display="block">\text{UT} = [\text{T}, \text{U1}, \dots, \text{Un}]</math> where <math>\text{T} = [\text{t1}, \dots, \text{tm}]'</math></li> <li>• A structure array containing data for all input ports.</li> <li>• A comma-separated list of tables. Each table corresponds to a specific input port, and must be an array, a structure, a <code>Simulink.Timeseriesobject</code>, or a <code>Simulink.TsArray</code> object.</li> </ul> <p>See “Importing Data from a Workspace” for a description of the array and structure input formats.</p> |

## Examples

This command simulates the Van der Pol equations, using the `vdp` model that comes with Simulink software. 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

**Purpose**

Get settings of 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 software 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');
```

# simget

---

This command retrieves the value of the `Refine` property for the `vdp` model.

```
refine = simget('vdp', 'Refine');
```

## See Also

`sim`, `simset`



**Purpose**

Plot simulation data in figure window

**Syntax**

```
simplot(data);  
simplot(time, data);  
simplot(data, ports);  
simplot(data, 'diff')  
simplot(time, data, ports, 'diff')
```

**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.

The data to be plotted can be either a data structure or a matrix of the form produced by Simulink output blocks.

**Specifying a Separate Time Vector**

If `data` is a matrix or a structure without time, you can specify a separate time vector. `time` must be a vector with the same length as `data`.

For example:

```
simplot(time,data)
```

**Specifying Specific Ports to Display**

If `data` is a structure produced by a multi-port Scope block, the data from each port is displayed in a separate subplot. You can select specific ports to display by supplying a vector of port indices.

For example:

```
ports = [1,3];  
simplot(data,ports)
```

plots the data from the first and third ports.

## Overlaying Plots from Multiple Runs

If data is a cell array of structures or matrices, Simulink software overlays the plots from each element so that you can compare multiple runs. Each run is assumed to have identical structure. Line styles are used to differentiate between runs.

For example:

```
data = {run1, run2};  
simplot(data)
```

overlays the data from run1 and run2.

---

**Note** If data contains Matrices or Structures without time, the data sets for all runs must be the same size.

---

You can use the 'diff' flag to display the differences between multiple runs. When you specify the 'diff' flag, Simulink software subtracts the first run from subsequent runs, and plots the results with the line style of the final run being compared.

For example:

```
data = {run1,run2};  
simplot(data, 'diff')
```

plots run2 — run 1 using the line style of run2.

---

**Note** Simulink software uses linear interpolation if the time vectors are not identical.

If the start and stop times differ between runs, the difference is only plotted for the region of overlap.

---

### Combining Input Argument Options:

The options described above can be used in various combinations. All input arguments except for data are optional but when included must be entered in the following order:

```
simplot(time, data, ports, 'diff')
```

### Obtaining Object Handles

You can obtain the handles for the plotted figure, its axes and lines using the `simplot` command:

- `hfig = simplot(data)` — returns the figure handles.
- `haxes = simplot(data)` — returns the handles for the figure axes.
- `hlins = simplot(data)` — returns the handles for the lines in the figure.

## 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: <b>Array</b> , <b>Structure</b> , <b>Structure with time</b> (see “Data Import/Export Pane”). |
| time | The vector of sample times produced by an output block when you have selected <b>Array</b> or <b>Structure</b> as the simulation’s output format.<br><br>The <code>simplot</code> command ignores this argument if the format of the data is Structure with time.        |

# simplot

---

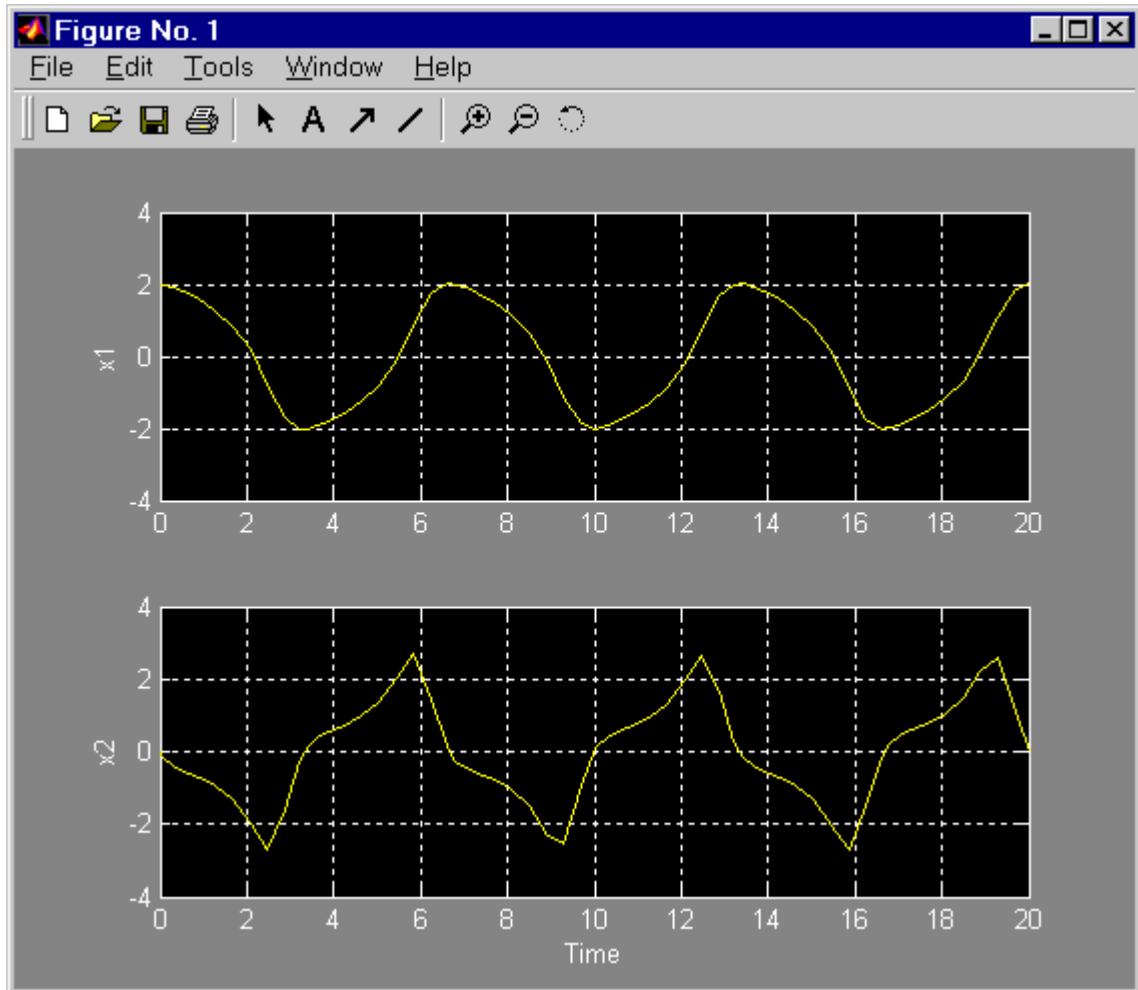
|        |                                                                                                                                                                                                                              |
|--------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| ports  | The vector of port indices from which to display data. If the data is a structure produced by a multi-port Scope block, the data from each port is displayed in a separate subplot.                                          |
| 'diff' | Displays the differences between multiple runs. When you specify the 'diff' flag, Simulink software subtracts the first run from subsequent runs, and plots the results with the line style of the final run being compared. |

## 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`, `plot`

# simset

---

**Purpose** Specify simulation options for simulations run via `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.

The block diagram parameter values in an `options` structure created by `simset` affect simulation only when the `sim` command executes with that `options` structure as an argument. After the simulation terminates, the values shown for block diagram parameters in the Configuration Parameters dialog box remain unchanged. The `options` structure persists and can be reused, perhaps after changing some of its values.

---

**Note** Use the `set_param` command to change a corresponding block diagram configuration parameter.

---

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

If a parameter is set more than once within a call to the `simset` command, the last specified value is used. For example:

```
simset('MaxStep', 0.01, 'MaxStep', 0.02)
```

assigns the final value of 0.02 to the `MaxStep` parameter.

## 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 *Simulink User’s Guide* 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. See “Superseding the Base Workspace” on page 4-160 for details.
- 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 software 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. The initial state values can be specified using either an array, structure, or structure-with-time format. See Importing and Exporting States for more information.
- 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 variable-step solvers and defaults to a value based upon the machine precision.
- 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

$$e(i) \leq \max(\text{RelTol} * \text{abs}(x(i)), \text{AbsTol}(i))$$

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**                {'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.

**SrcWorkspace**              {base} | current | parent  
*Where to evaluate expressions.* This property specifies the workspace in which to evaluate MATLAB expressions defined in the model. See “Superseding the Base Workspace” on page 4-160 for more information. **Limitation:** Setting SrcWorkspace has no effect on a referenced model that executes in Accelerator mode.

**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 software 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.

## Unspecified Parameters

You do not need to specify values for all block diagram parameters that simset accepts. In most cases, an unspecified parameter defaults to the block diagram value that is current when sim executes the model, but some options (such as MaxDataPoints) take on a different value. Additionally, not all parameters accepted by simset have an equivalent block diagram parameter.

For each parameter that simset accepts, the following table shows the equivalent block diagram parameter (if any) and the default value that applies if simset is called with no value specified for that simset parameter.

| Name of option specified to <code>simset</code> | Equivalent Block Diagram Parameter                     | Default Value when not specified to <code>simset</code> |
|-------------------------------------------------|--------------------------------------------------------|---------------------------------------------------------|
| AbsTol                                          | AbsTol                                                 | Block diagram parameter                                 |
| ConsecutiveZCsStepRelTol                        | ConsecutiveZCsStepRelTol                               | Block diagram parameter                                 |
| Debug                                           | Not available                                          | Not available                                           |
| Decimation                                      | Decimation                                             | Block diagram parameter                                 |
| DstWorkspace                                    | Not available                                          | Not available                                           |
| ExtrapolationOrder                              | ExtrapolationOrder                                     | Block diagram parameter                                 |
| FinalStateName                                  | SaveFinalState is 'on' and FinalStateName is non-empty | Block diagram parameter                                 |
| FixedStep                                       | FixedStep                                              | Block diagram parameter                                 |
| InitialState                                    | InitialState                                           | Block diagram parameter                                 |
| InitialStep                                     | InitialStep                                            | Block diagram parameter                                 |

| <b>Name of option specified to simset</b> | <b>Equivalent Block Diagram Parameter</b> | <b>Default Value when not specified to simset</b> |
|-------------------------------------------|-------------------------------------------|---------------------------------------------------|
| MaxConsecutiveMinStep                     | MaxConsecutiveMinStep                     | Block diagram parameter                           |
| MaxConsecutiveZCs                         | MaxConsecutiveZCs                         | Block diagram parameter                           |
| MaxDataPoints                             | MaxDataPoints                             | All points (no limit)                             |
| MaxOrder                                  | MaxOrder                                  | Block diagram parameter                           |
| MaxStep                                   | MaxStep                                   | Block diagram parameter                           |
| MinStep                                   | MinStep                                   | Block diagram parameter                           |
| NumberNewtonIterations                    | NumberNewtonIterations                    | Block diagram parameter                           |
| OutputPoints                              | Not available                             | Not available                                     |
| OutputVariables                           | Not available                             | Not available                                     |
| Refine                                    | Refine                                    | Block diagram parameter                           |

| <b>Name of option specified to <code>simset</code></b> | <b>Equivalent Block Diagram Parameter</b> | <b>Default Value when not specified to <code>simset</code></b> |
|--------------------------------------------------------|-------------------------------------------|----------------------------------------------------------------|
| RelTol                                                 | RelTol                                    | Block diagram parameter                                        |
| SaveFormat                                             | SaveFormat                                | Array                                                          |
| SignalLogging                                          | SignalLogging                             | Block diagram parameter                                        |
| SignalLoggingName                                      | SignalLoggingName                         | Block diagram parameter                                        |
| Solver                                                 | Solver                                    | Block diagram parameter                                        |
| SrcWorkspace                                           | Not available                             | Not available                                                  |
| TimeOut                                                | Not available                             | Not available                                                  |
| Trace                                                  | Not available                             | Not available                                                  |
| ZeroCross is 'on'                                      | ZeroCrossControl is enable all            | Block diagram parameter                                        |
| ZeroCross is 'off'                                     | ZeroCrossControl is disable all           | Block diagram parameter                                        |

## 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

# simulink

---

**Purpose** Open Simulink block library

**Syntax**  
`simulink`  
`simulink('open')`  
`simulink('close')`

**Description** `simulink` or `simulink('open')` opens the Simulink Library Browser.  
`simulink('close')` closes the Library Browser.



|                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Purpose</b>   | Return sample time information for a block                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| <b>Syntax</b>    | <code>ts = Simulink.Block.getSampleTimes(<i>block</i>)</code>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| <b>Arguments</b> | <i>block</i><br>Full name or handle of a Simulink block                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| <b>Returns</b>   | <i>ts</i><br>The command returns <i>ts</i> which is a 1xn array of Simulink.SampleTime objects associated with the model passed to Simulink.Block.getSampleTimes. Here n is the number of sample times associated with the block. The format of the returns is:<br><br>1xn Simulink.SampleTime<br>Package: Simulink<br><br>value: [1x2 double]<br>Description: [char string]<br>ColorRGBValue: [1x3 double]<br>Annotation: [char string]<br>OwnerBlock: [char string]<br>ComponentSampleTimes: [1x2 struct]<br><br>Methods<br><ul style="list-style-type: none"><li>• <i>value</i> — A two-element array of doubles that contains the sample time period and offset</li><li>• <i>Description</i> — A character string that describes the sample time type</li><li>• <i>ColorRGBValue</i> — A 1x3 array of doubles that contains the red, green and blue (RGB) values of the sample time color</li><li>• <i>Annotation</i> — A character string that represents the annotation of a specific sample time (e.g., 'D1')</li></ul> |

# Simulink.Block.getSampleTimes

---

- `OwnerBlock` — For asynchronous and variable sample times, a string containing the full path to the block that controls the sample time. For all other types of sample times, an empty string.
- `ComponentSampleTimes` — A structure array of elements of the same type as `Simulink.BlockDiagram.getSampleTimes` if the sample time is an async union or if the sample time is hybrid and the component sample times are available.

## Description

`ts = Simulink.Block.getSampleTimes(block)` performs an update diagram and then returns the sample times of the block connected to the input argument *mdl/signal*. This method performs an update diagram to ensure that the sample time information returned is up-to-date. If the model is already in the compiled state via a call to the model API, then an update diagram is not necessary.

Using this method allows you to access all information in the Sample Time Legend programmatically.

## See Also

`Simulink.BlockDiagram.getSampleTimes`

# Simulink.BlockDiagram.addBusToVector

---

## Purpose

Add Bus to Vector blocks to convert virtual bus signals into vector signals

## Syntax

```
[DstBlocks, BusToVectorBlocks] =  
Simulink.BlockDiagram.addBusToVector(model)  
[DstBlocks, BusToVectorBlocks] =  
Simulink.BlockDiagram.addBusToVector(model, includeLibs)  
[DstBlocks, BusToVectorBlocks] =  
Simulink.BlockDiagram.addBusToVector(model,  
includeLibs, reportOnly)
```

## Arguments

*model*

Model name or handle

*includeLibs*

Boolean specifying whether to search library blocks. Default: false; the function does not search library blocks.

*reportOnly*

Boolean specifying whether to change the model or just generate a report. Default: true; the function just generates a report.

## Returns

*DstBlocks*

An array of structures that contain information about blocks that are connected to buses but treat the buses as vectors. If no such blocks exist the array has 0 length. Each structure in the array contains the following fields:

**BlockPath**

A string specifying the path to the block to which the bus connects

**InputPort**

An integer specifying the input port to which the bus connects

# Simulink.BlockDiagram.addBusToVector

---

## LibPath

If the block is a library block instance, and *includeLibs* is true, the path to the source library block. Otherwise, LibPath is empty ( []).

## BusToVectorBlocks

If *reportOnly* is false, and *model* contains any buses used as vectors, a cell array containing the path to each Bus to Vector block that was added to the model. Otherwise, *BusToVectorBlocks* is empty ( []).

## Description

Simulink.BlockDiagram.addBusToVector reports whether a model contains any bus signals used implicitly as vectors, and optionally changes the model by inserting a Bus to Vector block into each such signal, replacing the implicit use with an explicit conversion. The report and any changes can be limited to the model itself, or can be extended to include any library block of which an instance appears in the model.

Before executing this function, you must do the following:

- 1 Set Configuration Parameters > Diagnostics > Connectivity > Buses > Mux blocks used to create bus signals** to error, or equivalently, execute `set_param(model, 'StrictBusMsg', 'ErrorLevel1')`.
- 2 Ensure that the model compiles without error.**
- 3 Save the model.**

If *includeLibs* is false (the default), the function does not report on or change any blocks in libraries. If the argument is true, the function reports on and may change blocks in libraries.

If *reportOnly* is true (the default), the function does not change the model or any libraries, displays the number of buses used as vectors, and returns a report in *DstBlocks*.

If *reportOnly* is false, the function displays the number of buses used as vectors, returns a report in *DstBlocks* and *BusToVectorBlocks*, and

# Simulink.BlockDiagram.addBusToVector

---

inserts a Bus to Vector block into each bus that is used as a vector, in the model and optionally in any libraries. The signal's source and destination blocks are unchanged by this insertion.

---

**Note** If `Simulink.BlockDiagram.addBusToVector` adds Bus to Vector blocks to the model or any library, the function permanently changes the saved copy of the diagram. Be sure to back up the model and any libraries before calling the function with *reportOnly* specified as `false`.

---

---

## Caution

If `Simulink.BlockDiagram.addBusToVector` changes a library block, the change affects every instance of that block in every Simulink model that uses the library. To preview the effects of the change on blocks in all models, call `Simulink.BlockDiagram.addBusToVector` with *includeLibs* = `true` and *reportOnly* = `true`, then examine the information returned in *DstBlocks*.

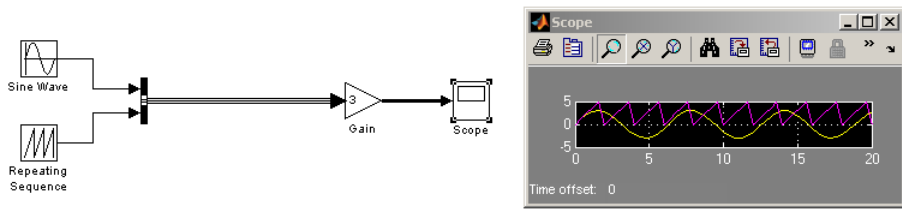
---

The Bus to Vector block is intended only for use in existing models to facilitate the elimination of implicit conversion of buses into vectors. New models and new parts of existing models should avoid implicitly using buses as vectors, and should not use Bus to Vector blocks for any purpose. See *Avoiding Mux/Bus Mixtures* for more information about using `Simulink.BlockDiagram.addBusToVector`.

## Example

The following model simulates correctly, but the input to the Gain block is a bus, while the output is a vector. Thus the Gain block uses a block as a vector.

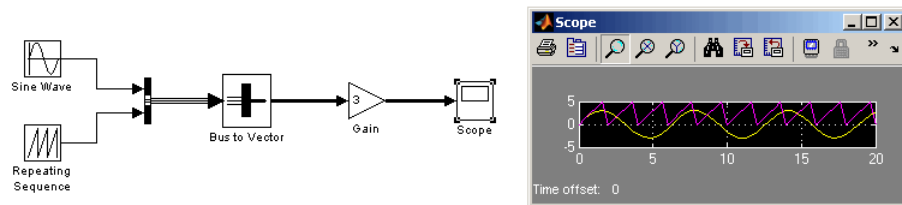
# Simulink.BlockDiagram.addBusToVector



If the model shown is open as the current model, you can eliminate the implicit conversion with the following command:

```
Simulink.BlockDiagram.addBusToVector(gcs, false, false)
```

Rebuilding and simulating the model then gives this result:



The Gain block no longer implicitly converts the bus to a vector; the inserted Bus to Vector block performs the conversion explicitly. Note that the results of simulation are the same for both models. The Bus to Vector block is virtual, and never affects simulation results, code generation, or performance.

## See Also

- “Using Composite Signals”
- “Using Buses”
- Avoiding Mux/Bus Mixtures
- Bus Assignment
- Bus Creator
- Bus Selector
- Bus to Vector

- `Simulink.Bus`
- `Simulink.Bus.cellToObject`
- `Simulink.Bus.createObject`
- `Simulink.BusElement`
- `Simulink.Bus.objectToCell`
- `Simulink.Bus.save`

# Simulink.BlockDiagram.copyContentsToSubSystem

---

**Purpose** Copy contents of block diagram to empty subsystem

**Syntax** `Simulink.BlockDiagram.copyContentsToSubSystem(bdiag,  
subsys)`

**Arguments** *bdiag*  
Block diagram name or handle  
*subsys*  
Subsystem name or handle

**Description** `Simulink.BlockDiagram.copyContentsToSubSystem` copies the contents of the block diagram *bdiag* to the subsystem *subsys*. The block diagram and subsystem must have already been loaded. The subsystem cannot be part of the block diagram. The function affects only blocks, lines, and annotations; it does not affect nongraphical information such as configuration sets. You can use this function to convert a referenced model derived from an atomic subsystem into an atomic subsystem that is equivalent to the original subsystem.

**Limitation** `Simulink.BlockDiagram.copyContentsToSubSystem` cannot be used if the destination subsystem contains any blocks or signals. Other types of information can exist in the destination subsystem and are not affected by the function. Use `Simulink.SubSystem.deleteContents` if necessary to empty the subsystem before using `Simulink.BlockDiagram.copyContentsToSubSystem`.

**Example** If two block diagrams exist, *f14* and *f16*, and *f16* contains an empty subsystem named *f14cp*, the following code copies the contents of *f14*, including all nested subsystems, to *f16/f14cp*. Nongraphical information in *f14* is not copied.

```
% open f14 and f16
open_system('f14');
open_system('f16');

% copy the block diagram f14 to an empty subsystem of f16 named f14cp
```



# Simulink.BlockDiagram.copyContentsToSubSystem

---

```
Simulink.BlockDiagram.copyContentsToSubSystem('f14', 'f16/f14cp');  
  
% close f14 and f16  
close_system('f14', 0);  
close_system('f16', 0);
```

## See Also

`Simulink.BlockDiagram.deleteContents`  
`Simulink.SubSystem.convertToModelReference`  
`Simulink.SubSystem.copyContentsToBlockDiagram`  
`Simulink.SubSystem.deleteContents`

# Simulink.BlockDiagram.createSubSystem

---

**Purpose** Create a subsystem containing a specified set of blocks

**Syntax** `Simulink.BlockDiagram.createSubSystem(blocks)`  
`Simulink.BlockDiagram.createSubSystem()`

**Arguments** *blocks*  
An array of block handles

**Description** `Simulink.BlockDiagram.createSubSystem(blocks)`, where *blocks* is an array of block handles, creates a subsystem and moves the specified blocks into the subsystem. All of the specified blocks must originally reside at the top level of the model or in the same subsystem.

If any of the blocks have unconnected input ports, the command creates input port blocks for each unconnected input port in the subsystem and connects the input port block to the unconnected input port.

The command similarly creates and connects output port blocks for unconnected output ports on the specified blocks. If any of the specified blocks is an input port, the command creates an input port block in the parent system and connects it to the corresponding input port of the newly created subsystem. The command similarly creates and connects output port blocks for each of the specified blocks that is an output port block.

`Simulink.BlockDiagram.createSubSystem()` creates a subsystem out of currently selected blocks.

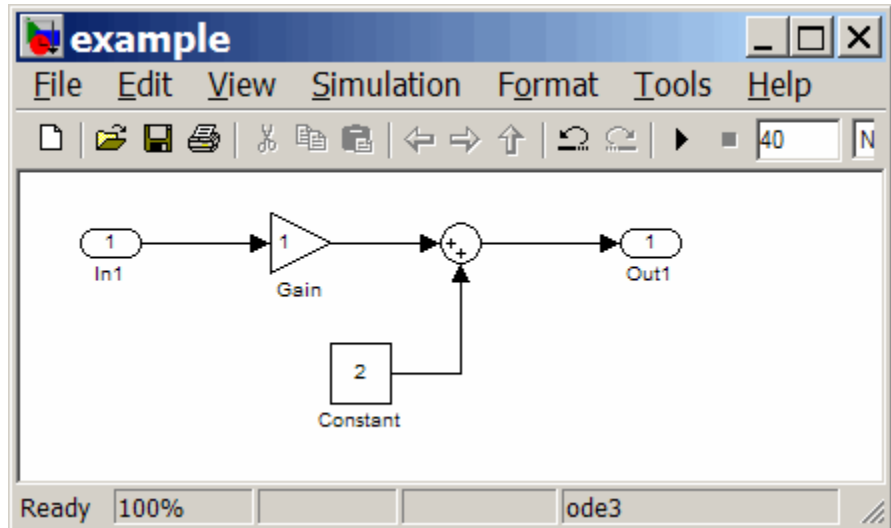
**Example** The following function converts the contents of a model or subsystem into a subsystem.

```
function convert2subsys(sys)
    blocks = find_system(sys, 'SearchDepth', 1);
    bh = [];
    for i = 2:length(blocks)
        bh = [bh get_param(blocks{i}, 'handle')];
    end
    Simulink.BlockDiagram.createSubSystem(bh);
```

# Simulink.BlockDiagram.createSubSystem

end

Consider, for example, the following model:

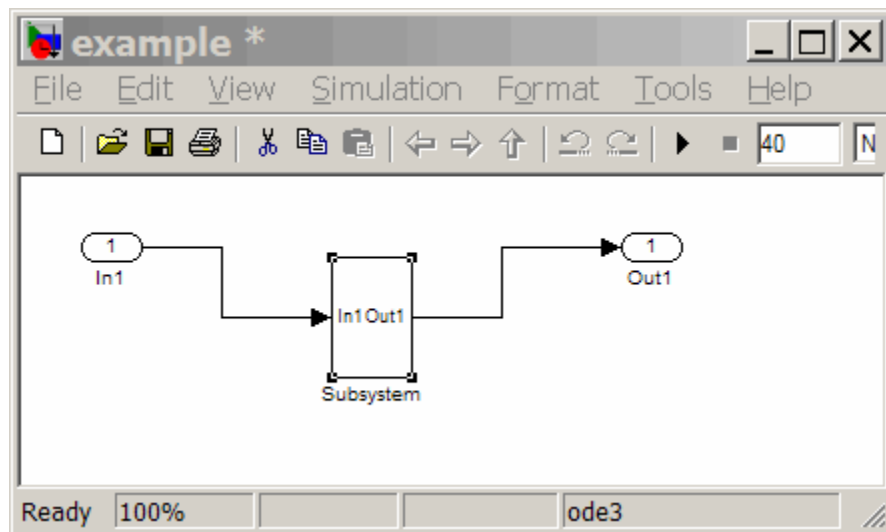


Executing

```
convert2subsys('example');
```

converts this model to:

# Simulink.BlockDiagram.createSubSystem



## See Also

`Simulink.BlockDiagram.copyContentsToSubSystem`  
`Simulink.BlockDiagram.deleteContents`  
`Simulink.SubSystem.convertToModelReference`  
`Simulink.SubSystem.copyContentsToBlockDiagram`

# Simulink.BlockDiagram.deleteContents

---

|                    |                                                                                                                                                                                                                                                                                               |
|--------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Purpose</b>     | Delete contents of block diagram                                                                                                                                                                                                                                                              |
| <b>Syntax</b>      | <code>Simulink.BlockDiagram.deleteContents(<i>bdiag</i>)</code>                                                                                                                                                                                                                               |
| <b>Arguments</b>   | <i>bdiag</i><br>Block diagram name or handle                                                                                                                                                                                                                                                  |
| <b>Description</b> | <code>Simulink.BlockDiagram.deleteContents</code> deletes the contents of the block diagram <i>bdiag</i> . The block diagram must have already been loaded. The function affects only blocks, lines, and annotations; it does not affect nongraphical information such as configuration sets. |
| <b>Example</b>     | <p>If an open block diagram named <code>f14</code> exists, the following code deletes the graphical contents of <code>f14</code>, including all subsystems. Nongraphical information in <code>f14</code> is unaffected.</p> <pre>Simulink.BlockDiagram.deleteContents('f14');</pre>           |
| <b>See Also</b>    | <code>Simulink.BlockDiagram.copyContentsToSubSystem</code><br><code>Simulink.SubSystem.convertToModelReference</code><br><code>Simulink.SubSystem.copyContentsToBlockDiagram</code><br><code>Simulink.SubSystem.deleteContents</code>                                                         |

# Simulink.BlockDiagram.getChecksum

---

**Purpose** Return checksum of model

**Syntax** `[checksum,details] = Simulink.BlockDiagram.getChecksum mdl`

**Description** `[checksum,details] = Simulink.BlockDiagram.getChecksum mdl` returns the checksum of the specified model. Simulink software computes the checksum based on attributes of the model and the blocks the model contains.

One use of this command is to determine why the Accelerator mode in Simulink software regenerates code. For an example, see the demo `slAccelDemoWhyRebuild`.

---

**Note** `Simulink.BlockDiagram.getChecksum` compiles the specified model, using the command `model([], [], [], 'compileForRTW')`, if the model is not already in a compiled state. To get the checksum for the model when Simulink software compiles it for simulation, use the command `model([], [], [], 'compile')` to place the model in a compiled state before using `Simulink.BlockDiagram.getChecksum`.

---

This command accepts the argument `mdl`, which is the full name or handle of the model for which you are returning checksum data.

This command returns the following output:

- `checksum` — Array of four 32-bit integers that represents the model's 128-bit checksum.
- `details` — Structure of the form

```
ContentsChecksum: [1x1 struct]
InterfaceChecksum: [1x1 struct]
ContentsChecksumItems: [nx1 struct]
InterfaceChecksumItems: [mx1 struct]
```

- **ContentsChecksum** — Structure of the following form that represents a checksum that provides information about all blocks in the model.

Value: [4x1 uint32]  
MarkedUnique: [bool]

- **Value** — Array of four 32-bit integers that represents the model's 128-bit checksum.
  - **MarkedUnique** — True if any blocks in the model have a property that prevents code reuse.
- **InterfaceChecksum** — Structure of the following form that represents a checksum that provides information about the model.

Value: [4x1 uint32]  
MarkedUnique: [bool]

- **Value** — Array of four 32-bit integers that represents the model's 128-bit checksum.
  - **MarkedUnique** — Always true. Present for consistency with ContentsChecksum structure.
- **ContentsChecksumItems** and **InterfaceChecksumItems** — Structure arrays of the following form that contain information that Simulink software uses to compute the checksum for ContentsChecksum and InterfaceChecksum, respectively:

Handle: [char array]  
Identifier: [char array]  
Value: [type]

- **Handle** — Object for which Simulink software added an item to the checksum. For a block, the handle is a full block path. For a block port, the handle is the full block path and a string that identifies the port.

# Simulink.BlockDiagram.getChecksum

---

- **Identifier** — Descriptor of the item Simulink software added to the checksum. If the item is a documented parameter, the identifier is the parameter name.
- **Value** — Value of the item Simulink software added to the checksum. If the item is a parameter, **Value** is the value returned by

```
get_param(handle, identifier)
```

## See Also

Simulink.SubSystem.getChecksum



**Purpose** Return initial state structure of block diagram

**Syntax** `x0 = Simulink.BlockDiagram.getInitialState(md1)`

**Description** `x0 = Simulink.BlockDiagram.getInitialState(md1)` returns the initial state structure of the block diagram specified by the input argument *md1*. This state structure can be used to specify the initial state vector in the **Configuration Parameters** dialog box or to provide an initial state condition to the linearization commands.

The command returns `x0`, a structure of the form

```
time: 0
signals: [1xn struct]
```

where *n* is the number of states contained in the model, including any models referenced by Model blocks. The `signals` field is a structure of the form

```
values: [1xm double]
dimensions: [1x1 double]
label: [char array]
blockName: [char array]
inReferencedModel: [bool]
sampleTime: [1x2 double]
```

- `values` — Numeric array of length *m*, where *m* is the number of states in the signal
- `dimensions` — Length of the values vector
- `label` — Indication of whether the state is continuous (CSTATE) or discrete. If the state is discrete:

The name of the discrete state will be shown for S-function blocks

The name of the discrete state will be shown for those built-in blocks that assign their own names to discrete states

DSTATE is used in all other cases

# Simulink.BlockDiagram.getInitialState

---

- `blockName` — Full path to block associated with this state
- `inReferencedModel` — Indication of whether the state originates in a model referenced by a Model block (1) or in the top-level model (0)
- `sampleTime` — Array containing the sample time and offset of the state.

Using the state structure simplifies specifying initial state values for models with multiple states, as each state is associated with the full path to its parent block.

## See Also

`linmod`

# Simulink.BlockDiagram.getSampleTimes

---

**Purpose** Return all sample times associated with a model

**Syntax** `ts = Simulink.BlockDiagram.getSampleTimes(mdl)`

**Arguments** *mdl*  
Name or handle of a Simulink model

**Returns** *ts*  
The command returns *ts* which is a 1xn array of Simulink.SampleTime objects associated with the model passed to Simulink.BlockDiagram.getSampleTimes. Here n is the number of sample times associated with the block diagram. The format of the returns is as follows:

```
1xn Simulink.SampleTime  
Package: Simulink
```

```
value: [1x2 double]  
Description: [char string]  
ColorRGBValue: [1x3 double]  
Annotation: [char string]  
OwnerBlock: [char string]  
ComponentSampleTimes: [1x2 struct]
```

## Methods

- **value** — A two-element array of doubles that contains the sample time period and offset
- **Description** — A character string that describes the sample time type
- **ColorRGBValue** — A 1x3 array of doubles that contains the red, green and blue (RGB) values of the sample time color
- **Annotation** — A character string that represents the annotation of a specific sample time (e.g., 'D1')

# Simulink.BlockDiagram.getSampleTimes

---

- **OwnerBlock** — For asynchronous and variable sample times, a string containing the full path to the block that controls the sample time. For all other types of sample times, an empty string.
- **ComponentSampleTimes** — A structure array of elements of the same type as `Simulink.BlockDiagram.getSampleTimes` if the sample time is an async union or if the sample time is hybrid and the component sample times are available.

## Description

`ts = Simulink.BlockDiagram.getSampleTimes(mdl)` performs an update diagram and then returns the sample times associated with the block diagram specified by the input argument *mdl*. The update diagram ensures that the sample time information returned is up-to-date. If the model is already in the compiled state via a call to the model API, then an update diagram is not necessary.

Using this method allows you to access all information in the Sample Time Legend programmatically.

## See Also

`Simulink.Block.getSampleTimes`

**Purpose** Convert 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**

- “Using Composite Signals”
- “Using Buses”
- Bus Assignment
- Bus Creator
- Bus Selector
- Bus to Vector
- Simulink.Bus
- Simulink.Bus.createObject
- Simulink.BusElement
- Simulink.Bus.objectToCell
- Simulink.Bus.save

# Simulink.Bus.createObject

---

**Purpose** Create 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**

- “Using Composite Signals”

- “Using Buses”
- Bus Assignment
- Bus Creator
- Bus Selector
- Bus to Vector
- Simulink.Bus
- Simulink.Bus.cellToObject
- Simulink.BusElement
- Simulink.Bus.objectToCell
- Simulink.Bus.save

# Simulink.Bus.objectToCell

---

**Purpose** Convert bus objects to cell array containing bus information

**Syntax** `Simulink.Bus.objectToCell(busNames)`

**Description** `Simulink.Bus.objectToCell(busNames)` creates a cell array of cell arrays that contains bus information from a set of bus objects in the MATLAB base workspace. Each element of the cell array represents a bus object that has been converted.

The argument *busNames* is a cell array of bus object names to convert to cell arrays. If the specified array is empty, the function converts all bus objects in the base workspace.

The function converts each bus object to a cell array with the following data:

```
{BusName, HeaderFile, Description,  
BusElements}
```

The *BusElements* field is an array containing the following data for each element:

```
{ElementName, Dimensions, DataType,  
SampleTime, Complexity, SamplingMode}
```

## See Also

- “Using Composite Signals”
- “Using Buses”
- Bus Assignment
- Bus Creator
- Bus Selector
- Bus to Vector
- Simulink.Bus
- Simulink.Bus.cellToObject
- Simulink.Bus.createObject



- `Simulink.BusElement`
- `Simulink.Bus.save`

# Simulink.Bus.save

---

**Purpose** Save bus objects in 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.

When the M-file generated for the `'cell'` format executes, it

- Calls `Simulink.Bus.cellToObject` to recreate the bus objects
- Returns the new bus objects in the cell array

To suppress the creation of bus objects, specify the optional argument `'false'` when you execute the M-file.

- *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

- “Using Composite Signals”
- “Using Buses”
- Bus Assignment
- Bus Creator
- Bus Selector
- Bus to Vector

- `Simulink.Bus`
- `Simulink.Bus.cellToObject`
- `Simulink.Bus.createObject`
- `Simulink.BusElement`
- `Simulink.Bus.objectToCell`

# Simulink.SubSystem.convertToModelReference

---

**Purpose** Convert atomic subsystem or function call subsystem to 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 or function call subsystem to a referenced model. The function creates a new model, copies the contents of the subsystem into the model, sets the new model's configuration parameters, and configures the model's root level Inport and Outport blocks. The function then replaces the subsystem block with a Model block that references the new model, or creates another, temporary model containing a Model block that references the new model, depending on the input option `ReplaceSubsystem`.

## Requirements

Converting a subsystem to a referenced model requires your model to have the following configuration parameter settings:

- **Configuration Parameters > Optimization > Inline parameters** must be On.
- **Configuration Parameters > Diagnostics > Data Validity > Signal resolution** must be Explicit only.
- **Configuration Parameters > Diagnostics > Connectivity > Mux blocks used to create bus signals** must be Error.

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');
```

## Error Handling

This function produces error or warning messages for models and subsystems that it cannot handle.

- For some errors, a message box appears that gives you the choice of cancelling or continuing.
- If continuing is impossible, Simulink cancels the conversion without offering a choice to continue.

Even if conversion is successful, you may still need to reconfigure the resulting model to meet your requirements.

## Limitations

In the new model, the **Interpolate data** parameter of each root input port is selected by default. You can clear the parameter wherever this default is not appropriate. See the Inport block documentation for information about **Interpolate data**.

## Demo

Execute

```
sldemo_md1ref_conversion
```

at the MATLAB command line for a demonstration of this command's usage.

## Arguments

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 supports the following option pairs:

# Simulink.SubSystem.convertToModelReference

---

- 'ReplaceSubsystem', [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.

## Returns

This function returns the following values:

- *success* — True if this function is successful; otherwise, false.
- *mdlRefBlkH* — Handle of the Model block that references the new model

## See Also

`Simulink.BlockDiagram.copyContentsToSubSystem`

`Simulink.Bus.save`

`Simulink.SubSystem.copyContentsToBlockDiagram`

“Converting a Subsystem to a Referenced Model”

# Simulink.SubSystem.copyContentsToBlockDiagram

---

|                    |                                                                                                                                                                                                                                                                                                                                                                                                                              |
|--------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Purpose</b>     | Copy contents of subsystem to empty block diagram                                                                                                                                                                                                                                                                                                                                                                            |
| <b>Syntax</b>      | <code>Simulink.SubSystem.copyContentsToBlockDiagram(<i>subsys</i>,<br/><i>bdiag</i>)</code>                                                                                                                                                                                                                                                                                                                                  |
| <b>Arguments</b>   | <i>subsys</i><br>Subsystem name or handle<br><br><i>bdiag</i><br>Block diagram name or handle                                                                                                                                                                                                                                                                                                                                |
| <b>Description</b> | <code>Simulink.SubSystem.copyContentsToBlockDiagram</code> copies the contents of the subsystem <i>subsys</i> to the block diagram <i>bdiag</i> . The subsystem and block diagram must have already been loaded. The subsystem cannot be part of the block diagram. The function affects only blocks, lines, and annotations; it does not affect nongraphical information such as configuration sets.                        |
| <b>Limitation</b>  | <code>Simulink.SubSystem.copyContentsToBlockDiagram</code> cannot be used if the destination block diagram contains any blocks or signals. Other types of information can exist in the destination block diagram and are unaffected by the function. Use <code>Simulink.BlockDiagram.deleteContents</code> if necessary to empty the block diagram before using <code>Simulink.SubSystem.copyContentsToBlockDiagram</code> . |
| <b>Example</b>     | If a block diagram named <code>f14</code> has a subsystem named <code>Controller</code> , the following code copies the graphical contents of <code>Controller</code> , including all nested subsystems, to a new block diagram. Nongraphical information in <code>Controller</code> is not copied.                                                                                                                          |

```
% open f14
open_system('f14');

% create a new model
newbd = new_system;
open_system(newbd);
```

# Simulink.SubSystem.copyContentsToBlockDiagram

---

```
% copy the subsystem
Simulink.SubSystem.copyContentsToBlockDiagram('f14/Controller', newbd);

% close f14 and the new model
close_system('f14', 0);
close_system(newbd, 0);
```

## See Also

Simulink.BlockDiagram.copyContentsToSubSystem  
Simulink.BlockDiagram.deleteContents  
Simulink.SubSystem.convertToModelReference  
Simulink.SubSystem.deleteContents



# Simulink.SubSystem.deleteContents

---

|                    |                                                                                                                                                                                                                                                                                                                                                             |
|--------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Purpose</b>     | Delete contents of subsystem                                                                                                                                                                                                                                                                                                                                |
| <b>Syntax</b>      | <code>Simulink.SubSystem.deleteContents(<i>subsys</i>)</code>                                                                                                                                                                                                                                                                                               |
| <b>Arguments</b>   | <i>subsys</i><br>Subsystem name or handle                                                                                                                                                                                                                                                                                                                   |
| <b>Description</b> | <code>Simulink.SubSystem.deleteContents</code> deletes the contents of the subsystem <i>subsys</i> . The subsystem must have already been loaded. The function affects only blocks, lines, and annotations; it does not affect nongraphical information such as configuration sets.                                                                         |
| <b>Example</b>     | <p>If an open block diagram named <code>f14</code> has a subsystem named <code>Controller</code>, the following code deletes the graphical contents of <code>Controller</code>, including all nested subsystems. Nongraphical information in <code>Controller</code> remains unchanged.</p> <pre>Simulink.SubSystem.deleteContents('f14/Controller');</pre> |
| <b>See Also</b>    | <code>Simulink.BlockDiagram.copyContentsToSubSystem</code><br><code>Simulink.BlockDiagram.deleteContents</code><br><code>Simulink.SubSystem.convertToModelReference</code><br><code>Simulink.SubSystem.copyContentsToBlockDiagram</code>                                                                                                                    |

# Simulink.SubSystem.getChecksum

---

**Purpose** Return checksum of subsystem

**Syntax** `[checksum,details] = Simulink.SubSystem.getChecksum(subsys)`

**Description** `[checksum,details] = Simulink.SubSystem.getChecksum(subsys)` returns the checksum of the specified subsystem. Simulink software computes the checksum based on subsystem parameter settings and the blocks the subsystem contains.

One use of this command is to determine why code generated for a subsystem is not being reused. For an example, see “Determining Why Subsystem Code Is Not Reused” in the Real-Time Workshop documentation.

---

**Note** `Simulink.SubSystem.getChecksum` compiles the model that contains the specified subsystem, using the command `model([], [], [], 'compileForRTW')`, if the model is not already in a compiled state. To get the checksum for the model when Simulink software compiles it for simulation, use the command `model([], [], [], 'compile')` to place the model in a compiled state before using `Simulink.SubSystem.getChecksum`.

---

This command accepts the argument `subsys`, which is the full name or handle of the atomic subsystem block for which you are returning checksum data.

This command returns the following output:

- `checksum` — Structure of the form
  - Value: [4x1 uint32]
  - MarkedUnique: [bool]
- Value — Array of four 32-bit integers that represents the subsystem’s 128-bit checksum.

- `MarkedUnique` — True if the subsystem or the blocks it contains have properties that would prevent the code generated for the subsystem from being reused; otherwise, false.
- *details* — Structure of the form

```
ContentsChecksum: [1x1 struct]
InterfaceChecksum: [1x1 struct]
ContentsChecksumItems: [nx1 struct]
InterfaceChecksumItems: [mx1 struct]
```

- `ContentsChecksum` — Structure of the same form as *checksum*, representing a checksum that provides information about all blocks in the system.
- `InterfaceChecksum` — Structure of the same form as *checksum*, representing a checksum that provides information about the subsystem's block parameters and connections.
- `ContentsChecksumItems` and `InterfaceChecksumItems` — Structure arrays of the following form that Simulink software uses to compute the checksum for `ContentsChecksum` and `InterfaceChecksum`, respectively:

```
Handle: [char array]
Identifier: [char array]
Value: [type]
```

- `Handle` — Object for which Simulink software added an item to the checksum. For a block, the handle is a full block path. For a block port, the handle is the full block path and a string that identifies the port.
- `Identifier` — Descriptor of the item Simulink software added to the checksum. If the item is a documented parameter, the identifier is the parameter name.
- `Value` — Value of the item Simulink software added to the checksum. If the item is a parameter, `Value` is the value returned by

# Simulink.SubSystem.getChecksum

---

```
get_param(handle, identifier)
```

**See Also**      Simulink.BlockDiagram.getChecksum

**Purpose** Create MATLAB structure describing 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`

# 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.

# slCharacterEncoding

---

**Purpose** Change 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 developed by IBM® Corp. and available on the Internet. 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.

---

# sldebug

---

**Purpose** Start 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 6, “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 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.

`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:

| 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.                                                                  |

# sldiagnostics

---

| Option        | Description                                                                                                                                                                              |
|---------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 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. 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 software.

```
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 software; 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 software, and counts the number of blocks used in the Controller subsystem.

```
f14; sldiagnostics('f14/Controller', 'CountBlocks')
```

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`

# sldiscmdl

---

## Purpose

Discretize 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:

| <b>Value</b>                | <b>Description</b>               |
|-----------------------------|----------------------------------|
| '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:

| <b>Value</b> | <b>Description</b>                                                                                           |
|--------------|--------------------------------------------------------------------------------------------------------------|
| '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:

| <b>Value</b>   | <b>Description</b>                                          |
|----------------|-------------------------------------------------------------|
| '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
```

# sIsFileChangedOnDisk

---

**Purpose** Determine whether model has changed since it was loaded

**Syntax** `Changed = sIsFileChangedOnDisk(sys)`

**Description** `Changed = sIsFileChangedOnDisk(sys)` Returns true if the file which contains block diagram `sys` was changed on disk since the block diagram was loaded.

**Example** To ensure that code is not generated for a model whose file has changed on disk since it was loaded, include the following in the 'entry' section of the `STF_make_rtw_hook.m` file:

```
if (sIsFileChangedOnDisk(sys))
    error('File has changed on disk since it was loaded. Aborting code generation.');
```

end

**See Also** “Customizing the Target Build Process with the `STF_make_rtw` Hook File”

“Model File Change Notification”

**Purpose** Open Model Discretizer GUI

**Syntax** `slmdliscui('name')`

**Description** `slmdliscui('name')` opens the Model Discretizer with the library or model specified by 'name'.

**Examples** This command opens the Model Discretizer with the f14 model.

```
slmdliscui('f14')
```

This command opens the Model Discretizer with the library named Test.

```
slmdliscui('Test')
```

# slreplace\_mux

---

**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 Overview” 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.

---

`[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

# slupdate

---

**Purpose** Replace blocks from previous releases with 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 software with the latest versions.

---

**Note** Best practice is to first open the model before 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.

- 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`)

## Purpose

Find trim point of 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,options] = trim('sys',x0,u0,y0,ix,iu,iy,dx0,idx,
    options)
[x,u,y,dx,options] = trim('sys',x0,u0,y0,ix,iu,iy,dx0,idx,
    options,t)
```

## 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,dx] = 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)
```



`[x,u,y,dx] = trim('sys',x0,u0,y0)` finds the trim point nearest to `x0`, `u0`, `y0`, that is, the point that minimizes the maximum value of

$$\text{abs}([x-x0; u-u0; y-y0])$$

`[x,u,y,dx] = 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,

$$\text{abs}([x(ix)-x0(ix); u(iu)-u0(iu); y(iy)-y0(iy)])$$

`[x,u,y,dx] = trim('sys',x0,u0,y0,ix,iu,iy,dx0,idx)` finds 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.

`[x,u,y,dx,options] = trim('sys',x0,u0,y0,ix,iu,iy,dx0,idx,options)` specifies 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.

The following table describes how each element affects the search for a trim point. Array elements 1, 2, 3, 4, and 10 are particularly useful for finding trim points.

| No. | Default | Description                                                                                                    |
|-----|---------|----------------------------------------------------------------------------------------------------------------|
| 1   | 0       | Specifies display options. 0 specifies no display; 1 specifies tabular output; -1 suppresses warning messages. |

| No. | Default                   | Description                                                                         |
|-----|---------------------------|-------------------------------------------------------------------------------------|
| 2   | $10^{-4}$                 | Precision the computed trim point must attain to terminate the search.              |
| 3   | $10^{-4}$                 | Precision the trim search goal function must attain to terminate the search.        |
| 4   | $10^{-6}$                 | Precision the state derivatives must attain to terminate the search.                |
| 5   | N/A                       | Not used.                                                                           |
| 6   | N/A                       | Not used.                                                                           |
| 7   | N/A                       | Used internally.                                                                    |
| 8   | N/A                       | Returns the value of the trim search goal function ( $\lambda$ in goal attainment). |
| 9   | N/A                       | Not used.                                                                           |
| 10  | N/A                       | Returns the number of iterations used to find a trim point.                         |
| 11  | N/A                       | Returns the number of function gradient evaluations.                                |
| 12  | 0                         | Not used.                                                                           |
| 13  | 0                         | Number of equality constraints.                                                     |
| 14  | 100*(Number of variables) | Maximum number of function evaluations to use to find a trim point.                 |
| 15  | N/A                       | Not used.                                                                           |
| 16  | $10^{-8}$                 | Used internally.                                                                    |
| 17  | 0.1                       | Used internally.                                                                    |
| 18  | N/A                       | Returns the step length.                                                            |

```
[x,u,y,dx,options] =
trim('sys',x0,u0,y0,ix,iu,iy,dx0,idx,options,t) sets the time
to t if the system is dependent on time.
```

## 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
    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.

**Purpose** Create Simulink parameter objects from tunable parameters

**Syntax** `tunablevars2parameterobjects (modelName)`  
`tunablevars2parameterobjects (modelName, class)`

**Arguments**

*modelName*  
Model name or handle

*class*  
Parameter class to use for creating objects. Default: `Simulink.Parameter`.

**Description** This function creates Simulink parameter objects in the base workspace for the variables listed in a model's Tunable Parameters dialog, then deletes the source information from the dialog. To preserve the information, save the resulting Simulink parameter objects into a MAT-file.

If *class* is specified, the parameter objects are of that class. Otherwise, the parameter objects default to class `Simulink.Parameter`.

If a tunable variable is already defined as a numeric variable in the base workspace, the variable will be replaced by a parameter object and the original variable will be copied to the object's Value property.

If a tunable variable is already defined as a Simulink parameter object, the object will not be modified but the information for the variable will still be deleted from the Tunable Parameters dialog.

If a tunable variable is defined as any other class of variable, the variable will not be modified and the information for the variable will not be deleted from the Tunable Parameters dialog.

**See Also**

# ufix

---

**Purpose** Create MATLAB structure describing 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`



---

|                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|--------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Purpose</b>     | Create MATLAB structure describing unsigned fractional data type                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| <b>Syntax</b>      | <pre>a = ufrac(TotalBits) a = ufrac(TotalBits, GuardBits)</pre>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| <b>Description</b> | <p><code>ufrac(TotalBits)</code> returns a MATLAB structure that describes the data type of an unsigned fractional number with a word size given by <code>TotalBits</code>.</p> <p><code>ufrac(TotalBits, GuardBits)</code> returns a MATLAB structure that describes the data type of an unsigned fractional number. The total word size is given by <code>TotalBits</code> with <code>GuardBits</code> bits located to the left of the binary point.</p> <p><code>ufrac</code> is automatically called when an unsigned fractional data type is specified in a block dialog box.</p> <p>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.</p> |
| <b>Examples</b>    | <p>Define an 8-bit unsigned fractional data type with 4 guard bits. Note that the range of this number is from 0 to <math>(1 - 2^{-8}) \cdot 2^4 = 15.9375</math>:</p> <pre>a = ufrac(8,4) a =     Class: 'FRAC'    IsSigned: 0   MantBits: 8  GuardBits: 4</pre>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| <b>See Also</b>    | <code>fixdt</code> , <code>float</code> , <code>sfix</code> , <code>sfrac</code> , <code>sint</code> , <code>ufix</code> , <code>uint</code>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |

# uint

---

**Purpose** Create MATLAB structure describing 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`, `frac`

---

|                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|--------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Purpose</b>     | Extract signal logging objects from signal logs and write them into MATLAB workspace                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| <b>Syntax</b>      | <code>log.unpack</code><br><code>tsarray.unpack</code><br><code>log.unpack('systems')</code><br><code>log.unpack('all')</code>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| <b>Description</b> | <p><code>log.unpack</code> or <code>unpack(log)</code> extracts the top level elements of the <code>Simulink.ModelDataLogs</code> or <code>Simulink.SubsysDataLogs</code> object named <b>log</b> (e.g., <code>logout</code>).</p> <p><code>log.unpack('systems')</code> or <code>unpack(log, 'systems')</code> extracts <code>Simulink.Timeseries</code> and <code>Simulink.TsArray</code> objects from the <code>Simulink.ModelDataLogs</code> or <code>Simulink.SubsysDataLogs</code> object named <code>log</code>. This command does not extract <code>Simulink.Timeseries</code> objects from <code>Simulink.TsArray</code> objects nor does it write intermediate <code>Simulink.ModelDataLogs</code> or <code>Simulink.SubsysDataLogs</code> objects to the MATLAB workspace.</p> <p><code>log.unpack('all')</code> or <code>unpack(log, 'all')</code> extracts all the <code>Simulink.Timeseries</code> objects contained by the <code>Simulink.ModelDataLogs</code>, <code>Simulink.TsArray</code>, or <code>Simulink.SubsysDataLogs</code> object named <code>log</code>.</p> <p><code>tsarray.unpack</code> extracts the time-series objects of class <code>Simulink.Timeseries</code> from the <code>Simulink.TsArray</code> object named <code>tsarray</code>.</p> |
| <b>See Also</b>    | “Importing and Exporting Data”, <code>Simulink.ModelDataLogs</code> , <code>Simulink.SubsysDataLogs</code> , <code>Simulink.ScopeDataLogs</code> , <code>Simulink.Timeseries</code> , <code>Simulink.TsArray</code> , <code>who</code> , <code>whos</code>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |

# view\_mdhrefs

---

**Purpose** Display graph of model reference dependencies

**Syntax** `view_mdhrefs('model_name')`

**Description** `view_mdhrefs('model_name')` launches the Model Dependency Viewer, which 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.

The default display omits library blocks. You could see this same display by opening `model_name` and choosing **Tools > Model Dependencies > Model Dependency Viewer > .mdl File Dependencies Excluding Libraries** from the model menu. Use **View > Dependency Type** to see other dependency displays.

The Model Dependency Viewer is the same tool, and provides the same options, whether you launch it by typing `view_mdhrefs` or by using the Simulink GUI. See “Using the Model Dependency Viewer” for details. To see a demo of the Model Dependency Viewer, type `sldemo_mdhref_depgraph` in the memory integrity checking option is enabled in the MATLAB Command Window.

**See Also** `find_mdhrefs`

---

|                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|--------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Purpose</b>     | List names of top-level data logging objects in Simulink data log                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| <b>Syntax</b>      | <code>log.who</code><br><code>tsarray.who</code><br><code>log.who('systems')</code><br><code>log.who('all')</code>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <b>Description</b> | <p><code>log.who</code> or <code>who(log)</code> lists the names of the top-level signal logging objects contained by <code>log</code>, where <code>log</code> is the handle of a <code>Simulink.ModelDataLogs</code> object name.</p> <p><code>tsarray.who</code> or <code>who(tsarray)</code> lists the names of <code>Simulink.TimeSeries</code> objects contained by the <code>Simulink.TsArray</code> object named <code>tsarray</code>.</p> <p><code>log.who('systems')</code> or <code>who(log, 'systems')</code> lists the names of all signal logging objects contained by <code>log</code> except for <code>Simulink.Timeseries</code> objects stored in <code>Simulink.TsArray</code> objects contained by <code>log</code>.</p> <p><code>log.who('all')</code> or <code>who(log, 'all')</code> lists the names of all the <code>Simulink.Timeseries</code> objects contained by the <code>Simulink.ModelDataLogs</code>, <code>Simulink.TsArray</code>, or <code>Simulink.SubsysDataLogs</code> object named <code>log</code>.</p> <p>For information about other uses of <code>who</code>, execute <code>help who</code> in the MATLAB Command Window.</p> |
| <b>See Also</b>    | “Importing and Exporting Data”, <code>Simulink.ModelDataLogs</code> , <code>Simulink.SubsysDataLogs</code> , <code>Simulink.ScopeDataLogs</code> , <code>Simulink.Timeseries</code> , <code>Simulink.TsArray</code> , <code>whos</code> , <code>unpack</code>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |

# whos

---

**Purpose** List names and types of top-level data logging objects in Simulink data log

**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 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.whos('systems')` or `whos(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`.

`logs.who('all')` or `whos(log, 'all')` lists the names and types of all the `Simulink.Timeseries` objects contained by the `Simulink.ModelDataLogs`, `Simulink.TsArray`, or `Simulink.SubsysDataLogs` object named `log`.

For information about other uses of `whos`, execute `help whosin` in the MATLAB Command Window.

**See Also** “Importing and Exporting Data”, `Simulink.ModelDataLogs`, `Simulink.SubsysDataLogs`, `Simulink.ScopeDataLogs`, `Simulink.Timeseries`, `Simulink.TsArray`, `who`, `unpack`

# Mask Icon Drawing Commands

---

|               |                                                                                   |
|---------------|-----------------------------------------------------------------------------------|
| color         | Change drawing color of subsequent mask icon drawing commands                     |
| disp          | Display text on icon of masked subsystem                                          |
| dpoly, droots | Display transfer function or zero-pole representation on icon of masked subsystem |
| fprintf       | Display variable text centered on icon of masked subsystem                        |
| image         | Display image on icon of masked subsystem                                         |
| patch         | Draw color patch of specified shape on icon of masked subsystem                   |
| plot          | Draw graph connecting series of points                                            |
| port_label    | Draw port label on icon of masked subsystem                                       |
| text          | Display text at specific location on icon of masked subsystem                     |

# color

---

**Purpose** Change drawing color of subsequent mask icon drawing commands

**Syntax** `color(colorstr)`

**Description** `color(colorstr)` sets the drawing color of all subsequent mask drawing commands to the color specified by the string `colorstr`.

`colorstr` must be one of the following supported color strings.

```
blue
green
red
cyan
magenta
yellow
black
```

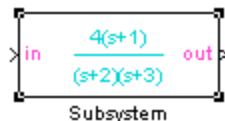
Entering any other string or specifying the color using RGB values results in a warning at the MATLAB command prompt and the color change is ignored. The specified drawing color does not influence the color used by the `patch` or `image` drawing commands.

## Examples

The following commands

```
color('cyan');
roots([-1], [-2 -3], 4)
color('magenta')
port_label('input',1,'in')
port_label('output',1,'out')
```

draw the following mask icon.





**See Also**      `droots, port_label`

# disp

---

**Purpose** Display text on icon of masked subsystem

**Syntax** `disp(text)`  
`disp(text, 'texmode', 'on')`

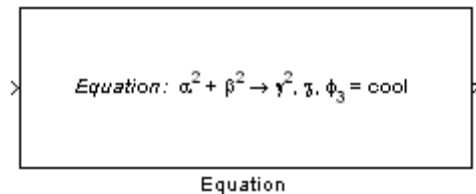
**Description** `disp(text)` displays *text* centered on the icon where *text* is any MATLAB expression that evaluates to a string.

`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 software.

**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 transfer function or zero-pole representation on icon of 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, droots

---

```
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 software displays three question marks (? ? ?) in the icon. When the parameter values are entered in the mask dialog box, Simulink software evaluates the transfer function and displays the resulting equation in the icon.

**See Also**      `disp, port_label, text`

# fprintf

---

**Purpose** Display variable text centered on icon of 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.

---

**Examples** This command

```
fprintf('Hello');
```

displays the string 'Hello' on the icon.

This command

```
fprintf('Juhi = %d',17);
```

uses the decimal notation format (%d) to display the variable 17.

**See Also** `disp`, `port_label`, `text`

**Purpose** Display image on icon of masked subsystem

**Syntax**

```
image(a)
image(a, position)
image(a, position, 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.

`image(a, position)` creates the image at the specified position:

| Position                    | Description                                                                                                                                                                                    |
|-----------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <code>[x, y, w, h]</code>   | Position ( <code>x, y</code> ) and size ( <code>w, h</code> ) of the image where the position is relative to the lower-left corner of the mask. The image is scaled to fit the specified size. |
| <code>'center'</code>       | Center of the mask                                                                                                                                                                             |
| <code>'top-left'</code>     | Top left corner of the mask, unscaled                                                                                                                                                          |
| <code>'bottom-left'</code>  | Bottom left corner of the mask, unscaled                                                                                                                                                       |
| <code>'top-right'</code>    | Top right corner of the mask, unscaled                                                                                                                                                         |
| <code>'bottom-right'</code> | Bottom right corner of the mask, unscaled                                                                                                                                                      |

`image(a, position, 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'))
```

# image

---

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`



**Purpose** Draw color patch of specified shape on icon of 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.



Pyramid

**See Also** `image`, `plot`

# plot

---

**Purpose** Draw graph connecting 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 software 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.

Simulink software 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.



**See Also**

image

# port\_label

---

**Purpose** Draw port label on icon of 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. Valid values for *port\_type* include the following:

| Value  | Description                                                               |
|--------|---------------------------------------------------------------------------|
| input  | Simulink input port                                                       |
| output | Simulink output port                                                      |
| lconn  | Physical Modeling connection port on the left side of a masked subsystem  |
| rconn  | Physical Modeling connection port on the right side of a masked subsystem |

The input argument *port\_number* is an integer, and *label* is a string specifying the port's label.

---

**Note** Physical Modeling port labels are assigned based on the nominal port location. If the masked subsystem has been rotated or flipped, for example, a port labeled using 'lconn' as the *port\_type* may not appear on the left side of the block.

---

`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 software.

**Examples**

The command

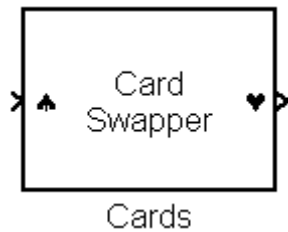
```
port_label('input', 1, 'a')
```

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.

**See Also**

disp, fprintf, text

# text

---

**Purpose** Display text at specific location on icon of 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.

`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 software.

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     |

| 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

**text**

---



# Simulink Debugger Commands

---

|                       |                                                                               |
|-----------------------|-------------------------------------------------------------------------------|
| <code>animate</code>  | Enable or disable animation mode                                              |
| <code>ashow</code>    | Show algebraic loop                                                           |
| <code>atrace</code>   | Set algebraic loop trace level                                                |
| <code>bafter</code>   | Insert breakpoint after specified method                                      |
| <code>break</code>    | Insert breakpoint before specified method                                     |
| <code>bshow</code>    | Show specified block                                                          |
| <code>clear</code>    | Clear breakpoints from model                                                  |
| <code>continue</code> | Continue simulation                                                           |
| <code>disp</code>     | Display block's I/O when simulation stops                                     |
| <code>ebreak</code>   | Enable (or disable) breakpoint on solver errors                               |
| <code>elist</code>    | List simulation methods in order in which they are executed during simulation |
| <code>emode</code>    | Toggle model execution between accelerated and normal mode                    |
| <code>etrace</code>   | Enable or disable method tracing                                              |
| <code>help</code>     | Display help for debugger commands                                            |

|          |                                                                                       |
|----------|---------------------------------------------------------------------------------------|
| nanbreak | Set or clear nonfinite value break mode                                               |
| next     | Advance simulation to start of next method at current level in model's execution list |
| probe    | Display block data                                                                    |
| quit     | Abort simulation                                                                      |
| rbreak   | Break when simulation requires solver reset                                           |
| run      | Run simulation to completion                                                          |
| slist    | Display sorted list of model's root system and of each of its nonvirtual subsystems   |
| states   | Display current state values                                                          |
| status   | Display debugging options in effect                                                   |
| step     | Advance simulation by one or more methods                                             |
| stimes   | Display sample times defined by model being debugged                                  |
| stop     | Stop simulation                                                                       |
| strace   | Set solver trace level                                                                |
| systems  | List model's nonvirtual systems                                                       |
| tbreak   | Set or clear time breakpoint                                                          |
| trace    | Display block's I/O each time block executes                                          |
| undisp   | Remove block from debugger's list of display points                                   |
| untrace  | Remove block from debugger's list of trace points                                     |
| where    | Display current location of simulation in simulation loop                             |

---

|         |                                                         |
|---------|---------------------------------------------------------|
| xbreak  | Break when debugger encounters step-size-limiting state |
| zcbreak | Toggle breaking at nonsampled zero-crossing events      |
| zclist  | List blocks containing nonsampled zero crossings        |

# animate

---

**Purpose** Enable or disable animation mode

**Syntax** `animate [delay | stop]`

**Short Form** `ani`

**Arguments**

|                          |                                                               |
|--------------------------|---------------------------------------------------------------|
| <code>delay</code>       | Length in seconds between method calls (1 second by default). |
| <code><b>stop</b></code> | 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`

**Purpose** Show algebraic loop

**Syntax** `ashow <gcb | s:b | s#n | clear>`

**Short Form** `as`

**Arguments**

|                    |                                                                                    |
|--------------------|------------------------------------------------------------------------------------|
| <code>gcb</code>   | Current block.                                                                     |
| <code>s:b</code>   | The block whose system index is <code>s</code> and block index is <code>b</code> . |
| <code>s#n</code>   | The algebraic loop numbered <code>n</code> in system <code>s</code> .              |
| <code>clear</code> | 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 `n`th algebraic loop in system `s`. The `ashow clear` command removes algebraic loop highlights from the model diagram.

**See Also** `atrace`, `slist`

# atrace

---

**Purpose** Set algebraic loop trace level

**Syntax** `atrace level`

**Short Form** `at`

**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                                                                                  |
|-----------------------|-------------------------------------------------------------------------------------------------------------------|
| <code>atrace 0</code> | No information                                                                                                    |
| <code>atrace 1</code> | The loop variable solution, the number of iterations required to solve the loop, and the estimated solution error |
| <code>atrace 2</code> | Same as level 1                                                                                                   |
| <code>atrace 3</code> | Level 2 plus Jacobian matrix used to solve loop                                                                   |
| <code>atrace 4</code> | Level 3 plus intermediate solutions of the loop variable                                                          |

**See Also** `states`, `systems`

**Purpose** Insert breakpoint after specified method

**Syntax**

```
bafter
bafter m:mid
bafter <sid:bid | gcb> [meth] [tid:TID]
bafter <s:sid | gcs> [meth] [tid:TID]
bafter mdl [meth] [tid:TID]
```

**Short Form** ba

**Arguments**

|                |                                                 |
|----------------|-------------------------------------------------|
| <i>mid</i>     | Method ID                                       |
| <i>sid:bid</i> | Block ID                                        |
| <b>gcb</b>     | Currently selected block                        |
| <i>sid</i>     | System ID                                       |
| <b>gcs</b>     | Currently selected system                       |
| <b>mdl</b>     | Currently selected model                        |
| <i>meth</i>    | A method name, e.g., <code>Outputs.Major</code> |
| <b>TID</b>     | 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*.

# bafter

---

---

**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 `nth` 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`



**Purpose** Insert breakpoint before specified method

**Syntax**

```
break
break m:mid
break <sid:bid | gcb> [meth] [tid:TID]
break <s:sid | gcs> [meth] [tid:TID]
break mdl [meth] [tid:TID]
```

**Short Form** b

**Arguments**

|                |                                                 |
|----------------|-------------------------------------------------|
| <i>mid</i>     | Method ID                                       |
| <i>sid:bid</i> | Block ID                                        |
| <b>gcb</b>     | Currently selected block                        |
| <i>sid</i>     | System ID                                       |
| <i>gcs</i>     | Currently selected system                       |
| <b>mdl</b>     | Currently selected model                        |
| <i>meth</i>    | A method name, e.g., <code>Outputs.Major</code> |
| <i>TID</i>     | 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*.

# break

---

---

**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 *nth* 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`

**Purpose** Show specified block

**Syntax** `bshow s:b`

**Short Form** `bs`

**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`

# clear

---

**Purpose** Clear breakpoints from model

**Syntax**

```
clear  
clear m:mid  
clear id  
clear <sid:bid | gcb>
```

## Short Form

```
cl
```

**Arguments**

|                |                          |
|----------------|--------------------------|
| <i>mid</i>     | Method ID                |
| <i>id</i>      | Breakpoint ID            |
| <i>sid:bid</i> | Block ID                 |
| <b>gcb</b>     | 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

|                    |                                                                                                                                                                                                                                                                                                                                                                |
|--------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Purpose</b>     | Continue simulation                                                                                                                                                                                                                                                                                                                                            |
| <b>Syntax</b>      | <code>continue</code>                                                                                                                                                                                                                                                                                                                                          |
| <b>Short Form</b>  | <code>c</code>                                                                                                                                                                                                                                                                                                                                                 |
| <b>Description</b> | The <code>continue</code> 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. |
| <b>See Also</b>    | <code>run</code> , <code>stop</code> , <code>quit</code> , <code>animate</code>                                                                                                                                                                                                                                                                                |

# disp

---

**Purpose** Display block's I/O when simulation stops

**Syntax**  
disp  
disp **gcb**  
disp s:b

**Short Form**  
d

**Arguments**

|            |                                                         |
|------------|---------------------------------------------------------|
| <b>s:b</b> | The block whose system index is s and block index is b. |
| <b>gcb</b> | 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

|                    |                                                                                                                                                                                                                                             |
|--------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Purpose</b>     | Enable (or disable) breakpoint on solver errors                                                                                                                                                                                             |
| <b>Syntax</b>      | ebreak                                                                                                                                                                                                                                      |
| <b>Short Form</b>  | eb                                                                                                                                                                                                                                          |
| <b>Description</b> | 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. |
| <b>See Also</b>    | break, bafter, tbreak, xbreak, nanbreak, zcbreak, rbreak, clear, where, slist, systems                                                                                                                                                      |

## Purpose

List simulation methods in order in which they are executed during simulation

## Syntax

```
elist m:mid [tid:TID]
elist <gcs | s:sid> [mth] [tid:TID]
elist <gcb | sid:bid> [mth] [tid:TID]
```

## Short Form

el

## 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 Output.Outputs 'vdp/Out1' [tid=0]
  0:2 Integrator.Outputs 'vdp/x2' [tid=0]
  ...
      ↑           ↑           ↑           ↑
Blockid      Method      Block      Taskid
```

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

- 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 software 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

---

|                    |                                                                                                                                                                                                                        |
|--------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Purpose</b>     | Toggle model execution between accelerated and normal mode                                                                                                                                                             |
| <b>Syntax</b>      | emode                                                                                                                                                                                                                  |
| <b>Short Form</b>  | em                                                                                                                                                                                                                     |
| <b>Description</b> | Toggles the simulation between accelerated and normal mode when using the Accelerator mode in Simulink software. See “Using the Accelerator Mode with the Simulink Debugger” in “Using Simulink” for more information. |

**Purpose** Enable or disable method tracing

**Syntax** `etrace level level-number`

**Short Form**

`et`

**Description** This command enables or disables method tracing, depending on the value of `level`:

| <b>Level</b> | <b>Description</b>                      |
|--------------|-----------------------------------------|
| 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

---

|                    |                                                                                                                                                    |
|--------------------|----------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Purpose</b>     | Display help for debugger commands                                                                                                                 |
| <b>Syntax</b>      | help                                                                                                                                               |
| <b>Short Form</b>  | ? or h                                                                                                                                             |
| <b>Description</b> | 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. |

|                    |                                                                                                                                                                          |
|--------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Purpose</b>     | Set or clear nonfinite value break mode                                                                                                                                  |
| <b>Syntax</b>      | nanbreak                                                                                                                                                                 |
| <b>Short Form</b>  | na                                                                                                                                                                       |
| <b>Description</b> | 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. |
| <b>See Also</b>    | break, bafter, ebreak, rbreak, tbreak, xbreak, zcbreak                                                                                                                   |

## next

---

**Purpose** Advance simulation to start of next method at current level in model's execution list

**Syntax** next

**Short Form** n

**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

**Short Form** p

**Arguments**

|            |                                                         |
|------------|---------------------------------------------------------|
| s:b        | The block whose system index is s and block index is b. |
| <b>gcb</b> | 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.

# probe

---

## **See Also**

disp, trace

|                    |                                                     |
|--------------------|-----------------------------------------------------|
| <b>Purpose</b>     | Abort simulation                                    |
| <b>Syntax</b>      | quit                                                |
| <b>Short Form</b>  | q                                                   |
| <b>Description</b> | The quit command terminates the current simulation. |
| <b>See Also</b>    | stop                                                |

# rbreak

---

**Purpose** Break when simulation requires solver reset

**Syntax** rbreak

**Short Form** rb

**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

**Purpose** Run simulation to completion

**Syntax** run

**Short Form** r

**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

# slist

---

**Purpose** Display sorted list of model's root system and of each of its nonvirtual subsystems

**Syntax** `slist`

**Short Form** `sli`

**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' (Output)
0:2   'vdp/x2' (Integrator)
0:3   'vdp/Out2' (Output)
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 software 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 software uses sorted lists to create block method execution lists (see `elist`) for root system and nonvirtual subsystem methods that invoke the 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`

# states

---

**Purpose** Display current state values

**Syntax** states

**Short Form** state

**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')
```



|                    |                                                                        |
|--------------------|------------------------------------------------------------------------|
| <b>Purpose</b>     | Display debugging options in effect                                    |
| <b>Syntax</b>      | status                                                                 |
| <b>Short Form</b>  | stat                                                                   |
| <b>Description</b> | The status command displays a list of the debugging options in effect. |

# step

---

**Purpose** Advance simulation by one or more methods

**Syntax**

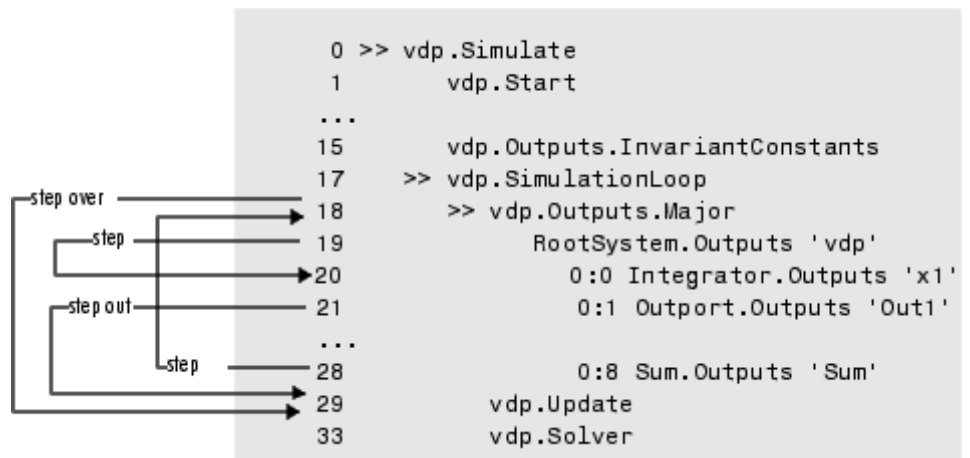
```
step [in into]  
step over  
step out  
step top  
step blockmth
```

**Short Form** s

**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.



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

# stimes

---

**Purpose** Display sample times defined by model being debugged

**Syntax** stimes

**Short Form** sti

**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
```

|                    |                                        |
|--------------------|----------------------------------------|
| <b>Purpose</b>     | Stop simulation                        |
| <b>Syntax</b>      | stop                                   |
| <b>Short Form</b>  | sto                                    |
| <b>Description</b> | The stop command stops the simulation. |
| <b>See Also</b>    | continue, run, quit                    |

# strace

---

**Purpose** Set solver trace level

**Syntax** `strace level`

**Short Form** `i`

**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                                                                           |
|-----------------------|------------------------------------------------------------------------------------|
| <code>strace 0</code> | No information                                                                     |
| <code>strace 1</code> | 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 0[F]
                        Begin iterative search to bracket zero crossing event
[Tz = 3.621111157580072 ] [Hz = 0.005777824246771424 ] [Iz = 4.2222e-003] 0[F]
[Tz = 3.621116982080098 ] [Hz = 0.005783648746797265 ] [Iz = 4.2164e-003] 0[F]
[Tz = 3.621116987943544 ] [Hz = 0.005783654610242994 ] [Iz = 4.2163e-003] 0[F]
[Tz = 3.621116987943544 ] [Hz = 0.005783654610242994 ] [Iz = 1.1804e-011] 0[F]
[Tz = 3.621116987949452 ] [Hz = 0.005783654616151157 ] [Iz = 5.8962e-012] 0[F]
[Tz = 3.621116987949452 ] [Hz = 0.005783654616151157 ] [Iz = 5.1514e-014] 0[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`

# systems

---

|                    |                                                                                                   |
|--------------------|---------------------------------------------------------------------------------------------------|
| <b>Purpose</b>     | List model's nonvirtual systems                                                                   |
| <b>Syntax</b>      | systems                                                                                           |
| <b>Short Form</b>  | sys                                                                                               |
| <b>Description</b> | The <code>systems</code> command lists a model's nonvirtual systems in the MATLAB Command Window. |
| <b>See Also</b>    | <code>slist</code>                                                                                |



**Purpose** Set or clear time breakpoint

**Syntax** tbreak  
tbreak t

**Short Form** tb

**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

# trace

---

**Purpose**                    Display block's I/O each time block executes

**Syntax**                    `trace gcb`  
                              `trace s:b`

**Short Form**                `tr`

**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`

|                    |                                                                                                                                        |
|--------------------|----------------------------------------------------------------------------------------------------------------------------------------|
| <b>Purpose</b>     | Remove block from debugger's list of display points                                                                                    |
| <b>Syntax</b>      | <code>undisp gcb</code><br><code>undisp s:b</code>                                                                                     |
| <b>Short Form</b>  | <code>und</code>                                                                                                                       |
| <b>Arguments</b>   | <code>s:b</code> The block whose system index is <code>s</code> and block index is <code>b</code> .<br><code>gcb</code> Current block. |
| <b>Description</b> | The <code>undisp</code> command removes the specified block from the debugger's list of display points.                                |
| <b>See Also</b>    | <code>disp</code> , <code>slist</code>                                                                                                 |

# untrace

---

|                    |                                                                                                                                        |
|--------------------|----------------------------------------------------------------------------------------------------------------------------------------|
| <b>Purpose</b>     | Remove block from debugger's list of trace points                                                                                      |
| <b>Syntax</b>      | <code>untrace gcb</code><br><code>untrace s:b</code>                                                                                   |
| <b>Short Form</b>  | <code>unt</code>                                                                                                                       |
| <b>Arguments</b>   | <code>s:b</code> The block whose system index is <code>s</code> and block index is <code>b</code> .<br><code>gcb</code> Current block. |
| <b>Description</b> | The <code>untrace</code> command removes the specified block from the debugger's list of trace points.                                 |
| <b>See Also</b>    | <code>trace</code> , <code>slist</code>                                                                                                |

**Purpose** Display current location of simulation in simulation loop

**Syntax** `where [detail]`

**Short Form** `w`

**Description** The `where` command displays the current location of the simulation in the simulation loop, for example,

```
sldebug @7): where
  0 >> vdp.Simulate
  1   >> vdp.Start
  2     >> RootSystem.Start 'vdp'
  7       >| 0:8 Sum.Start 'Sum'
```

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`)

# where

---

- 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

|                    |                                                                                                                                                                                                                                                |
|--------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Purpose</b>     | Break when debugger encounters step-size-limiting state                                                                                                                                                                                        |
| <b>Syntax</b>      | <code>xbreak</code>                                                                                                                                                                                                                            |
| <b>Short Form</b>  | <code>x</code>                                                                                                                                                                                                                                 |
| <b>Description</b> | The <code>xbreak</code> command pauses execution of the model when the debugger encounters a state that limits the size of the steps that the solver takes. If <code>xbreak</code> mode is already on, <code>xbreak</code> turns the mode off. |
| <b>See Also</b>    | <code>break</code> , <code>bafter</code> , <code>ebreak</code> , <code>zcbreak</code> , <code>tbreak</code> , <code>nanbreak</code> , <code>rbreak</code>                                                                                      |

# zcbreak

---

|                    |                                                                                                                                                                       |
|--------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Purpose</b>     | Toggle breaking at nonsampled zero-crossing events                                                                                                                    |
| <b>Syntax</b>      | zcbreak                                                                                                                                                               |
| <b>Short Form</b>  | zcb                                                                                                                                                                   |
| <b>Description</b> | 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. |
| <b>See Also</b>    | break, bafter, xbreak, tbreak, nanbreak, zclist                                                                                                                       |



|                    |                                                                                                                                                                     |
|--------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Purpose</b>     | List blocks containing nonsampled zero crossings                                                                                                                    |
| <b>Syntax</b>      | <code>zclist</code>                                                                                                                                                 |
| <b>Short Form</b>  | <code>zcl</code>                                                                                                                                                    |
| <b>Description</b> | The <code>zclist</code> command displays a list of blocks in which nonsampled zero crossings can occur. The command displays the list in the MATLAB Command Window. |
| <b>See Also</b>    | <code>zcbreak</code>                                                                                                                                                |



# Simulink Classes

---

|                                     |                                                                                 |
|-------------------------------------|---------------------------------------------------------------------------------|
| EventData                           | Provide information about block method execution events                         |
| Simulink.AliasType                  | Create alias for signal and/or parameter data type                              |
| Simulink.Annotation                 | Specify properties of model annotation                                          |
| Simulink.BlockCompDworkData         | Provide postcompilation information about block's DWork vector                  |
| Simulink.BlockCompInputPortData     | Provide postcompilation information about block input port                      |
| Simulink.BlockCompOutputPortData    | Provide postcompilation information about block output port                     |
| Simulink.BlockData                  | Provide run-time information about block-related data, such as block parameters |
| Simulink.BlockPortData              | Describe block input or output port                                             |
| Simulink.BlockPreCompInputPortData  | Provide precompilation information about block input port                       |
| Simulink.BlockPreCompOutputPortData | Provide precompilation information about block output port                      |
| Simulink.Bus                        | Specify properties of signal bus                                                |
| Simulink.BusElement                 | Describe element of signal bus                                                  |
| Simulink.ConfigSet                  | Access model configuration set                                                  |

|                                         |                                                                                                                      |
|-----------------------------------------|----------------------------------------------------------------------------------------------------------------------|
| <code>Simulink.ConfigSetRef</code>      | Link model to configuration set stored independently of any model                                                    |
| <code>Simulink.ModelAdvisor</code>      | Run Model Advisor from M-file                                                                                        |
| <code>Simulink.ModelDataLogs</code>     | Container for model's signal data logs                                                                               |
| <code>Simulink.ModelWorkspace</code>    | Describe model workspace                                                                                             |
| <code>Simulink.MSFcnRunTimeBlock</code> | Get run-time information about Level-2 M-file S-function block                                                       |
| <code>Simulink.NumericType</code>       | Specify data type                                                                                                    |
| <code>Simulink.Parameter</code>         | Specify value, value range, data type, and other properties of block parameter                                       |
| <code>Simulink.ParamRTWInfo</code>      | Specify information needed to generate code for parameter                                                            |
| <code>Simulink.RunTimeBlock</code>      | Allow Level-2 M-file S-function and other M-file programs to get information about block while simulation is running |
| <code>Simulink.ScopeDataLogs</code>     | Store data logged by Scope signal viewer                                                                             |
| <code>Simulink.Signal</code>            | Specify attributes of signal                                                                                         |
| <code>Simulink.SignalRTWInfo</code>     | Specify information needed to generate code for signal                                                               |
| <code>Simulink.StructElement</code>     | Describe element of data structure                                                                                   |
| <code>Simulink.StructType</code>        | Describe data structure used as value of signal or parameter                                                         |
| <code>Simulink.SubsysDataLogs</code>    | Container for subsystem's signal data logs                                                                           |
| <code>Simulink.TimeInfo</code>          | Provide information about time data in <code>Simulink.Timeseries</code> object                                       |

---

Simulink.Timeseries

Store data for any signal except mux  
or bus signal

Simulink.TsArray

Store data for mux or bus signal

# EventData

---

**Purpose** Provide information about block method execution events

**Description** Simulink software 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 *Simulink User’s Guide* 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 alias for 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 7-6). 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 software 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 software 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 7-7) 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 software displays an error.

- 2 Select **Simulink.AliasType** from the Model Explorer's **Add** menu.

Simulink software 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 7-11 for information on the names, permitted values, and usage of the properties of data type alias objects.

## Data Type Aliases in the Generated Code

You can cause data type aliases to appear in the code generated for a model using any of the following methods.

- Specifying the signal data type of a block in the model as a Simulink.AliasType via the **Block Parameters** dialog box.
- Creating a Simulink.Signal object that uses the Simulink.AliasType as its data type. Use this signal object as the name of a signal in the model and specify that the signal name must resolve to an object in the MATLAB workspace. See “Signal Objects” in the Real-Time Workshop User's Guide for more information.
- Creating a Simulink.Parameter object that uses the Simulink.AliasType as its data type. Use this parameter object as a block parameter in the model. See “Generated Code for Parameter Data Types” in the Real-Time Workshop User's Guide for more information.

---

## Notes

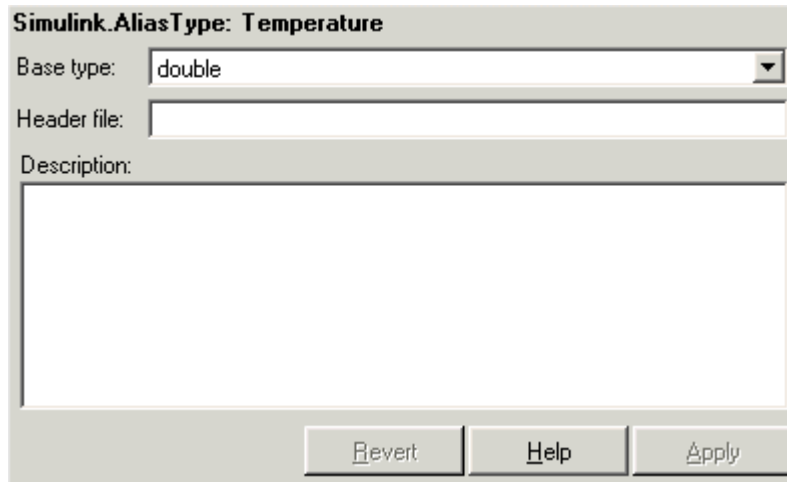
- If you assign a data type in a block's **Block Parameters** dialog box and by using a `Simulink.Signal` object on the signal feeding into the block, the code is always generated using the data type in the dialog box.
  - The Real-Time Workshop code generator tries to preserve the names of alias types in the generated code. However, in some cases, an alias type name might revert to its underlying equivalent built-in data type. If you have a Real-Time Workshop Embedded Coder license, you can guarantee that the code generator uses the alias type name in the generated code, by using replacement types (see “Replacing Built-In Data Type Names in Generated Code” in the Real-Time Workshop Embedded Coder documentation).
- 

**Parent** None

**Children** None

# Simulink.AliasType

## 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. ( <b>Base Type</b> )                                                   |
| Description | A string that describes the usage of the data type. May be a null string. ( <b>Description</b> )                                       |
| HeaderFile  | A string that specifies the name of a C header file that defines a data type having the same name as the alias. ( <b>Header File</b> ) |

# Simulink.Annotation

---

**Purpose** Specify properties of 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';
```

**Children** None.

## Property Summary

| Property    | Description                                                                                                                                                                                                                      | Values |
|-------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|
| Text        | String specifying text of annotation. Same as Name.                                                                                                                                                                              | string |
| ClickFcn    | Specifies MATLAB code to be executed when a user single-clicks this annotation. Simulink software stores the code entered in this field with the model. See “Associating Click Functions with Annotations” for more information. | string |
| Description | String that describes this annotation.                                                                                                                                                                                           | string |

| Property        | Description                                                                                                                           | Values                                          |
|-----------------|---------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------|
| FontAngle       | String specifying the angle of the annotation's font. The default value, 'auto', specifies use of the model's preferred font angle.   | 'normal'   'italic'   'oblique'   {'auto'}      |
| FontName        | String specifying name of annotation's font. The default value, 'auto', specifies use of the model's preferred font.                  | string                                          |
| FontSize        | Integer specifying size of annotation's font in points. The default value, -1, specifies use of the model's preferred font size.      | real {'-1'}                                     |
| FontWeight      | String specifying the weight of the annotation's font. The default value, 'auto', specifies use of the model's preferred font weight. | 'light'   'normal'   'demi'   'bold'   {'auto'} |
| Handle          | Annotation handle.                                                                                                                    | real                                            |
| HiliteAncestors | For internal use.                                                                                                                     |                                                 |
| Name            | String specifying text of annotation. Same as Text.                                                                                   | string                                          |
| Selected        | String specifying whether this annotation is currently selected ('on') or not selected ('off').                                       | {'on'}   'off'                                  |
| Parent          | String specifying parent name of annotation object.                                                                                   | string                                          |
| Path            | Path to the annotation.                                                                                                               | string                                          |

# Simulink.Annotation

| Property             | Description                                                                                                                                 | Values                                                                                                                                                                                                                                                                                                                                                                            |
|----------------------|---------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 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]. | vector [left bottom] not enclosed in quotation marks. The maximum value for a coordinate is 32767.                                                                                                                                                                                                                                                                                |
| Horizontal-Alignment | String specifying the horizontal alignment of this annotation, e.g., 'center'.                                                              | {'center'}   'left'   'right'                                                                                                                                                                                                                                                                                                                                                     |
| VerticalAlignment    | String specifying the vertical alignment of this annotation, e.g., 'middle'.                                                                | {'middle'}   'top'   'cap'   'baseline'   'bottom'                                                                                                                                                                                                                                                                                                                                |
| ForegroundColor      | String specifying foreground color of this annotation.                                                                                      | 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, delineated with commas. The alpha value is optional and ignored.<br><br>Block background color can also be 'black', 'white', 'red', 'green', 'blue', 'cyan', 'magenta', 'yellow', 'gray', 'lightBlue', 'orange', 'darkGreen'. |



| Property        | Description                                                                                                                                                            | Values                                                                                                                                                                                                                                                                                                                                                                                   |
|-----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| BackgroundColor | String specifying background color of this annotation.                                                                                                                 | <p>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, delineated with commas. The alpha value is optional and ignored.</p> <p>Block background color can also be 'black', 'white', 'red', 'green', 'blue', 'cyan', 'magenta', 'yellow', 'gray', 'lightBlue', 'orange', 'darkGreen'.</p> |
| DropShadow      | String specifying whether to display a drop shadow. Options are 'on' or 'off'.                                                                                         | 'on'   {'off'}                                                                                                                                                                                                                                                                                                                                                                           |
| TeXMode         | String specifying whether to render TeX markup. Options are 'on' or 'off'.                                                                                             | 'on'   {'off'}                                                                                                                                                                                                                                                                                                                                                                           |
| Type            | Annotation type. This is always 'annotation'                                                                                                                           | string                                                                                                                                                                                                                                                                                                                                                                                   |
| 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. | string                                                                                                                                                                                                                                                                                                                                                                                   |

# Simulink.Annotation

| Property                       | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Values         |
|--------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|
| DeleteFcn                      | String specifying M-code to be executed before deleting this annotation. See “Annotation Callback Functions” in the online Simulink documentation.                                                                                                                                                                                                                                                                                                                                                                         | string         |
| RequirementInfo                | For internal use.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | string         |
| Tag                            | User-specified text that is assigned to the annotation’s Tag parameter and saved with the annotation.                                                                                                                                                                                                                                                                                                                                                                                                                      | string         |
| UseDisplayText-AsClickCallback | <p>String specifying whether to use the contents of the Text property as this annotation’s click function. Options are 'on' or 'off'.</p> <p>If set to 'on', the text of the annotation is interpreted as a valid MATLAB expression and run. If set to 'off', clicking on the annotation runs the click function, if there is one. If there is no click function, clicking the annotation has no effect.</p> <p>See “Associating Click Functions with Annotations” in the Simulink documentation for more information.</p> | 'on'   {'off'} |
| UserData                       | Any data that you want to associate with this annotation.                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | vector         |

**Purpose** Provide postcompilation information about block's DWork vector

**Description** Simulink software 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 7-136 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                                                                               |
|----------------------|-------------------------------------------------------------------------------------------|
| "Usage" on page 7-17 | Usage type of this DWork vector.                                                          |
| "UsedAsDiscState"    | True if this DWork vector is being used to store the values of a block's discrete states. |

## Properties

---

Usage

### Description

Returns a string indicating how this DWork vector is used. Permissible values are:

- DWork
- DState
- Scratch
- Mode

### Data Type

string

### Access

RW for M-file S-function blocks, RO for other blocks.

# Simulink.BlockCompDworkData

---

---

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.

**Purpose** Provide postcompilation information about block input port

**Description** Simulink software 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 7-137 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** Provide postcompilation information about block output port

**Description** Simulink software 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 7-138 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.

**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                                       |
|------------------------------------------|---------------------------------------------------|
| "AliasedThroughDataType" on page 7-22    | Fundamental base data type.                       |
| "AliasedThroughDataType-ID" on page 7-23 | Fundamental base data type ID.                    |
| "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

AliasedThroughDataType

### Description

Data type aliases allow a data type (B) to be recursively aliased to another alias type or **BaseType** (A). If alias type A is aliased to another alias type that is aliased to another alias type and so forth, this property allows the alias type to be iteratively searched (aliased through) until the type is no longer an alias type and that final result is the value of the property returned. For example, assume that you have created the Simulink Alias types A and B as follows:

```
A=Simulink.AliasType('double')
```

```
A =  
Simulink.AliasType  
  Description: ''  
  HeaderFile: ''  
  BaseType: 'double'  
B=Simulink.AliasType('A')
```

```
B =  
Simulink.AliasType  
  Description: ''  
  HeaderFile: ''  
  BaseType: 'A'
```

If the data type of an item of block data is B, this property returns the base type A instead of B.

### Data Type

string

### Access

RO



---

AliasedThroughDataTypeID

**Description**

Index of the data type alias returned by the AliasedThroughDataType property.

**Data Type**

integer

**Access**

RO

---

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. Enter the numeric value for the desired data type, as follows:

| Data Type   | Value |
|-------------|-------|
| 'inherited' | -1    |
| 'double'    | 0     |
| 'single'    | 1     |
| 'int8'      | 2     |
| 'uint8'     | 3     |
| 'int16'     | 4     |
| 'uint16'    | 5     |

| Data Type                           | Value |
|-------------------------------------|-------|
| 'int32'                             | 6     |
| 'uint32'                            | 7     |
| 'boolean' or fixed-point data types | 8     |

**Data Type**

integer

**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:

# Simulink.BlockData

---

| 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.                       |
| '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 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

---

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 “How to Specify the 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

---

| <b>Value</b> | <b>Description</b>                                                                                                         |
|--------------|----------------------------------------------------------------------------------------------------------------------------|
| '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



**Purpose** Provide precompilation information about block input port

**Description** Simulink software 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 7-137 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 block output port

**Description** Simulink software 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 7-138 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

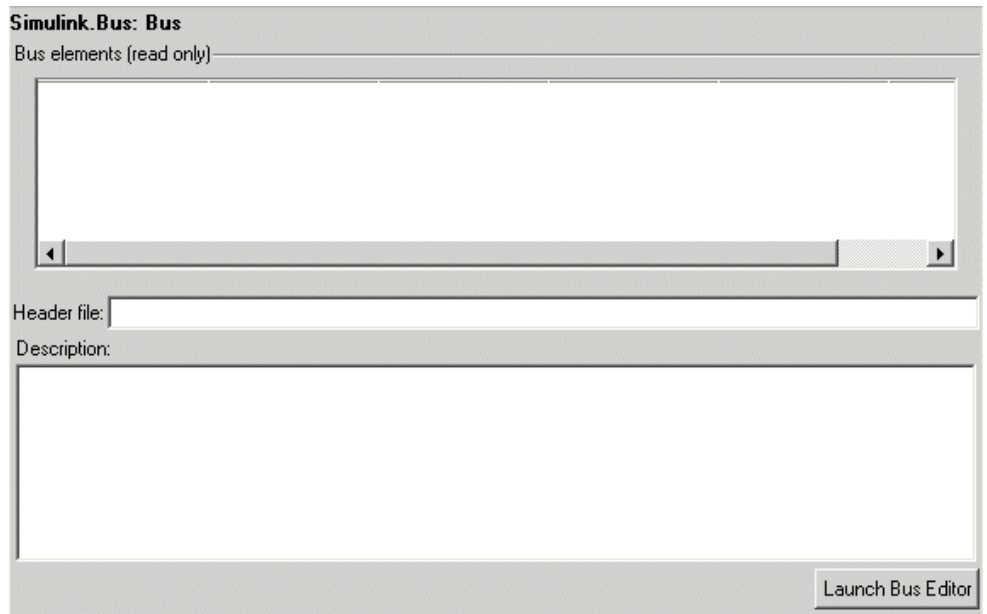
RW for M-file S functions, RO for other blocks

**Purpose** Specify properties of 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 software to validate the properties 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 software checks whether the buses connected to the blocks have the properties specified by the bus objects. If not, Simulink software 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 Using the Bus Editor), or MATLAB commands (see "Working with Data Objects") to create bus objects in the base MATLAB workspace. If you attempt to create an alias in a model workspace, Simulink software displays an error. You must use the Bus Editor or the MATLAB command line to set the properties of a bus object. Simulink software also provides a set of utility functions for creating and saving bus objects.

## 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 “Using Bus Objects”) 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 software (see “Code Generation with User-Defined Data Types” *Real-Time Workshop Embedded Coder User's Guide*). Simulink software ignores this field.

## Description

Description of this structure. This field is intended for you to use to document this bus. Simulink software does not use this field.

## Properties

| Name        | Access | Description                                                                                                                                                                                          |
|-------------|--------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Description | RW     | String that describes this bus. This property is intended for user use. Simulink software does not use it. (Description)                                                                             |
| Elements    | RW     | An array of <code>Simulink.BusElement</code> 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 software. Simulink does not use it. (Header file) |

## See Also

- “Using Composite Signals”
- “Using Buses”
- Bus Assignment
- Bus Creator
- Bus Selector
- Bus to Vector
- `Simulink.Bus.cellToObject`
- `Simulink.Bus.createObject`

# Simulink.Bus

---

- `Simulink.BusElement`
- `Simulink.Bus.objectToCell`
- `Simulink.Bus.save`

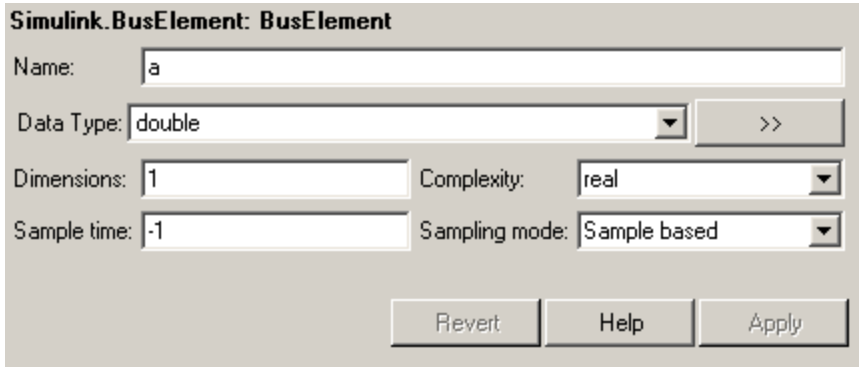
**Purpose** Describe element of signal bus

**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. |

**Property Dialog Box**



**Properties**

**Complexity**  
Numeric type ('real' or 'complex') of this element. Must be 'real' if this bus element is itself a bus.

**Data Type:** string

# Simulink.BusElement

---

Access: RW

---

## Data Type

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.

Click the **Show data type assistant** button  to display the **Data Type Assistant**, which helps you set the **Data type** parameter. (See “Using the Data Type Assistant”.)

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 "How to Specify the 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 models.

Data Type: string

Access: RW

## See Also

- "Using Composite Signals"
- "Using Buses"
- Bus Assignment
- Bus Creator
- Bus Selector

# Simulink.BusElement

---

- Bus to Vector
- Simulink.Bus
- Simulink.Bus.cellToObject
- Simulink.Bus.createObject
- Simulink.Bus.objectToCell
- Simulink.Bus.save

**Purpose** Access 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 Sets” and “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 for simulation with this configuration. |

**Note** You can use the **Model Configuration** dialog box to set the **Name** and **Description** properties of a configuration set. See “Model Configuration Dialog Box” 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.                                    |
| “isActive”        | Determine whether a configuration set is the active set of the model that owns it. |

# Simulink.ConfigSet

---

| Name             | Description                                                                          |
|------------------|--------------------------------------------------------------------------------------|
| “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. This field can remain blank.

### Data Type

string

### Access

RW

---

Name

### Description

Configuration set's name. This name represents the configuration set in the Model Explorer.

**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.

# Simulink.ConfigSet

---

```
hCs = getActiveConfigSet('B');  
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 *Simulink User’s Guide* 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 pathname 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. Specifying *paramName* as 'ObjectParameters' returns the names of the valid parameters in the configuration set.

## 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.ConfigSetRef

---

## Purpose

Link model to configuration set stored independently of any model

## Description

Instances of this handle class allow a model to reference configuration sets that exist outside any model. See “Configuration Sets”, “Configuration Set API”, and “Referencing Configuration Sets” for more information.

## Property Summary

| Name          | Description                                                                    |
|---------------|--------------------------------------------------------------------------------|
| “Description” | Description of the configuration reference.                                    |
| “Name”        | Name of the configuration reference.                                           |
| “WSVarName”   | Name of the workspace variable that contains the referenced configuration set. |

---

**Note** You can use the **Configuration Reference** dialog box to set the Name, Description, and WSVarName properties of a configuration reference. See “Creating and Attaching a Configuration Reference” for details.

---

## Method Summary

| Name              | Description                                                                                  |
|-------------------|----------------------------------------------------------------------------------------------|
| “copy”            | Create a copy of a configuration reference.                                                  |
| “getFullName”     | Get the full pathname of a configuration reference.                                          |
| “getModel”        | Get the handle of the model that owns a configuration reference.                             |
| “get_param”       | Get the value of a configuration set parameter indirectly through a configuration reference. |
| “getRefConfigSet” | Get the configuration set specified by a configuration reference.                            |

---

| Name       | Description                                                                                      |
|------------|--------------------------------------------------------------------------------------------------|
| “isActive” | Determine whether a configuration reference is the active configuration object of the model.     |
| “refresh”  | Update configuration reference after any change to properties or configuration set availability. |

## Properties

---

Description

**Description**

Description of the configuration reference. You can use this property to provide additional information about a configuration reference, such as its purpose. This field can remain blank.

**Data Type**

string

**Access**

RW

---

Name

**Description**

Name of the configuration reference. This name represents the configuration reference in the GUI.

**Data Type**

string

**Access**

RW

---

WSVarName

**Description**

Name of the workspace variable that contains the referenced configuration set.

# Simulink.ConfigSetRef

---

## Data Type

string

## Access

RW

## Methods

---

copy

### Purpose

Create a copy of this configuration reference.

### Syntax

copy

### Description

This method creates a copy of this configuration set.

---

**Note** You must use this method to create copies of configuration references. This is because `Simulink.ConfigSetRef` is a handle class. See “Handle Versus Value Classes” for more information.

---

---

getFullName

### Purpose

Get the full pathname of a configuration reference.

### Syntax

getFullName

### Description

This method returns a string specifying the full pathname of a configuration reference, e.g., 'vdp/Configuration'.

---

getModel

### Purpose

Get the model that owns this configuration reference.

**Syntax**

getModel

**Description**

Returns a handle to the model that owns this configuration reference.

**Example**

The following command opens the block diagram of the model that owns the configuration set referenced by the MATLAB workspace variable hCr.

```
open_system(hCr.getModel);
```

---

get\_param

**Purpose**

Get the value of a configuration set parameter indirectly through a configuration reference.

**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 from the configuration set to which the configuration reference points. To obtain this value, the method uses the value of *WSVarName* to retrieve the configuration set, then retrieves the value of *paramName* from that configuration set. Specifying *paramName* as 'ObjectParameters' returns the names of all valid parameters in the configuration set. If a valid configuration set is not attached to the configuration reference, the method returns unreliable values.

The inverse method, `set_param`, is not defined for configuration references. To obtain a parameter value through a configuration reference, you must first use the `getRefConfigSet` method to retrieve

the configuration set from the reference, then use `set_param` directly on the configuration set itself.

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.

### 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');
```

---

`getRefConfigSet`

### Purpose

Get the configuration set specified by a configuration reference

### Syntax

`getRefConfigSet`

### Description

Returns a handle to the configuration set specified by the `WSVarName` property of a configuration reference.

---

`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.



---

refresh

**Purpose**

Update configuration reference after any change to properties or configuration set availability

**Syntax**

refresh

**Description**

Updates a configuration reference after using the API to change any property of the reference, or after providing a configuration set that did not exist at the time the set was originally specified in `WSVarName`. If you omit executing `refresh` after any such change, the configuration reference handle will be stale, and using it will give incorrect results.

# 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. MATLAB software 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 IDs

Many `Simulink.ModelAdvisor` object methods require or return IDs. An *ID* is a string that identifies a Model Advisor check, task, or group. ID must remain constant. A `Simulink.ModelAdvisor` object includes methods that enable you to retrieve the ID or IDs for all checks, tasks, and groups, checks belonging to groups and tasks, the active check, and selected checks, tasks and groups. See the `Simulink.ModelAdvisor` "Method Summary" for more information.

## Syntax

```
ma = Simulink.ModelAdvisor
```

## Arguments

*ma*

A variable representing the `Simulink.ModelAdvisor` object you create.

## Method Summary

| Name            | Description                 |
|-----------------|-----------------------------|
| "closeReport"   | Close Model Advisor report. |
| "deselectCheck" | Deselect checks.            |

| <b>Name</b>             | <b>Description</b>                                                 |
|-------------------------|--------------------------------------------------------------------|
| “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 tasks.                                                    |
| “deselectTaskAll”       | Deselect all tasks.                                                |
| “displayReport”         | Display Model Advisor report.                                      |
| “exportReport”          | Copy report to a specified location.                               |
| “getBaselineMode”       | Get baseline mode setting for the Model Advisor.                   |
| “getCheckAll”           | Get the 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 IDs of the groups of tasks performed by the Model Advisor. |

# Simulink.ModelAdvisor

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| <b>Name</b>                          | <b>Description</b>                                           |
|--------------------------------------|--------------------------------------------------------------|
| “getInputParameters” on page 7-68    | Get input parameters of a check.                             |
| “getListViewParameters” on page 7-69 | Get list view parameters of a check.                         |
| “getModelAdvisor”                    | Get the Model Advisor for a model or subsystem.              |
| “getSelectedCheck”                   | Get selected checks.                                         |
| “getSelectedSystem” on page 7-71     | Get path of system currently targeted by the Model Advisor.  |
| “getSelectedTask”                    | Get selected tasks.                                          |
| “getTaskAll”                         | Get the 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 checks.                                               |
| “selectCheckAll”                     | Select all checks.                                           |
| “selectCheckForGroup”                | Select a group of checks.                                    |
| “selectCheckForTask”                 | Select checks that belong to a specified task.               |
| “selectTask”                         | Select tasks.                                                |
| “selectTaskAll”                      | Select all tasks.                                            |
| “setActionEnable” on page 7-77       | Set enable/disable status for a check action.                |

| Name                                 | Description                                                                                             |
|--------------------------------------|---------------------------------------------------------------------------------------------------------|
| "setBaselineMode"                    | Set baseline mode for the Model Advisor.                                                                |
| "setCheckErrorSeverity" on page 7-78 | Set severity of a check failure.                                                                        |
| "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.                                                   |
| "setListViewParameters" on page 7-82 | Set list view parameters for a 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. |
| "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

### closeReport

#### Purpose

Close Model Advisor report.

#### Syntax

closeReport

**Description**

Closes the report associated with this Model Advisor object, which closes the Model Advisor window.

**See Also**

“displayReport”

**deselectCheck****Purpose**

Deselect a check.

**Syntax**

```
success = deselectCheck(ID)
```

**Arguments**

ID

String or cell array that specifies the IDs of the checks to be deselected

success

True (1) if the check is deselected.

**Description**

This method deselects the checks specified by ID.

---

**Note** This method cannot deselect disabled checks.

---

**See Also**

“getCheckAll”, “deselectCheckForGroup”, “selectCheck”

**deselectCheckAll****Purpose**

Deselect all checks.

**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(ID)
```

## Arguments

ID

String or cell array of strings that specify the 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 ID argument.

## See Also

“getTaskAll”, “selectCheckForTask”

## deselectTask

### Purpose

Deselect a task.

### Syntax

```
success = deselectTask(ID)
```

## Arguments

ID

String or cell array that specifies the ID of tasks to be deselected

success

True (1) if the method succeeded in deselecting the specified tasks

## Description

Deselects the tasks specified by ID.

## See Also

“selectTask”, “getTaskAll”

## deselectTaskAll

### Purpose

Deselect all tasks.

### 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`

Path name 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 IDs of all checks.

### Syntax

```
IDs = getCheckAll
```

## Arguments

IDs

Cell array of strings specifying the IDs of all checks performed by the Model Advisor

## Description

Returns a cell array of strings specifying the IDs of all checks performed by the Model Advisor.

## See Also

“getTaskAll”, “getGroupAll”

## getCheckForGroup

### Purpose

Get checks that belong to a check group.

### Syntax

```
IDs = getCheckForTask(groupName)
```

### Arguments

groupName

String specifying the name of a group

IDs

Cell array of IDs

## Description

Returns a cell array of 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

ID of a task

checkIDs

Cell array of IDs of checks belonging to the specified task

## Description

Returns a cell array of 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(ID)
```

### Arguments

ID

ID of a check or cell array of check IDs

result

A check result or cell array of check results

### Description

Gets results for the specified checks. The format of the results depends on the checks that generated the data.

---

**Note** This method is intended for accessing results generated by custom checks created with the Model Advisor’s customization API, an optional feature available with Simulink® Verification and Validation™ software (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(ID)
```

**Arguments**

ID

Check ID or cell array of check 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 software (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(ID)
```

## Arguments

ID

Check ID or cell array of check 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

IDs = getGroupAll

### Arguments

IDs

Cell array of IDs of all groups of checks performed by the Model Advisor.

### Description

Returns a cell array of IDs of all groups of checks performed by the Model Advisor.

### See Also

“getCheckAll”, “getTaskAll”

## getInputParameters

### Purpose

Get input parameters of a check.

### Syntax

*params* = *obj*.getInputParameters(*check\_ID*)

## Arguments

*params*

A cell array of `ModelAdvisor.InputParameter` objects.

*obj*

A variable representing the `Simulink.ModelAdvisor` object.

*check\_ID*

A string that uniquely identifies the check.

You can omit the *check\_ID* if you use the method inside a check callback function.

## Description

Returns the input parameters associated with a check.

---

**Note** This method is intended for accessing custom checks created with the Model Advisor's customization API, an optional feature available with Simulink Verification and Validation software (see the online Simulink Verification and Validation documentation for more information).

---

## See Also

`ModelAdvisor.InputParameter`

## getListViewParameters

### Purpose

Get list view parameters of a check.

### Syntax

```
params = obj.getListViewParameters(check_ID)
```

### Arguments

*params*

A cell array of `ModelAdvisor.ListViewParameter` objects.

*obj*

A variable representing the `Simulink.ModelAdvisor` object.

*check\_ID*

A string that uniquely identifies the check.

You can omit the *check\_ID* if you use the method inside a check callback function.

## Description

Returns the list view parameters associated with a check.

---

**Note** This method is intended for accessing custom checks created with the Model Advisor's customization API, an optional feature available with Simulink Verification and Validation software (see the online Simulink Verification and Validation documentation for more information).

---

## See Also

“setListViewParameters” on page 7-82,  
`ModelAdvisor.ListViewParameter`

## getModelAdvisor

### Purpose

Get a Model Advisor object for a system or subsystem.

### Syntax

```
obj = Simulink.ModelAdvisor.getModelAdvisor(system)
obj = Simulink.ModelAdvisor.getModelAdvisor(system, 'new')
```

### Arguments

`system`

Name of model for which the Model Advisor is to be gotten

'new'

Required when changing Model Advisor working scope from one system to another without closing the previous session.



Alternatively, you can close the previous session before invoking `getModelAdvisor`, in which case 'new' can be omitted.

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**

IDs = `getSelectedCheck`

### **Arguments**

IDs  
Cell array of IDs of currently selected checks

## **Description**

Returns the checks currently selected in the Model Advisor.

## **See Also**

“`getSelectedTask`”

## **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.ModelAdvisor.getModelAdvisor`.

**See Also**

“`getModelAdvisor`”

**getSelectedTask****Purpose**

Get selected tasks.

**Syntax**

```
IDs = getSelectedTask
```

**Arguments**

IDs

Cell array of IDs of currently selected tasks.

**Description**

Returns the tasks currently selected in the Model Advisor.

**See Also**

“`getSelectedCheck`”

**getTaskAll****Purpose**

Get the tasks performed by the Model Advisor.

**Syntax**

```
IDs = getTaskAll
```

**Arguments**

IDs

Cell array of IDs of tasks performed by the Model Advisor.

**Description**

Returns a cell array of 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 path name 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 the MATLAB 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 Selected Checks** button on the Model Advisor window.

**See Also**

“selectTask”

**selectCheck****Purpose**

Select a check.

**Syntax**

```
success = selectCheck(ID)
```

**Arguments**

ID

ID or cell array of 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(ID)
```

### **Arguments**

ID

ID or cell array of group IDs

success

True (1) if this method succeeded in selecting the specified groups

### **Description**

Selects the groups specified by ID.

### **See Also**

“deselectCheckForGroup”

## **selectCheckForTask**

### **Purpose**

Select checks that belong to a specified task or set of tasks.

**Syntax**

`success = selectCheckForTask(ID)`

**Arguments**

ID

ID or cell array of 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 ID argument.

**See Also**

“deselectCheckForTask”

**selectTask****Purpose**

Select a task.

**Syntax**

`success = selectTask(ID)`

**Arguments**

ID

ID or cell array of 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”

**setActionEnable****Purpose**

Set enable/disable status for check action

**Syntax**

```
obj.setActionEnable(value)
```

**Arguments**

*obj*

A variable representing the Simulink.ModelAdvisor object.

*value*

Boolean value indicating whether the Action box is enabled or disabled.

- true — Enable the Action box.
- false — Disable the Action box.

**Description**

The setActionEnable method specifies the enables or disables the Action box. Only a check callback function can invoke this method.

---

**Note** This method is intended for accessing custom checks created with the Model Advisor’s customization API, an optional feature available with Simulink Verification and Validation software (see the online Simulink Verification and Validation documentation for more information).

---

## See Also

ModelAdvisor.Action

## 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”

## setCheckErrorSeverity

### Purpose

Set severity of a check failure.

### Syntax

```
obj.setCheckErrorSeverity(value)
```



## Arguments

*obj*

A variable representing the `Simulink.ModelAdvisor` object.

*value*

Integer indicating severity of failure.

- 0 — Check Result = Warning
- 1 — Check Result = Failed

## Description

Sets result status for a currently running check that fails to *value*. Only a check callback function can invoke this method.

---

**Note** This method is intended for accessing custom checks created with the Model Advisor’s customization API, an optional feature available with Simulink Verification and Validation software (see the online Simulink Verification and Validation documentation for more information).

---

## See Also

“setCheckResultStatus”

## 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 software (see the online Simulink Verification and Validation documentation for more information).

---

## **See Also**

“getCheckResult”, “setCheckResultData”, “setCheckResultStatus”

## **setCheckResultData**

### **Purpose**

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 software (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 software (see the online Simulink Verification and Validation documentation for more information).

---

## See Also

“getCheckResultStatus”, “setCheckResult”, “setCheckResultData”, “setCheckErrorSeverity” on page 7-78

## setListViewParameters

### Purpose

Specify list view parameters for a check.

### Syntax

```
obj.setListViewParameters(check_ID, params)
```

### Arguments

*obj*

A variable representing the `Simulink.ModelAdvisor` object.

*check\_ID*

A string that uniquely identifies the check.

You can omit the *check\_ID* if you use the method inside a check callback function.

*params*

A cell array of `ModelAdvisor.ListViewParameter` objects.

### Description

Set the list view parameters for the check.

---

**Note** This method is intended for accessing custom checks created with the Model Advisor’s customization API, an optional feature available with Simulink Verification and Validation software (see the online Simulink Verification and Validation documentation for more information).

---

## See Also

“getListViewParameters” on page 7-69,  
`ModelAdvisor.ListViewParameter`

## **verifyCheckRan**

### **Purpose**

Verify that the Model Advisor has run a set of checks.

### **Syntax**

```
[success, missingChecks, additionalChecks] =  
verifyCheckRan(IDs)
```

### **Arguments**

IDs

Cell array of IDs of checks to verify

success

Boolean value specifying whether the checks ran

missingChecks

Cell array of IDs for specified checks that ran

additionalChecks

Cell array of IDs for unspecified checks that ran

### **Description**

The output variable `success` returns `true` if all the checks specified by IDs 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] = verifyCheckResult(baseline, checkIDs)
```

### **Arguments**

baseline

Pathname of the baseline check results MAT-file

`checkIDs`

Cell array of check 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 returns `true` as the value of the `success` output variable.

---

**Note** You must run the checks specified by `checkIDs` (see “`runCheck`”) before invoking `verifyCheckResult`.

---

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] = verifyCheckResultStatus(baseline,  
checkIDs)
```

### Arguments

baseline

Array of Boolean variables

checkIDs

Cell array of check IDs.

success

Boolean value specifying whether the method succeeded

message

String specifying an error message

### 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 model's signal data logs

**Description** Simulink software creates instances of this class to contain signal logs that it creates while simulating a model (see “Logging Signals”). In particular, Simulink software 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 software 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 logouts.

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.ModelDataLogs  
Container for the data logs of a model
- Simulink.SubsysDataLogs  
Container for the data logs of a subsystem
- Simulink.ScopeDataLogs  
Container for the data logs of Scope signal viewers
- Simulink.Timeseries  
Data log for any signal except a mux or bus signal
- Simulink.TsArray  
Data log for a mux or bus signal

The names of the properties identify the data being logged as follows:

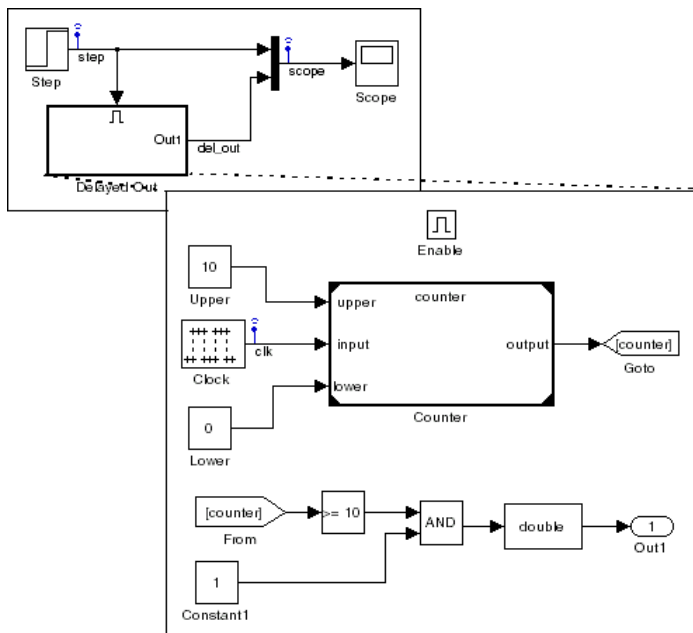
- For signal data logs, the name of the signal
- For a subsystem or model log container, the name of the subsystem or model, respectively
- For a scope viewer data log, the name specified on the viewer's parameter dialog box

---

**Note** If a name contains spaces, the ModelDataLogs objects specifies its name as (' **name** ') where **name** is the actual name, e.g., (' Brake Subsystem '). See "Handling Spaces and Newlines in Logged Names" for more information.

---

Consider, for example, the following model.



# Simulink.ModelDataLogs

---

As indicated by the testpoint icons, this model specifies that Simulink software 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:

```
>> logcout

logcout =

Simulink.ModelDataLogs (siglgex):
      Name                Elements  Simulink Class
      scope                2        TsArray
      step                 1        Timeseries
      ('Delayed Out')      2        SubsysDataLogs
```

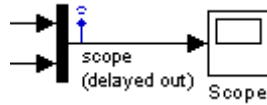
The `logcout` variable contains the signal data logged during the simulation. You can use fully qualified object names or the Simulink `unpack` command to access the signal data stored in `logcout`. For example, to access the amplitudes of the `clk` signal in the `Delayed Out` subsystem, enter

```
>> data = logcout('Delayed Out').clk.Data;
```

or

```
>> logcout.unpack('all');
>> data = clk.Data;
```

You can use a custom logging name or signal name when logging a signal. If you use the signal name, and that name occupies more than one line, include an `sprintf('\n')` between the lines of the signal name when accessing the logged data. For example, to access the signal in the following model:



Use the following syntax:

```
logout(['scope' sprintf('\n') '(delayed out)'])
```

See “Handling Spaces and Newlines in Logged Names” for more information.

## See Also

“Importing and Exporting Data”, `Simulink.SubsysDataLogs`, `Simulink.ScopeDataLogs`, `Simulink.Timeseries`, `Simulink.TsArray`, `who`, `whos`, `unpack`

# Simulink.ModelWorkspace

---

**Purpose** Describe model workspace

**Description** Instances of this class describe model workspaces. Simulink software creates an instance of this class for each model that you open during a Simulink session. See “Using Model Workspaces” in *Simulink User’s Guide* for more information.

## Property Summary

| Name       | Access | Description                                                                                                                                                             |
|------------|--------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| DataSource | RW     | Specifies the source used to initialize this workspace. Valid values are <ul style="list-style-type: none"><li>'MDL-File'</li><li>'MAT-File'</li><li>'M-Code'</li></ul> |
| FileName   | RW     | Specifies the name of the MAT-file used to initialize this workspace. Simulink software ignores this property if DataSource is not 'MAT-File'.                          |
| MCode      | RW     | A string specifying M code used to initialize this workspace. Simulink software 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.

# Simulink.ModelWorkspace

---

## **Syntax**

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 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 software and provide information to Simulink software about a Level-2 M-file S-function block. Simulink software creates an instance of this class for each Level-2 M-file S-function block in a model. Simulink software 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 software. 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 *Simulink User’s Guide* for more information.

The Level-2 M-file S-Function template `matlabroot/toolbox/simulink/blocks/msfuntmp1.m` shows how to use a number of the following methods.

**Parent Class** Simulink.RunTimeBlock

**Derived Classes** None

**Property Summary**

| Name                         | Description                                                       |
|------------------------------|-------------------------------------------------------------------|
| “AllowSignalsWithMoreThan2D” | Enable Level-2 M-file S-function to use multidimensional signals. |

| 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. |

# Simulink.MSFcnRunTimeBlock

---

| Name                                  | Description                                                                                                                |
|---------------------------------------|----------------------------------------------------------------------------------------------------------------------------|
| "RegBlockMethod"                      | Register a callback method for this block.                                                                                 |
| "RegisterDataTypeFxpBinaryPoint"      | Register fixed-point data type with binary point-only scaling.                                                             |
| "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.                 |
| "SetPreCompInpPortInfoToDynamic"      | Set precompiled attributes of this block's input ports to be inherited.                                                    |
| "SetPreCompOutPortInfoToDynamic"      | Set precompiled attributes of this block's output ports to be inherited.                                                   |
| "SetPreCompPortInfoToDefaults"        | Set precompiled attributes of this block's ports to the default values.                                                    |

| Name                  | Description                                                    |
|-----------------------|----------------------------------------------------------------|
| “SetSimViewingDevice” | Specify whether block is a viewer.                             |
| “WriteRTWParam”       | Write custom parameter information to Real-Time Workshop file. |

## Properties

---

AllowSignalsWithMoreThan2D

### Description

Allow Level-2 M-file S-functions to use multidimensional signals. You must set the AllowSignalsWithMoreThan2D property in the setup method.

### Data Type

Boolean

### Access

RW

---

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. For example, the following lines initializes three dialog parameters where the first is tunable, the second is not tunable, and the third is tunable only during simulation.

```
block.NumDialogPrms      = 3;  
block.DialogPrmsTunable = {'Tunable', 'Nontunable', 'SimOnlyTunable'};
```

### Data Type

array

# Simulink.MSFcnRunTimeBlock

---

## **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**

Use in the PostPropagationSetup method to 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 ProcessParameters.



See the S-function `matlabroot/toolbox/simulink/simdemos/adapt_lms.m` in the Simulink model `sldemo_msfcn_lms.mdl` for an example.

---

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 software computes the values of block outputs that cannot change during the simulation (see “Constant Sample Time” in the *Simulink User’s Guide*). Use this method in the `Outputs` 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.

# Simulink.MSFcnRunTimeBlock

---

---

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 the `Outputs` or `Update` methods.

---

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

Global index of the 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. The sample time index stIdx is a global index for the Simulink model. For example, consider a model that contains three sample rates of 0.1, 0.2, and 0.5, and an M-file S-function block that contains two rates of 0.2 and 0.5. In the M-file S-function, `block.IsSampleHit(0)` returns true for the rate 0.1, not the rate 0.2.

This block method is similar to `ssIsSampleHit` for C-MEX S-functions, however `ssIsSampleHit` returns values based on only the sample times contained in the S-function. For example, if the model described

above contained a C-MEX S-function with sample rates of 0.2 and 0.5, `ssIsSampleHit(S,0,tid)` returns true for the rate of 0.2.

Use port-based sample times to avoid using the global sample time index for multi-rate systems (see `Simulink.BlockPortData`).

---

`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.

`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.

# Simulink.MSFcnRunTimeBlock

---

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 the `setup` function of 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,  
fractionalLength, 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 software 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.

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 software 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 software 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

# Simulink.MSFcnRunTimeBlock

---

methods defined for instances of this class, such as “DatatypeSize” on page 7-135.

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 “RegisterDataTypeFxpFSSlopeFixExpBias” 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 Accelerator mode of Simulink software.

## **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. See the S-function *matlabroot/toolbox/simulink/blocks/msfcn\_times\_two.m* in the Simulink model *msfcndemo\_timestwo.mdl* for an example.



---

SetPreCompInPortInfoToDynamic

**Purpose**

Set precompiled attributes of this block's input ports to be inherited.

**Syntax**

```
SetPreCompInPortInfoToDynamic;
```

**Description**

Initialize the compiled information (dimensions, data type, complexity, and sampling mode) of this block's input ports to be inherited. See the S-function *matlabroot/toolbox/simulink/simdemos/adapt\_lms.m* in the Simulink model *sldemo\_msfcn\_lms.mdl* for an example.

---

SetPreCompOutPortInfoToDynamic

**Purpose**

Set precompiled attributes of this block's output ports to be inherited.

**Syntax**

```
SetPreCompOutPortInfoToDynamic;
```

**Description**

Initialize the compiled information (dimensions, data type, complexity, and sampling mode) of the block's output ports to be inherited. See the S-function *matlabroot/toolbox/simulink/simdemos/adapt\_lms.m* in the Simulink model *sldemo\_msfcn\_lms.mdl* for an example.

---

SetPreCompPortInfoToDefaults

**Purpose**

Set precompiled attributes of this block's ports to the default values.

**Syntax**

```
SetPreCompPortInfoToDefaults;
```

**Description**

Initialize the compiled information (dimensions, data type, complexity, and sampling mode) of the block's ports to the default values. By default, a port accepts a real scalar sampled signal with a data type of double.

# Simulink.MSFcnRunTimeBlock

---

---

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 WriteRTW 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. See the S-function `matlabroot/toolbox/simulink/simdemos/adapt_lms.m` in the Simulink model `sldemo_msfcn_lms.mdl` for an example.

# Simulink.NumericType

---

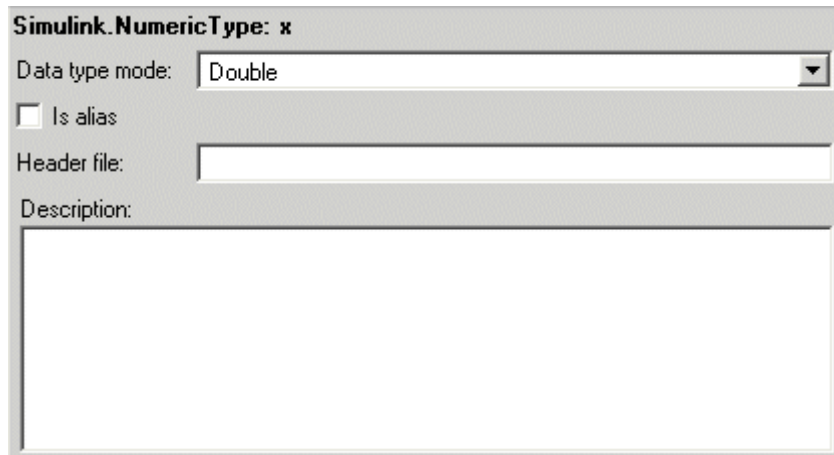
**Purpose** Specify data type

**Description** This class lets you specify a data type. To do this,

- 1 Create an instance of this class in the MATLAB base workspace. If you attempt to create a numeric type in a model workspace, Simulink software displays an error.
- 2 Set object's properties to the properties of the custom data type
- 3 Assign the data type to all signals and parameters of your model that you want to conform to the data type.

Assigning a 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



The screenshot shows a dialog box titled "Simulink.NumericType: x". It features a "Data type mode" dropdown menu currently set to "Double". Below this is an unchecked checkbox labeled "Is alias". There is a text input field for "Header file:" and a larger text area for "Description:".

### 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:<br>unspecified<br>scaling    | A fixed-point data type with unspecified scaling.    |
| Fixed-point:<br>binary point<br>scaling   | A fixed-point data type with binary-point scaling.   |
| Fixed-point:<br>slope and bias<br>scaling | A fixed-point data type with slope and bias scaling. |

Selecting a category causes Simulink software 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 for a workspace object of this type, Simulink software uses the name of the object as the data type for all objects that specify the object as its data type. Otherwise, Simulink software uses the category of the data type as its name, or, if the category is a fixed-point category, Simulink software 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

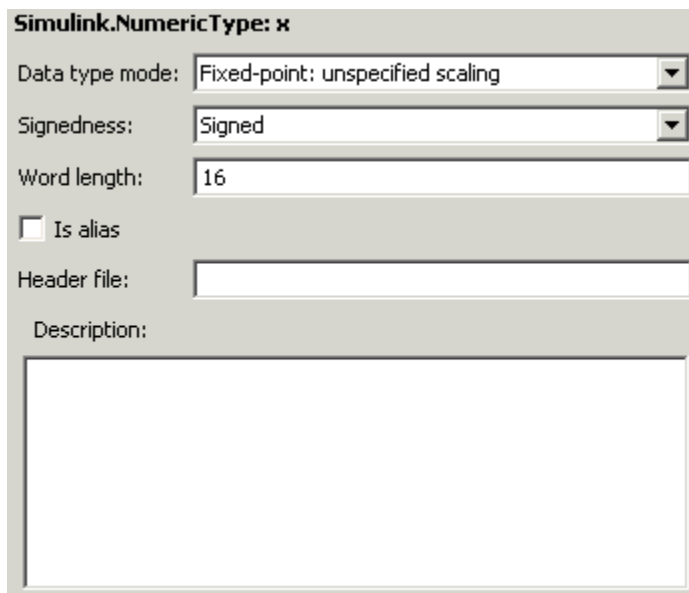
# Simulink.NumericType

---

the specified header file. If this field is empty, the generated code defines the numeric type itself.

## Description

Description of this data type. This field is intended for use in documenting this data type. Simulink software ignores it.



The image shows a configuration dialog box titled "Simulink.NumericType: x". It contains several fields for configuring a numeric type:

- Data type mode:** A dropdown menu currently set to "Fixed-point: unspecified scaling".
- Signedness:** A dropdown menu currently set to "Signed".
- Word length:** A text input field containing the value "16".
- Is alias:** An unchecked checkbox.
- Header file:** An empty text input field.
- Description:** A large empty text area for providing a description of the data type.

## Signedness

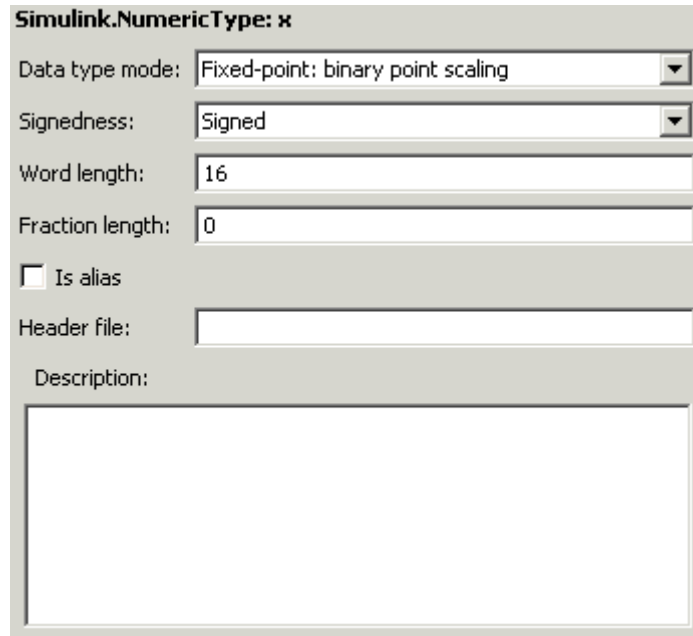
Specifies whether the data type is signed or unsigned, or inherits its signedness. Set the option to **Signed**, **Unsigned**, or **Auto**. This option is enabled only for fixed-point data type categories.

## 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.



The image shows a configuration dialog box for 'Simulink.NumericType: x'. It contains several fields and a checkbox:

- Data type mode:** A dropdown menu set to 'Fixed-point: binary point scaling'.
- Signedness:** A dropdown menu set to 'Signed'.
- Word length:** A text input field containing the value '16'.
- Fraction length:** A text input field containing the value '0'.
- Is alias:** An unchecked checkbox.
- Header file:** An empty text input field.
- Description:** A large empty text area.

## Slope

Slope for slope and bias scaling. This option is enabled only if the data type category is Fixed-point: slope and bias scaling.

# Simulink.NumericType

The screenshot shows the configuration dialog for Simulink.NumericType: x. It includes the following fields and options:

- Data type mode:** Fixed-point: slope and bias scaling (dropdown menu)
- Signedness:** Signed (dropdown menu)
- Word length:** 16 (text input)
- Slope:** 2^0 (text input)
- Bias:** 0 (text input)
- Is alias (checkbox)
- Header file:** (empty text input)
- Description:** (empty text area)

## Bias

Bias for slope and bias scaling. This option is enabled only if the data type category is Fixed-point: slope and bias scaling. See the preceding figure.

## 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) |



| 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 software to set the FractionLength and Slope properties accordingly, and vice versa. This property applies only if the data type category is Fixed-point: binary point scaling or Fixed-point: slope and bias scaling. It does not appear on the object's Property dialog box, but can be accessed from the MATLAB command prompt. |
| 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 software to set the FixedExponent property accordingly, and vice versa. This field is intended for use by the Simulink Fixed Point product. (Fraction length)                                                                                                                  |

# Simulink.NumericType

| Name       | Access | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|------------|--------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 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)                                                                                                                                                                                                                                                                                                                                                                                                                             |
| Signedness | RW     | Boolean that specifies whether this data type is signed, unsigned, or inherits its signedness. Valid values are 1 (signed), 0 (unsigned), or Auto (inherit signedness). (Signedness)                                                                                                                                                                                                                                                                                                                                                                                                     |
| Slope      | RW     | Slope for slope and bias scaling of fixed-point numbers. This property equals $\text{SlopeAdjustmentFactor} * 2^{\text{FixedExponent}}$ . If $\text{SlopeAdjustmentFactor}$ is 1.0, Simulink software displays the value of this field as $2^{\text{SlopeAdjustmentFactor}}$ . Otherwise, it displays it as a numeric value. Setting this property causes Simulink software to set the $\text{FixedExponent}$ and $\text{SlopeAdjustmentFactor}$ properties accordingly, and vice versa. This property appears only if $\text{Category}$ is Fixed-point: slope and bias scaling. (Slope) |

| Name                  | Access | Description                                                                                                                                                                                                                                                                                                                                                  |
|-----------------------|--------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| SlopeAdjustmentFactor | RW     | Slope for slope and bias scaling of fixed-point numbers. Setting this property causes Simulink software to adjust the Slope property accordingly, and vice versa. This property applies only if Category is Fixed-point: slope and bias scaling. It does not appear on the object's Property dialog box, but can be accessed from the MATLAB command prompt. |
| 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 value, value range, data type, and other properties of 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. You can create a `Simulink.Parameter` object in the base MATLAB workspace or a model workspace. However, to create the object in a model workspace, you must set the object's storage class to `Auto`.

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 products use information specified by `Simulink.Parameter` objects to determine whether the parameter is tunable (see “Changing the Values of Block Parameters During Simulation” in *Simulink User's Guide*).

The Simulink software performs range checking of parameter values. The software alerts you when the parameter object's value lies outside a range that corresponds to its specified minimum and maximum values and data type.

## Property Dialog Box

**Simulink.Parameter: Param**

Value:

Data type:

Dimensions:  Complexity:

Minimum:  Maximum:

Units:

Code generation options

Storage class:

Alias:

Description:

### 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                               |
|--------------------------|-------------------------------------------|
| <code>single(1.0)</code> | Specifies a single-precision value of 1.0 |

# Simulink.Parameter

---

| Expression                     | Description                                                                                                                |
|--------------------------------|----------------------------------------------------------------------------------------------------------------------------|
| <code>int8(2)</code>           | Specifies an 8-bit integer of value 2                                                                                      |
| <code>int32(3+2i)</code>       | Specifies a complex value whose real and imaginary parts are 32-bit integers                                               |
| <code>fi(2.3,true,16,3)</code> | 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 menu 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 that Simulink software supports (see “Data Types Supported by Simulink” ).
- A `Simulink.NumericType` object
- A `Simulink.AliasType` object

Click the **Show data type assistant** button  to display the **Data Type Assistant**, which helps you set the **Data type** parameter. (See “Using the Data Type Assistant” in *Simulink User's Guide*.)

---

**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 software ignores it.

## Dimensions

Dimensions of the parameter. Simulink software 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 software 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. Specify a value that evaluates to a scalar, real number with `double` data type. The Simulink software generates a warning if the parameter value is less than the minimum value or if the minimum value is outside the range of the parameter data type. When updating the diagram or starting a simulation, Simulink generates an error in these cases.

## Maximum

Maximum value that the parameter can have. Specify a value that evaluates to a scalar, real number with `double` data type. The Simulink software generates a warning if the parameter value is greater than the maximum value or if the maximum value is outside the range of the parameter data type. When updating the diagram or starting a simulation, Simulink generates an error in these cases.

# Simulink.Parameter

---

## Storage class

Storage class of this parameter. Simulink code generation products use this property to allocate memory for this parameter in generate code. See “Tunable Parameter Storage Classes” in *Real-Time Workshop User’s Guide* for more information.

## Alias

Alternate name for this parameter. Simulink software ignores this setting.

## Description

Description of this parameter. This field is intended for use in documenting this parameter. Simulink software ignores it.

## Properties

| Name        | Access | Description                                                                                                                                                                  |
|-------------|--------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Value       | RW     | Value of this parameter. (Value)                                                                                                                                             |
| RTWInfo     | RW     | Information used by Real-Time Workshop software for generating code for this parameter. The value of this property is an object of <code>Simulink.ParamRTWInfo</code> class. |
| Description | RW     | String that describes this parameter. This property is intended for user use. Simulink software itself does not use it. (Description)                                        |
| DataType    | RW     | String specifying the data type of this parameter. (Data type)                                                                                                               |
| 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)                                                                                                      |



| <b>Name</b> | <b>Access</b> | <b>Description</b>                                                                                       |
|-------------|---------------|----------------------------------------------------------------------------------------------------------|
| Complexity  | RO            | String specifying the numeric type of this parameter. Valid values are 'real' or 'complex'. (Complexity) |
| Dimensions  | RO            | Vector specifying the dimensions of this parameter. (Dimensions)                                         |

# Simulink.ParamRTWInfo

---

**Purpose** Specify information needed to generate code for parameter

**Description** Simulink software creates an instance of this class for each instance of a `Simulink.Parameter` object that it creates. Simulink software 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 `myparam`.

```
myparam.RTWInfo.StorageClass = 'ExportedGlobal';
```

**Property Dialog Box** Use the Code Generation Options section of 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 “Using 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 “Parameter Storage, Interfacing, and Tuning” in the Real-Time Workshop documentation for more information.                    |

## Purpose

Allow Level-2 M-file S-function and other M-file programs to get information about block while simulation is running

## Description

This class allows a Level-2 M-file S-function or other M program to obtain information about a block. Simulink software creates an instance of this class or a derived class for each block in a model. Simulink software 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 software. 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 the Simulink documentation for more information.

---

**Note** Simulink.RunTimeBlock objects do not support MATLAB sparse matrices. For example, the following line of code attempts to assign a sparse identity matrix to the run-time object’s output port data. This line of code in a Level-2 M-file S-function produces an error:

```
block.Outputport(1).Data = speye(10);
```

---

## Parent Class

None

## Derived Classes

Simulink.MSFcnRunTimeBlock

## Property Summary

| Name          | Description              |
|---------------|--------------------------|
| “BlockHandle” | Block’s handle.          |
| “CurrentTime” | Current simulation time. |

# Simulink.RunTimeBlock

---

| Name                 | Description                                                                |
|----------------------|----------------------------------------------------------------------------|
| "NumDworks"          | Number of discrete work vectors used by the block.                         |
| "NumOutputPorts"     | Number of block output ports.                                              |
| "NumContStates"      | Number of block's continuous states.                                       |
| "NumDworkDiscStates" | Number of block's discrete states                                          |
| "NumDialogPrms"      | Number of parameters that can be entered on S-function block's dialog box. |
| "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.                          |

| Name                    | Description                                          |
|-------------------------|------------------------------------------------------|
| “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.  |

## 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

---

NumDworkDiscStates

**Description**

Number of discrete states. In an M-file S-function, you need to use DWorks to set up discrete states.

**Access**

RW

**See Also**

ssGetNumDiscStates

---

NumDialogPrms

**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

---

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**

Block’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**

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

# Simulink.RunTimeBlock

---

---

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 Fixed-Point Toolbox software. 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

# Simulink.RunTimeBlock

---

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.BlockPreComp-OutputPortData` 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.BlockPreComp-OutputPortData`, `Simulink.BlockCompOutputPortData`

---

`RuntimePrm`

### Purpose

Get an S-function's run-time parameters.

### Syntax

```
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`

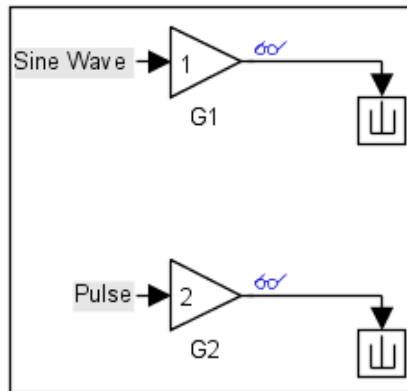
# Simulink.ScopeDataLogs

---

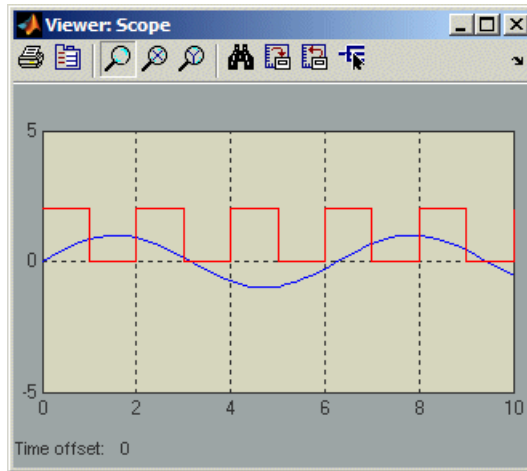
**Purpose** Store data logged by Scope signal viewer

**Description** Simulink software creates instances of this class to log data displayed on Scope viewers (see “Visualizing Simulation Results”). In particular, if you have enabled data logging for a model, Simulink software 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.

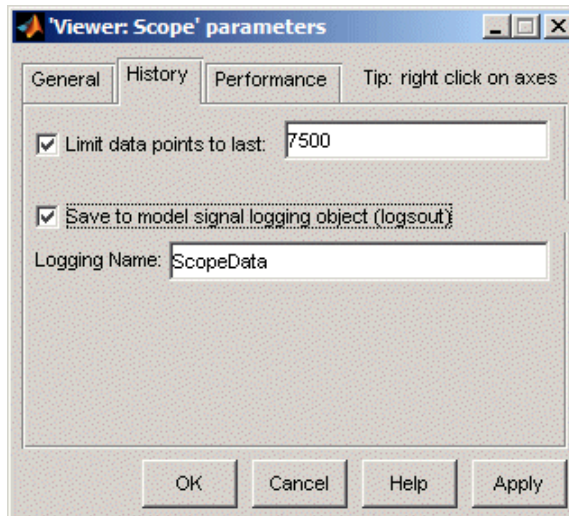
Consider, for example, the following model:



This model displays signals `out1` and `out2` on a scope viewer that has only one set of axes.



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 logout.



# Simulink.ScopeDataLogs

---

After simulation of the model, the MATLAB workspace contains a `Simulink.ModelDataLogs` object named `logouts` 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.,

```
>> logouts.ScopeData.axes1
```

```
ans =
```

```
Simulink.ScopeDataLogs (axes1):
```

| Name | Elements | Simulink Class |
|------|----------|----------------|
| out1 | 1        | Timeseries     |
| out2 | 1        | Timeseries     |

## See Also

“Importing and Exporting Data”, `Simulink.ModelDataLogs`, `Simulink.SubsysDataLogs`, `Simulink.Timeseries`, `Simulink.TsArray`, `who`, `whos`, `unpack`



**Purpose** Specify attributes of signal

**Description** This class enables you to create workspace objects that you can use to assign or validate the attributes of a signal or discrete state, such as its data type, numeric type, dimensions, and so on. You can create a `Simulink.Signal` object in the MATLAB workspace or in a model workspace. If you create the object in a model workspace, you must set the object's storage class to `Auto`.

Objects of this class allow you to assign or validate signal or discrete state attributes by giving the signal or discrete state the same name as the workspace variable that references the `Simulink.Signal` object. For brevity, the rest of section refers only to specifying and validating signal attributes. The same techniques work with discrete states also.

You can use a variety of techniques to associate a signal object with a signal. For examples, see “Using Signal Objects to Initialize Signals and Discrete States”, “Using Signal Objects to Tune Initial Values”, and “Applying CSCs to Parameters and Signals”.

### **Multiple Signal Objects**

A given signal object can be associated with more than one signal only if the storage class of the signal object is `Auto`. If the object's storage class is other than `Auto`, it can be associated with at most one signal.

A given signal can be associated with at most one signal object under any circumstances. The signal can refer to the object more than once, but every reference must resolve to exactly the same object. A different signal object that has exactly the same properties will not meet the requirement for uniqueness.

A compile-time error occurs if a model associates more than one signal object with any signal. To prevent the error, decide which object the signal will use, then delete or reconfigure all references to any other signal objects, so that all remaining references resolve to the chosen signal object. See “Displaying Signal Sources and Destinations” for a description of techniques that you can use to trace the full extent of a signal.

## Using Signal Objects to Assign Signal Attributes

You can use a signal object to assign values to signal attributes that are left unassigned (have a value of -1 or auto) by the signal source. To use a signal object to assign signal attribute values:

- Create a `Simulink.Signal` object that has the same name as the signal.
- Set the properties of the object that correspond to the attributes left unspecified by the signal source.
- Enable explicit or implicit signal resolution:
  - **Explicit resolution:** In the signal's Signal Properties dialog box, enable **Signal name must resolve to Simulink signal object**. This is the preferred technique. See “Explicit and Implicit Symbol Resolution” for more information.
  - **Implicit resolution:** Set the model's **Configuration Parameters > Diagnostics > Data Validity > Signal resolution** option to `Explicit` and `implicit` or `Explicit` and `warn implicit`. The MathWorks recommends using explicit resolution only.

The signal object then provides the value of each signal attribute to which the signal source assigns a value of -1 or auto. (The same object could also validate any attribute to which the signal source assigns a specific value, rather than -1 or auto, as described in “Using Signal Objects to Validate Signal Attributes” on page 7-147.)

## Using a Signal Specification Block

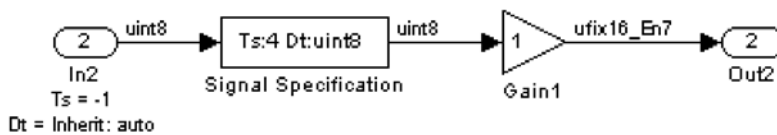
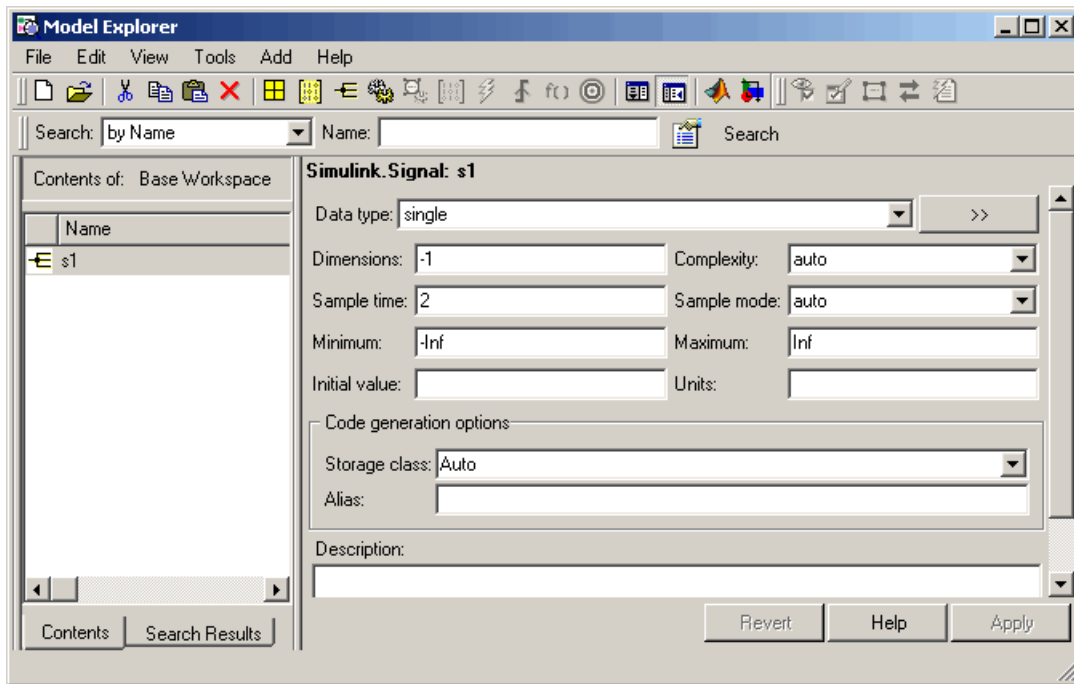
You can use a `Signal Specification` block rather than a `Simulink.Signal` object to assign properties left unspecified by a signal source. Each technique has advantages and disadvantages:

- Using a signal object simplifies the model and allows you to change signal property values without editing the model, but does not show signal property values directly in the block diagram.

- Using a Signal Specification block displays signal property values directly in the block diagram, but complicates the model and requires editing it to change signal property values.

The following model illustrates the respective advantages of the two ways of assigning attributes to a signal.

# Simulink.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, using 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 Validate Signal Attributes

You can use a signal object to validate signal attributes whose values are explicitly assigned by the signal source. Such attributes have values other than `-1` or `auto`. Successful validation guarantees that the signal has the attributes that you intended it to have. To use a signal object to validate signal attributes:

- Create a `Simulink.Signal` object that has the same name as the signal.
- Set properties of the object to the values that corresponding signal attributes must have.
- Enable explicit or implicit signal resolution:
  - **Explicit resolution:** In the signal's Signal Properties dialog box, enable **Signal name must resolve to Simulink signal object**. This is the preferred technique. See “Explicit and Implicit Symbol Resolution” for more information.
  - **Implicit resolution:** Set the model's **Configuration Parameters > Diagnostics > Data Validity > Signal resolution** option to `Explicit and implicit` or `Explicit and warn implicit`. The MathWorks recommends using explicit resolution only.

If the signal source assigns any value other than -1 or auto to a signal property, and the assigned value differs from the corresponding signal object value, the signal does not match the signal object and is therefore invalid. (The same object could also provide values for attributes that the signal source defines as -1 or auto, as described in “Using Signal Objects to Assign Signal Attributes” on page 7-144.)

The result when a signal does not match a signal object can depend on several factors. The Simulink engine can validate a signal property when you update the diagram, while you run a simulation, or both. When and how validation occurs can depend on internal rules that are subject to change, and sometimes on configuration parameter settings.


Not all signal validation compares signal source attributes with signal object properties. For example, if you specify Minimum and Maximum signal values using a signal object, the signal source must specify the same values as the signal object (or inherit the values from the object) but such validation relates only to agreement between the source and the object, not to enforcement of the Minimum and Maximum values during simulation.

If the value of **Configuration Parameters > Diagnostics > Data Validity > Simulation range checking** is none (the default) the Simulink engine does not enforce any signal’s Minimum and Maximum values during simulation, even though a signal object provided or validated them. To enforce Minimum and Maximum signal values during simulation, you must set **Simulation range checking** to warning or error. See “Checking Signal Ranges” and “Diagnostics Pane: Data Validity” for more information.

## Property Dialog Box

### Data type

Data type of the signal. The default entry, auto, specifies that Simulink software should determine the data type. Use the adjacent pulldown 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.

Click the **Show data type assistant** button  to display the **Data Type Assistant**, which helps you set the

**Data type** parameter. (See “Using the Data Type Assistant” in *Simulink User’s Guide*.)

## 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 M×N matrix signal.

## Complexity

Numeric type of the signal. Valid values are `auto` (determined by Simulink software), `real`, or `complex`.

## Sample time

Rate at which the value of this signal should be computed. See “How to Specify the Sample Time” in the Simulink documentation for information on how to specify the sample time.

## Sample mode

Sample mode of this signal. Simulink software ignores the setting of this field.

## Minimum

Minimum value that the signal should have. Specify a value that evaluates to a scalar, real number with `double` data type. Simulink software uses this value in the following ways:

- When updating the diagram or starting a simulation, Simulink generates an error if the signal’s initial value is less than the minimum value or if the minimum value is outside the range of the signal’s data type.
- When the **Simulation range checking** diagnostic is enabled, Simulink alerts you during simulation if the signal’s value is less than the minimum value (see “Simulation range checking”).

## Maximum

Maximum value that the signal should have. Specify a value that evaluates to a scalar, real number with `double` data type. Simulink software uses this value in the following ways:



- When updating the diagram or starting a simulation, Simulink generates an error if the signal's initial value is greater than the maximum value or if the maximum value is outside the range of the signal's data type.
- When the **Simulation range checking** diagnostic is enabled, Simulink alerts you during simulation if the signal's value is greater than the maximum value (see "Simulation range checking").

## 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';
```

If necessary, Simulink software 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. Also, Simulink performs range checking of the initial value. The software alerts you when the signal's initial value lies outside a range that corresponds to its specified minimum and maximum values and data type.

# Simulink.Signal

---

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

## 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 software ignores it.

## Storage class

Storage class of this signal. See “Tunable Parameter Storage Classes” in the Real-Time Workshop User’s Guide for more information.

## Alias

Alternate name for this signal. Simulink software ignores this setting. This property is used for code generation.

## Description

Description of this signal. This field is intended for use in documenting this signal. This property is used by the Simulink Report Generator and for code generation.

## Properties

| Name        | Access | Description                                                                                                                                                                |
|-------------|--------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| RTWInfo     | RW     | Information used by Real-Time Workshop software for generating code for this signal. The value of this property is an object of <code>Simulink.SignalRTWInfo</code> class. |
| Description | RW     | Description of this signal. This field is intended for use in documenting this signal. (Description)                                                                       |

| <b>Name</b>   | <b>Access</b> | <b>Description</b>                                                                                             |
|---------------|---------------|----------------------------------------------------------------------------------------------------------------|
| DataType      | RW            | String specifying the data type of this signal. (Data type)                                                    |
| Min           | RW            | Minimum value that this signal can have. (Minimum)                                                             |
| Max           | RW            | Maximum value that this signal can have. (Maximum)                                                             |
| DocUnits      | RW            | Measurement units in which this signal's value is expressed. (Units)                                           |
| 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) |
| SampleTime    | RW            | Rate at which this signal should be updated. (Sample time)                                                     |
| Sampling Mode | RW            | Sampling mode of this signal. (Sample mode)                                                                    |
| InitialValue  | RW            | Signal or state value before a simulation takes its first time step. (Initial Value)                           |

# Simulink.SignalRTWInfo

---

## Purpose

Specify information needed to generate code for signal

## Description

Simulink software creates an instance of this class for each instance of a `Simulink.Signal` object that it creates. Simulink software uses the `Simulink.SignalRTWInfo` object to store information needed to generate code for the signal specified by the `Simulink.Signal` object.

You can set the properties of an instance of this class via the `RTWInfo` property or the property dialog box of the `Simulink.Signal` object that uses it. For example, the following MATLAB expression sets the `StorageClass` property of a `Simulink.SignalRTWInfo` object used by a signal object name `mysignal`.

```
mysignal.RTWInfo.StorageClass = 'ExportedGlobal';
```

## Property Dialog Box

Use the Code Generation Options section of the `Simulink.Signal` property dialog box to set the `StorageClass` and `Alias` properties of objects of this class.

## Properties

| Name               | Description                                                                                                                                                     |
|--------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Alias              | Alternate name for this signal.                                                                                                                                 |
| CustomAttributes   | Custom storage class attributes of this signal. See “Using Custom Storage Classes” in the Real-Time Workshop Embedded Coder documentation for more information. |
| CustomStorageClass | Custom storage class of this signal.                                                                                                                            |
| StorageClass       | Storage class of this signal. See “Signal Storage, Optimization, and Interfacing” in the Real-Time Workshop documentation for more information.                 |

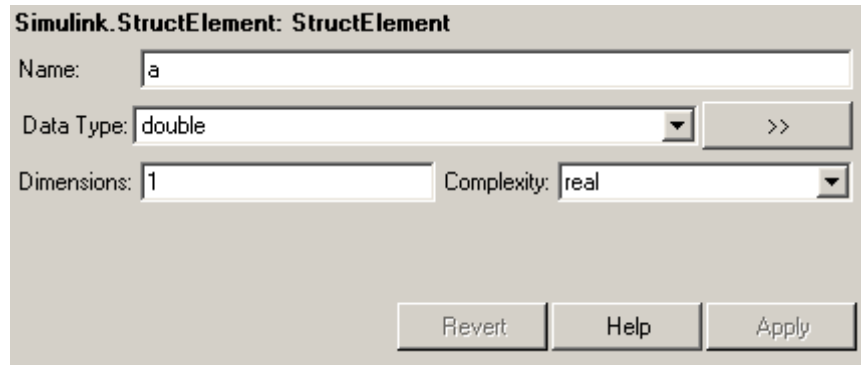
## Purpose

Describe element of data structure

## Description

Objects of this class describe elements of structures described by objects of the `Simulink.StructType` class.

## Property Dialog Box



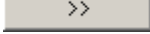
### Name

Specify a name for the element.

### Data type

Specify a data type for this element. You can either select a data type from the adjacent pulldown list or enter a string. If you enter a string, it must evaluate to one of the following:

- A built-in data type supported by Simulink software (see “Data Types Supported by Simulink”)
- A `Simulink.NumericType` object
- A `Simulink.AliasType` object

Click the **Show data type assistant** button  to display the **Data Type Assistant**, which helps you set the **Data type** parameter. (See “Using the Data Type Assistant” in *Simulink User’s Guide*.)

# Simulink.StructElement

---

## Dimensions

Specify a vector that represents the dimensions of the element.

## Complexity

Specify the numeric type (i.e., real or complex) of this element.

## Properties

| Name       | Access | Description                                                                                |
|------------|--------|--------------------------------------------------------------------------------------------|
| Name       | RW     | String specifying the name of this element. (Name)                                         |
| 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) |
| Dimensions | RW     | A vector specifying the dimensions of this element. (Dimensions)                           |

## See Also

Simulink.StructType

## Purpose

Describe data structure used as value of 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. You must create structure types in the MATLAB workspace. If you attempt to create a structure type in a model workspace, Simulink software displays an error.

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 `simstruc.h` header file for more information). You can connect signal structures

# Simulink.StructType

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

**Simulink.StructType: state**

Struct elements

| Name     | Dimension | Data/Bus Type | Complexity |
|----------|-----------|---------------|------------|
| velocity | 1         | single        | real       |
| roll     | 1         | double        | real       |
| pitch    | 1         | double        | real       |
| yaw      | 1         | double        | real       |

Header file:

Description:

### 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 software. Simulink software ignores it.

## Description

Description of this structure. This field is intended for you to use to document this structure. Simulink software itself does not use this field.

## Properties

| Name        | Access | Description                                                                                                                                                                                                  |
|-------------|--------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Elements    | RW     | An array of <code>Simulink.StructElement</code> 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 software 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

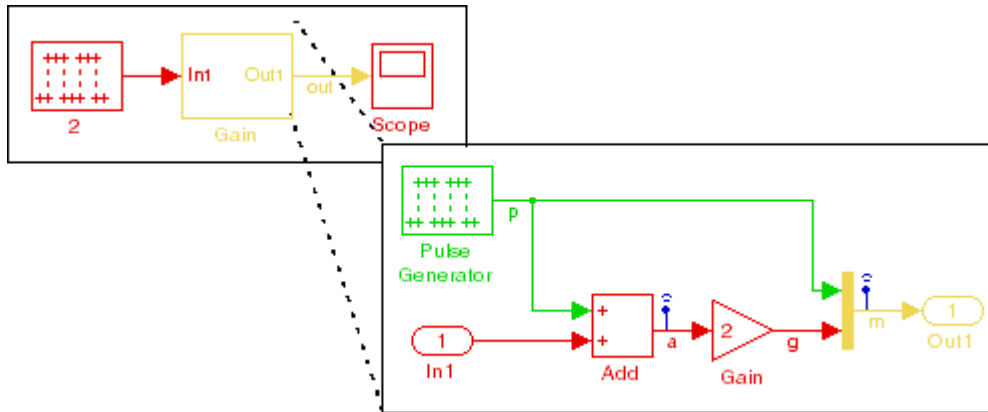
`Simulink.StructElement`

# Simulink.SubsysDataLogs

**Purpose** Container for subsystem's signal data logs

**Description** Simulink software creates instances of this class to contain logs for signals belonging to a subsystem (see “Logging Signals” in the Simulink documentation). 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 `logout`, that contains a `Simulink.SubsysDataLogs` object, named `Gain`, that contains the log data for signals `a` and `m` in the subsystem named `Gain`.

```
>> logout.Gain
```

```
ans =
```

```
Simulink.SubsysDataLogs (Gain):
```

```
    Name          Elements  Simulink Class
```

|   |   |            |
|---|---|------------|
| a | 1 | Timeseries |
| m | 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 = logout.Gain.a.Data;
```

or

```
>> logout.unpack('all');  
data = a.Data;
```

## See Also

“Importing and Exporting Data”, `Simulink.ModelDataLogs`, `Simulink.ScopeDataLogs`, `Simulink.Timeseries`, `Simulink.TsArray`, `who`, `whos`, `unpack`

# Simulink.TimeInfo

---

**Purpose** Provide information about time data in `Simulink.Timeseries` object

**Description** Simulink software 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 <code>Simulink.Timeseries</code> 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 <code>Simulink.Timeseries</code> 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 <code>Simulink.Timeseries</code> object. If the signal is in a conditionally executed subsystem, this field contains an array of times when the system became inactive. |

| Name      | Access | Description                                                                                                                                                                                                                                                                                                                                                               |
|-----------|--------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Increment | RW     | The interval between simulation times at which signal data is logged in the associated <code>Simulink.Timeseries</code> object. If the signal is aperiodic (continuous signal with variable-step solver), this property has a value of NaN. A signal is periodic if it has a discrete sample time (not continuous or constant) or is continuous with a fixed-step solver. |
| Length    | W      | The number of signal samples recorded in the associated <code>Simulink.Timeseries</code> object, i.e., the length of the arrays referenced by the object's <code>Time</code> and <code>Data</code> properties.                                                                                                                                                            |

## See Also

`Simulink.Timeseries`

# Simulink.Timeseries

---

**Purpose** Store data for any signal except mux or bus signal

**Description** Simulink software creates instances of this class to store signal data that it logs for any signal except a mux or bus signal, which are stored in a `Simulink.TsArray`. See “Logging Signals” for more information. The MATLAB Time Series Tools can import and manipulate instances of this class, as described in Using Time Series Tools in the MATLAB Data Analysis documentation.

## 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 mux or a virtual bus; otherwise, the same as <code>SignalName</code> . |
| TimeInfo   | RW     | An object of <code>Simulink.TimeInfo</code> 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

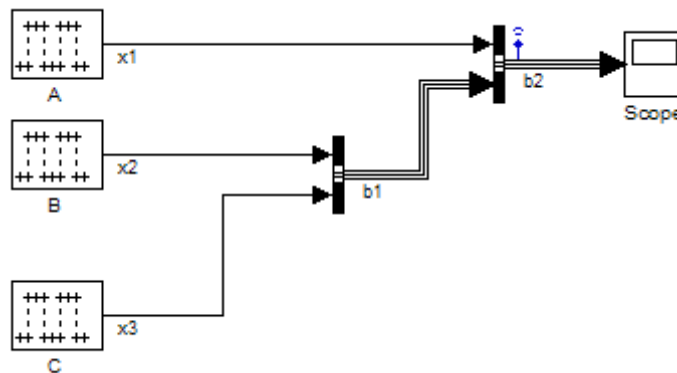
“Importing and Exporting Data”,  
`Simulink.TimeInfo``Simulink.ModelDataLogs`,  
`Simulink.SubsysDataLogs`, `Simulink.ScopeDataLogs`,  
`Simulink.TsArray`, `who`, `whos`, `unpack`

**Purpose** Store data for mux or bus signal

**Description** Simulink software creates instances of this class to contain the data that it logs for a mux or bus signal. Other types of signals are stored in a `Simulink.Timeseries`. See “Logging Signals” for more information.

Objects of the `Simulink.TsArray` class have a variable number of properties. The first property, called `Name`, specifies the log name of the logged signal. The remaining properties reference logs for the elements of the logged signal: `Simulink.Timeseries` objects for elementary signals and `Simulink.TsArray` objects for mux or bus signals. The name of each property is the log name of the corresponding signal.

For example, consider the following model.



This model specifies that Simulink software should log the values of the signal `b2` during simulation. After simulation of this model, the MATLAB workspace contains a `Simulink.ModelDataLogs` object, named `logouts`, 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., `logouts.b2`, at the MATLAB command line reveals the structure of the signal log for this model.

```
>> logouts.b2
```

# Simulink.TsArray

---

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 = logout.b2.x1.Data;
```

or

```
>> logout.unpack('all');  
data = x1.Data;
```

## See Also

“Importing and Exporting Data”, `aSimulink.ModelDataLogs`, `Simulink.SubsysDataLogs`, `Simulink.ScopeDataLogs`, `Simulink.Timeseries`, `who`, `whos`, `unpack`



# Model and Block Parameters

---

- “Model Parameters” on page 8-2
- “Common Block Parameters” on page 8-83
- “Block-Specific Parameters” on page 8-96
- “Mask Parameters” on page 8-218

## Model Parameters

### In this section...

“About Model Parameters” on page 8-2

“Examples of Setting Model Parameters” on page 8-82

### About Model Parameters

The following sections list parameters that you can set for Simulink models and blocks, using the `set_param` command.

This table lists and describes, in alphabetical order, parameters that describe a model. The table also includes model callback parameters (see “Using Callback Functions” in the Simulink User’s Guide). The **Description** column indicates where you can set the value on a dialog box. For examples, see “Examples of Setting Model Parameters” on page 8-82.

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 in Alphabetical Order

| Parameter | Description                                                                                                                                                                                                    | Values            |
|-----------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|
| AbsTol    | Specify the largest acceptable solver error, as the value of the measured state approaches zero.<br><br>Set by <b>Absolute tolerance</b> on the <b>Solver</b> pane of the Configuration Parameters dialog box. | string — {'auto'} |

### Model Parameters in Alphabetical Order (Continued)

| Parameter           | Description                                                                                                                                                                                                                                                                         | Values                                  |
|---------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------|
| AccelVerboseBuild   | <p>Controls the verbosity level during code generation for Simulink Accelerator mode, model reference Accelerator mode, and Rapid Accelerator mode.</p> <p>Set by <b>Verbose accelerator builds</b> on the <b>Optimization</b> pane of the Configuration Parameters dialog box.</p> | string — {'off'}   'on'                 |
| AlgebraicLoopMsg    | <p>Specifies diagnostic action to take when there is an algebraic loop.</p> <p>Set by <b>Algebraic loop</b> on the <b>Solver Diagnostics</b> pane of the Configuration Parameters dialog box.</p>                                                                                   | string — 'none'   {'warning'}   'error' |
| ArrayBoundsChecking | <p>Select the diagnostic action to take when blocks write data to locations outside the memory allocated to them.</p> <p>Set by <b>Array bounds exceeded</b> on the <b>Data Validity Diagnostics</b> pane of the Configuration Parameters dialog box.</p>                           | string — {'none'}   'warning'   'error' |

### Model Parameters in Alphabetical Order (Continued)

| Parameter                   | Description                                                                                                                                                                                                                                                                                                  | Values                                                     |
|-----------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------|
| ArtificialAlgebraic-LoopMsg | <p>Specifies diagnostic action to take if algebraic loop minimization cannot be performed for a subsystem because an input port of that subsystem has direct feedthrough.</p> <p>Set by <b>Minimize algebraic loop</b> on the <b>Solver Diagnostics</b> pane of the Configuration Parameters dialog box.</p> | string — 'none'   {'warning'}   'error'                    |
| AssertControl               | <p>Enable model verification blocks in the current model either globally or locally.</p> <p>Set by <b>Model Verification block enabling</b> on the <b>Data Validity Diagnostics</b> pane of the Configuration Parameters dialog box.</p>                                                                     | string — {'UseLocalSettings'}   'EnableAll'   'DisableAll' |
| AutoInsertRateTranBlk       | <p>Specify whether Simulink software inserts hidden Rate Transition blocks between blocks that have different sample rates.</p> <p>Set by <b>Automatically handle rate transition for data transfer</b> on the <b>Solver</b> pane of the Configuration Parameters dialog box.</p>                            | string — 'on'   {'off'}                                    |

**Model Parameters in Alphabetical Order (Continued)**

| <b>Parameter</b>               | <b>Description</b>                                                                                                                                                                                                                      | <b>Values</b>                  |
|--------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------|
| BlockDescription-StringDataTip | Specifies whether to display the user description string for a block as a data tip.<br><br>Set by <b>User Description String</b> on the <b>View &gt; Block Data Tips Options</b> menu of the Model Editor.                              | string — 'on'   {'off'}        |
| BlockNameDataTip               | Specifies whether to display the block name as a data tip. Set by <b>Block Name</b> on the <b>View &gt; Block Data Tips Options</b> menu of the Model Editor.                                                                           | string — 'on'   {'off'}        |
| BlockParametersDataTip         | Specifies whether to display a block parameter in a data tip.<br><br>Set by <b>Parameter Names and Values</b> on the <b>View &gt; Block Data Tips Options</b> menu of the Model Editor.                                                 | string — 'on'   {'off'}        |
| BlockPriorityViolationMsg      | Select the diagnostic action to take if Simulink software detects a block priority specification error.<br><br>Set by <b>Block priority violation</b> on the <b>Solver Diagnostics</b> pane of the Configuration Parameters dialog box. | string — {'warning'}   'error' |

### Model Parameters in Alphabetical Order (Continued)

| Parameter               | Description                                                                                                                                                                       | Values                  |
|-------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------|
| BlockReduction          | <p>Enables block reduction optimization.</p> <p>Set by <b>Block reduction</b> on the <b>Optimization</b> pane of the Configuration Parameters dialog box.</p>                     | string — {'on'}   'off' |
| BlockReductionOpt       | See BlockReduction parameter for more information.                                                                                                                                |                         |
| BooleanDataType         | <p>Enable Boolean mode.</p> <p>Set by <b>Implement logic signals as boolean data (vs. double)</b> on the <b>Optimization</b> pane of the Configuration Parameters dialog box.</p> | string — {'on'}   'off' |
| BrowserLookUnderMasks   | <p>Show masked subsystems in the Model Browser.</p> <p>Set by <b>Show Masked Subsystems</b> on the <b>View &gt; Model Browser Options</b> menu of the Model Editor.</p>           | string — 'on'   {'off'} |
| BrowserShowLibraryLinks | <p>Show library links in the Model Browser.</p> <p>Set by <b>Show Library Links</b> on the <b>View &gt; Model Browser Options</b> menu of the Model Editor.</p>                   | string — 'on'   {'off'} |
| BufferReusableBoundary  | For internal use.                                                                                                                                                                 |                         |

## Model Parameters in Alphabetical Order (Continued)

| Parameter                               | Description                                                                                                                                                                                                                                                                                         | Values                                  |
|-----------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------|
| BufferReuse                             | <p>Enable reuse of block I/O buffers.</p> <p>Set by <b>Reuse block outputs</b> on the <b>Optimization</b> pane of the Configuration Parameters dialog box.</p>                                                                                                                                      | string — {'on'}   'off'                 |
| BusObjectLabelMismatch                  | <p>Select the diagnostic action to take if the name of a bus element does not match the name specified by the corresponding bus object.</p> <p>Set by <b>Element name mismatch</b> on the <b>Connectivity Diagnostics</b> pane of the Configuration Parameters dialog box.</p>                      | string — 'none'   {'warning'}   'error' |
| CheckExecutionContext-PreStartOutputMsg | <p>Specify whether to display a warning if Simulink software detects potential initial output differences from previous releases.</p> <p>Set by <b>Check preactivation output of execution context</b> on the <b>Data Validity Diagnostics</b> pane of the Configuration Parameters dialog box.</p> | string — 'on'   {'off'}                 |

### Model Parameters in Alphabetical Order (Continued)

| Parameter                                  | Description                                                                                                                                                                                                                                                                                    | Values                                  |
|--------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------|
| CheckExecutionContext-<br>RuntimeOutputMsg | Specify whether to display a warning if Simulink software detects potential output differences from previous releases.<br><br>Set by <b>Check runtime output of execution context</b> on the <b>Data Validity Diagnostics</b> pane of the Configuration Parameters dialog box.                 | string — 'on'   {'off'}                 |
| CheckForMatrixSingularity                  | See <b>CheckMatrixSingularityMsg</b> parameter for more information.                                                                                                                                                                                                                           |                                         |
| CheckMatrixSingularityMsg                  | Select the diagnostic action to take if the Product block detects a singular matrix while inverting one of its inputs in matrix multiplication mode.<br><br>Set by <b>Division by singular matrix</b> on the <b>Data Validity Diagnostics</b> pane of the Configuration Parameters dialog box. | string — {'none'}   'warning'   'error' |



## Model Parameters in Alphabetical Order (Continued)

| Parameter                         | Description                                                                                                                                                                                                                                                                                | Values                                  |
|-----------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------|
| CheckModelReference-TargetMessage | <p>Select the diagnostic action to take if Simulink software detects a target that needs to be rebuilt.</p> <p>Set by <b>Never rebuild targets diagnostic</b> on the <b>Model Referencing</b> pane of the Configuration Parameters dialog box.</p>                                         | string — 'none'   'warning'   {'error'} |
| CheckSSInitialOutputMsg           | <p>Enable checking for undefined initial subsystem output.</p> <p>Set by <b>Check undefined subsystem initial output</b> on the <b>Data Validity Diagnostics</b> pane of the Configuration Parameters dialog box.</p>                                                                      | string — {'on'}   'off'                 |
| CloseFcn                          | <p>Set the close callback function, which can be a command or a variable.</p> <p>Set by <b>Model close function</b> on the <b>Callbacks</b> pane of the Model Properties dialog box.</p> <p>See “Creating Model Callback Functions” in the Simulink User’s Guide for more information.</p> | string — {''}                           |

### Model Parameters in Alphabetical Order (Continued)

| Parameter                   | Description                                                                                                                                                                                                                                                                            | Values                                  |
|-----------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------|
| ConditionallyExecute-Inputs | Enable conditional input branch execution optimization.<br><br>Set by <b>Conditional input branch execution</b> on the <b>Optimization</b> pane of the Configuration Parameters dialog box.                                                                                            | string — {'on'}   'off'                 |
| ConfigurationManager        | Configuration manager for this model.                                                                                                                                                                                                                                                  | string — {'None'}                       |
| ConsecutiveZCsStepRelTol    | Relative tolerance associated with the time difference between zero-crossing events.<br><br>Set by <b>Time tolerance</b> on the <b>Solver</b> pane of the Configuration Parameters dialog box.                                                                                         | string — {'10*128*eps'}                 |
| ConsistencyChecking         | Select the diagnostic action to take if S-functions have continuous sample times, but do not produce consistent results when executed multiple times.<br><br>Set by <b>Solver data inconsistency</b> on the <b>Solver Diagnostics</b> pane of the Configuration Parameters dialog box. | string — {'none'}   'warning'   'error' |

## Model Parameters in Alphabetical Order (Continued)

| Parameter           | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Values                  |
|---------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------|
| CovCompData         | <p>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.</p> <p>Set by <b>Additional data to include in report (cvdata objects)</b> on the <b>Report</b> pane of the Coverage Settings dialog box.</p>                                                                                                                                                                                                                                                                                             | string — { '' }         |
| CovCumulativeReport | <p>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.</p> <p>If set to on, the Simulink Verification and Validation software displays the coverage results from successive simulations in the report.</p> <p>If set to off, the Simulink Verification and Validation software displays the coverage results for the last simulation in the report.</p> <p>Set by the radial buttons <b>Cumulative runs (on) / Last run (off)</b> on the <b>Report</b> pane of the Coverage Settings dialog box.</p> | string — 'on'   {'off'} |

### Model Parameters in Alphabetical Order (Continued)

| Parameter            | Description                                                                                                                                                                                                                                                                                                                                                                                           | Values                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|----------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| CovCumulativeVarName | <p>If CovSaveCumulativeToWorkspaceVar is set to on, the Simulink Verification and Validation software saves the results of successive simulations in the workspace variable specified by this property.</p> <p>Set by <b>cvdata object name</b> below the selected <b>Save cumulative results in workspace variable</b> check box on the <b>Results</b> pane of the Coverage Settings dialog box.</p> | <p>string —<br/>{ 'covCumulativeData' }</p>                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| CovHTMLOptions       | <p>If CovHTMLReporting is set to on, use this parameter to select from a set of display options for the resulting model coverage report.</p> <p>On the <b>Report</b> pane of the Coverage Settings dialog box, select <b>Settings</b> to open a dialog box for selecting these options.</p>                                                                                                           | <p>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):</p> <ul style="list-style-type: none"> <li>• ' -aTS=1 ' <p>Include each test in the model summary</p> </li> <li>• ' -bRG=1 ' <p>Produce bar graphs in the model summary</p> </li> <li>• ' -bTC=0 ' <p>Use two color bar graphs (red, blue)</p> </li> <li>• ' -hTR=0 ' </li> </ul> |

## Model Parameters in Alphabetical Order (Continued)

| Parameter        | Description                                                                                                                                                                                                                                                                                    | Values                                                                                                                                                                                                                                                                                                                                                                                                            |
|------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                  |                                                                                                                                                                                                                                                                                                | <p>Display hit/count ratio in the model summary</p> <ul style="list-style-type: none"> <li>• '-nFC=0'</li> </ul> <p>Do not report fully covered model objects</p> <ul style="list-style-type: none"> <li>• '-scm=1'</li> </ul> <p>Include cyclomatic complexity numbers in summary</p> <ul style="list-style-type: none"> <li>• '-bcm=1'</li> </ul> <p>Include cyclomatic complexity numbers in block details</p> |
| CovHTMLReporting | <p>Set to on to tell the Simulink Verification and Validation software to create an HTML report containing the coverage data in the MATLAB Help browser at the end of simulation.</p> <p>Set by <b>Generate HTML report</b> on the <b>Report</b> pane of the Coverage Settings dialog box.</p> | string — {'on'}   'off'                                                                                                                                                                                                                                                                                                                                                                                           |

**Model Parameters in Alphabetical Order (Continued)**

| Parameter         | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Values                                                                                                                                                                                                                                                                                                                                                                                                 |
|-------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| CovMetricSettings | <p>Selects coverage metrics for a coverage report.</p> <p>Coverage metrics are enabled by selecting the check boxes for individual coverages in the <b>Coverage metrics</b> section of the <b>Coverage</b> pane of the Coverage Settings dialog box.</p> <p>Options 's' and 'w' are enabled by selecting <b>Treat Simulink Logic blocks as short-circuited</b> and <b>Warn when unsupported blocks exist in model</b>, respectively, on the <b>Options</b> pane of the Coverage Settings dialog box.</p> <p>Option 'e' is disabled by selecting <b>Display coverage results using model coloring</b> on the <b>Results</b> pane of the Coverage Settings dialog box.</p> | <p>string — {'dw'}</p> <p>Each order-independent character in the string enables a coverage metric or option as follows:</p> <ul style="list-style-type: none"> <li>• 'd'<br/>Enable decision coverage</li> <li>• 'c'<br/>Enable condition coverage</li> <li>• 'm'<br/>Enable MCDC coverage</li> <li>• 't'<br/>Enable lookup table coverage</li> <li>• 'r'<br/>Enable signal range coverage</li> </ul> |
|                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | <ul style="list-style-type: none"> <li>• 's'<br/>Treat Simulink logic blocks as short-circuited</li> <li>• 'w'<br/>Warn when unsupported blocks exist in model</li> <li>• 'e'<br/>Eliminate model coloring for coverage results</li> </ul>                                                                                                                                                             |

## Model Parameters in Alphabetical Order (Continued)

| Parameter           | Description                                                                                                                                                                                                                                                                                                                                                         | Values                                       |
|---------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------|
| CovModelRefEnable   | <p>If CovModelRefEnable is set to on or all, the Simulink Verification and Validation software generates coverage data for the entire model.</p> <p>Set by <b>Coverage for referenced models</b> on the <b>Coverage</b> pane of the Coverage Settings dialog box.</p>                                                                                               | string — 'on'   {'off'}   'all'   'filtered' |
| CovModelRefExcluded | <p>If CovModelRefEnable is set to filtered, this parameter stores a comma-separated list of referenced models for which coverage is disabled.</p> <p>Set by selecting <b>Coverage for referenced models</b> on the <b>Coverage</b> pane of the Coverage Settings dialog box and then clicking <b>Select Models</b>.</p>                                             | string — {''}                                |
| CovNameIncrementing | <p>If CovSaveSingleToWorkspaceVar is set to on, setting CovNameIncrementing to on causes the Simulink Verification and Validation software to append numerals to the workspace variable names for results so that earlier results are not overwritten (for example, covdata1, covdata2, etc.)</p> <p>Set by <b>Increment variable name with each simulation</b></p> | string — 'on'   {'off'}                      |

### Model Parameters in Alphabetical Order (Continued)

| Parameter        | Description                                                                                                                                                                                                                                                                                                             | Values                    |
|------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------|
|                  | below the selected <b>Save last run in workspace variable</b> check box on the <b>Results</b> pane of the Coverage Settings dialog box.                                                                                                                                                                                 |                           |
| CovPath          | <p>Model path of the subsystem for which the Simulink Verification and Validation software gathers and reports coverage data.</p> <p>Set by selecting <b>Coverage for this model: &lt;model name&gt;</b> on the <b>Coverage</b> pane of the Coverage Settings dialog box and then clicking <b>Select Subsystem</b>.</p> | string — { '/' }          |
| CovReportOnPause | <p>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.</p> <p>Set by <b>Update results on pause</b> on the <b>Results</b> pane of the Coverage Settings dialog box.</p>                                     | string — { 'on' }   'off' |



### Model Parameters in Alphabetical Order (Continued)

| Parameter                        | Description                                                                                                                                                                                                                                                                                                                                                                              | Values                  |
|----------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------|
| CovSaveCumulativeTo-WorkspaceVar | <p>If set to on, the Simulink Verification and Validation software accumulates and saves the results of successive simulations in the workspace variable specified by CovCumulativeVarName.</p> <p>Set by <b>Save cumulative results in workspace variable</b> on the <b>Results</b> pane of the Coverage Settings dialog box.</p>                                                       | string — {'on'}   'off' |
| CovSaveName                      | <p>If CovSaveSingleToWorkspaceVar is set to on, the Simulink Verification and Validation software saves the results of the last simulation run in the workspace variable specified by this property.</p> <p>Set by <b>cvdata object name</b> below the selected <b>Save last run in workspace variable</b> check box on the <b>Results</b> pane of the Coverage Settings dialog box.</p> | string — {'covdata'}    |

**Model Parameters in Alphabetical Order (Continued)**

| <b>Parameter</b>             | <b>Description</b>                                                                                                                                                                                                                                                                               | <b>Values</b>           |
|------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------|
| CovSaveSingleTo-WorkspaceVar | <p>If set to on, the Simulink Verification and Validation software saves the results of the last simulation run in the workspace variable specified by CovSaveName.</p> <p>Set by <b>Save last run in workspace variable</b> on the <b>Results</b> pane of the Coverage Settings dialog box.</p> | string — {'on'}   'off' |
| Created                      | <p>Date and time model was created.</p> <p>Set by <b>Created on</b> on the <b>History</b> pane of the Model Properties dialog box.</p> <p>See “Model History Controls” in the Simulink User’s Guide for more information.</p>                                                                    | string                  |
| Creator                      | <p>Name of model creator.</p> <p>Set by <b>Created by</b> on the <b>History</b> pane of the Model Properties dialog box.</p> <p>See “Model History Controls” in the Simulink User’s Guide for more information.</p>                                                                              | string                  |
| CurrentBlock                 | For internal use.                                                                                                                                                                                                                                                                                |                         |
| CurrentOutputPort            | For internal use.                                                                                                                                                                                                                                                                                |                         |

## Model Parameters in Alphabetical Order (Continued)

| Parameter        | Description                                                                                                                                                                                                          | Values                                                                                                        |
|------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------|
| DataTypeOverride | Specifies data type used to override fixed-point data types.<br>Set by <b>Data type override</b> on the Fixed-Point Tool.                                                                                            | string —<br>{ 'UseLocalSettings'  <br>'ScaledDoubles'  <br>'TrueDoubles'  <br>'TrueSingles'  <br>'ForceOff' } |
| Decimation       | Specify that Simulink software output only every N points, where N is the specified decimation factor.<br>Set by <b>Decimation</b> on the <b>Data Import/Export</b> pane of the Configuration Parameters dialog box. | string — {'1'}                                                                                                |
| DeleteChildFcn   | Delete child callback function.<br>Created on the <b>Callbacks</b> pane of the Block Properties dialog box.<br>See “Creating Block Callback Functions” in the Simulink User’s Guide for more information.            | string — {''}                                                                                                 |
| Description      | Description of this model.<br>Set by <b>Model description</b> on the <b>Description</b> pane of the Model Properties dialog box.                                                                                     | string — {''}                                                                                                 |
| Dirty            | If the parameter is on, the model has unsaved changes.                                                                                                                                                               | string — 'on'   {'off'}                                                                                       |

### Model Parameters in Alphabetical Order (Continued)

| Parameter                       | Description                                                                                                                                                                                                                            | Values                                  |
|---------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------|
| DiscreteInherit-ContinuousMsg   | Specifies diagnostic action to take when a Unit Delay block inherits a continuous sample time.<br><br>Set by <b>Discrete used as continuous</b> on the <b>Sample Time Diagnostics</b> pane of the Configuration Parameters dialog box. | string — 'none'   {'warning'}   'error' |
| DisplayBdSearchResults          | For internal use.                                                                                                                                                                                                                      |                                         |
| DisplayBlockIO                  | For internal use.                                                                                                                                                                                                                      |                                         |
| DisplayCallgraph-Dominators     | For internal use.                                                                                                                                                                                                                      |                                         |
| DisplayCompileStats             | For internal use.                                                                                                                                                                                                                      |                                         |
| DisplayCondInputTree            | For internal use.                                                                                                                                                                                                                      |                                         |
| DisplayCondStIdTree             | For internal use.                                                                                                                                                                                                                      |                                         |
| DisplayErrorDirections          | For internal use.                                                                                                                                                                                                                      |                                         |
| DisplayInvisibleSources         | For internal use.                                                                                                                                                                                                                      |                                         |
| DisplaySortedLists              | For internal use.                                                                                                                                                                                                                      |                                         |
| DisplayVectorAnd-FunctionCounts | For internal use.                                                                                                                                                                                                                      |                                         |
| DisplayVect-PropagationResults  | For internal use.                                                                                                                                                                                                                      |                                         |
| Echo                            | For internal use.                                                                                                                                                                                                                      |                                         |
| EnableOverflowDetection         | For internal use.                                                                                                                                                                                                                      |                                         |

## Model Parameters in Alphabetical Order (Continued)

| Parameter            | Description                                                                                                                                                                                                                         | Values                      |
|----------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------|
| ExecutionContextIcon | <p>Toggles display of execution context icons on this model's block diagram.</p> <p>Set by <b>Execution Context Indicator</b> on the <b>Format &gt; Block Displays</b> menu of the Model Editor.</p>                                | string — 'on'   {'off'}     |
| ExpressionFolding    | <p>Enables expression folding.</p> <p>Set by <b>Eliminate superfluous local variables (Expression folding)</b> on the <b>Optimization</b> pane of the Configuration Parameters dialog box.</p>                                      | string — {'on'}   'off'     |
| ExternalInput        | <p>Names of MATLAB workspace variables used to designate data and times to be loaded from the workspace.</p> <p>Set by the <b>Input</b> field on the <b>Data Import/Export</b> pane of the Configuration Parameters dialog box.</p> | scalar or vector — {'t, u'} |
| ExtMode...           | <p>Parameters whose names start with ExtMode apply to Simulink External Mode.</p> <p>See External Mode in the Real-Time Workshop User's Guide for more information.</p>                                                             |                             |

### Model Parameters in Alphabetical Order (Continued)

| Parameter                   | Description                                                                                                                                                                                                                                                                                                                             | Values                                                         |
|-----------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------|
| ExtrapolationOrder          | <p>Extrapolation order of the ode14x implicit fixed-step solver.</p> <p>Set by <b>Extrapolation order</b> on the <b>Solver</b> pane of the Configuration Parameters dialog box.</p>                                                                                                                                                     | integer — 1   2   3   {4}                                      |
| FcnCallInpInside-ContextMsg | <p>Specifies diagnostic action to take when Simulink software must compute any function-call subsystem inputs directly or indirectly during execution of a call to a function-call subsystem.</p> <p>Set by <b>Context-dependent inputs</b> on the <b>Connectivity Diagnostics</b> pane of the Configuration Parameters dialog box.</p> | string — {'Use local settings'}   'Enable All'   'Disable All' |
| FileName                    | For internal use.                                                                                                                                                                                                                                                                                                                       |                                                                |
| FinalStateName              | <p>Names of final states to save to the workspace after a simulation ends.</p> <p>Set by the <b>Final states</b> field on the <b>Data Import/Export</b> pane of the Configuration Parameters dialog box.</p>                                                                                                                            | string — {'xFinal'}                                            |

## Model Parameters in Alphabetical Order (Continued)

| Parameter                             | Description                                                                                                                                       | Values                                                                     |
|---------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------|
| FixedStep                             | Fixed-step size.<br>Set by <b>Fixed step size (fundamental sample time)</b> on the <b>Solver</b> pane of the Configuration Parameters dialog box. | string — {'auto'}                                                          |
| FixPtInfo                             | For internal use.                                                                                                                                 |                                                                            |
| FollowLinksWhen-OpeningFromGotoBlocks | Specifies whether to search for Goto tags in libraries referenced by the model when opening the From block dialog box.                            | string — 'on'   {'off'}                                                    |
| ForceArrayBoundsChecking              | For internal use.                                                                                                                                 |                                                                            |
| ForceConsistencyChecking              | For internal use.                                                                                                                                 |                                                                            |
| ForceModelCoverage                    | For internal use.                                                                                                                                 |                                                                            |
| ForwardingTable                       | Specifies the forwarding table for this library.<br>See “Forwarding Tables” in the Simulink User’s Guide for more information.                    | string — {'old_path_1', 'new_path_1'} ...<br>{'old_path_n', 'new_path_n'}} |
| ForwardingTableString                 | For internal use.                                                                                                                                 |                                                                            |
| GridSpacing                           | Spacing of the Model Editor grid in pixels.                                                                                                       | integer — {20}                                                             |
| Handle                                | Handle of the block diagram for this model.                                                                                                       | double                                                                     |
| HiliteAncestors                       | For internal use.                                                                                                                                 |                                                                            |

### Model Parameters in Alphabetical Order (Continued)

| Parameter                      | Description                                                                                                                                                                                                                                                                                     | Values                                  |
|--------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------|
| HiliteFcnCallInp-InsideContext | Enables highlighting of Function-Call Subsystem blocks when one or more inputs depend on source blocks that appear in their own calling context.                                                                                                                                                | string — 'on'   {'off'}                 |
| IgnoreBidirectionalLines       | For internal use.                                                                                                                                                                                                                                                                               |                                         |
| InheritedTsInSrcMsg            | Message behavior when the sample time is inherited.<br><br>Set by <b>Source block specifies -1 sample time</b> on the <b>Sample Time Diagnostics</b> pane of the Configuration Parameters dialog box.                                                                                           | string — 'none'   {'warning'}   'error' |
| InitFcn                        | Function that is called when this model is first compiled for simulation.<br><br>Set by <b>Model initialization function</b> on the <b>Callbacks</b> pane of the Model Properties dialog box.<br><br>See “Creating Model Callback Functions” in the Simulink User’s Guide for more information. | string — {''}                           |
| InitialState                   | Initial state name or values.<br><br>Set by the <b>Initial state</b> field on the <b>Data Import/Export</b> pane of the Configuration Parameters dialog box.                                                                                                                                    | variable or vector — {'xInitial'}       |



## Model Parameters in Alphabetical Order (Continued)

| Parameter         | Description                                                                                                                                                                                                                                                                               | Values                                                              |
|-------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------|
| InitialStep       | Initial step size.<br><br>Set by <b>Initial step size</b> on the <b>Solver</b> pane of the Configuration Parameters dialog box.                                                                                                                                                           | string — {'auto'}                                                   |
| InlineParams      | Enable inline of parameters in generated code.<br><br>Set by <b>Inline parameters</b> on the <b>Optimization</b> pane of the Configuration Parameters dialog box.                                                                                                                         | string — 'on'   {'off'}                                             |
| InsertRTBMode     | Control whether the Rate Transition block parameter <b>Ensure deterministic data transfer (maximum delay)</b> is set for auto-inserted Rate Transition blocks.<br><br>Set by <b>Deterministic data transfer</b> on the <b>Solver</b> pane of the Configuration Parameters dialog box.     | string — 'Always'   {'Whenever possible'}   'Never (minimum delay)' |
| InspectSignalLogs | Enable Simulink software to display logged signals in the MATLAB <b>Time Series Tools</b> viewer at the end of a simulation or whenever you pause the simulation.<br><br>Set by <b>Inspect signal logs when simulation is paused/stopped</b> on the <b>Data Import/Export</b> pane of the | string — 'on'   {'off'}                                             |

**Model Parameters in Alphabetical Order (Continued)**

| Parameter             | Description                                                                                                                                                                                                                                                  | Values                                  |
|-----------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------|
|                       | Configuration Parameters dialog box.                                                                                                                                                                                                                         |                                         |
| Int32ToFloatConvMsg   | Specify message behavior when a 32-bit integer is converted to a single-precision float.<br><br>Set by <b>32-bit integer to single precision float conversion</b> on the <b>Type Conversion Diagnostics</b> pane of the Configuration Parameters dialog box. | string — 'none'   {'warning'}           |
| IntegerOverflowMsg    | Specify message behavior when an integer overflow occurs.<br><br>Set by <b>Detect overflow</b> in the <b>Signals</b> section on the <b>Data Validity Diagnostics</b> pane of the Configuration Parameters dialog box.                                        | string — 'none'   {'warning'}   'error' |
| InvalidFcnCallConnMsg | Specify message behavior when an invalid function-call connection exists.<br><br>Set by <b>Invalid function-call connection</b> on the <b>Connectivity Diagnostics</b> pane of the Configuration Parameters dialog box.                                      | string — 'none'   'warning'   {'error'} |
| Jacobian              | For internal use.                                                                                                                                                                                                                                            |                                         |
| LastModifiedBy        | User name of the person who last modified this model.                                                                                                                                                                                                        | string                                  |
| LastModifiedDate      | Date used for version control.                                                                                                                                                                                                                               | string                                  |

## Model Parameters in Alphabetical Order (Continued)

| Parameter          | Description                                                                                                                                                                                                                                                                        | Values                                                |
|--------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------|
| LibraryLinkDisplay | Shows which blocks in the model are linked or have disabled or modified links.<br><br>Set by <b>Library Link Display</b> on the <b>Format</b> menu of the Model Editor.                                                                                                            | string — {'none'}   'user'   'all'                    |
| LibraryType        | For internal use.                                                                                                                                                                                                                                                                  |                                                       |
| LifeSpan           | Specify how long (in days) an application that contains blocks depending on elapsed or absolute time should be able to execute before timer overflow.<br><br>Set by <b>Application lifespan (days)</b> on the <b>Optimization</b> pane of the Configuration Parameters dialog box. | string — {'inf'}   any positive, nonzero scalar value |
| LimitDataPoints    | Specify that the number of data points exported to the MATLAB workspace be limited to the number specified.<br><br>Set by the <b>Limit data points to last</b> check box on the <b>Data Import/Export</b> pane of the Configuration Parameters dialog box.                         | string — {'on'}   'off'                               |
| LinearizationMsg   | For internal use.                                                                                                                                                                                                                                                                  |                                                       |
| Lines              | For internal use.                                                                                                                                                                                                                                                                  |                                                       |

**Model Parameters in Alphabetical Order (Continued)**

| <b>Parameter</b>      | <b>Description</b>                                                                                                                                                                                                                                                                              | <b>Values</b>           |
|-----------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------|
| LoadExternalInput     | Load input from workspace.<br>Set by the <b>Input</b> check box on the <b>Data Import/Export</b> pane of the Configuration Parameters dialog box.                                                                                                                                               | string — 'on'   {'off'} |
| LoadInitialState      | Load initial state from workspace.<br>Set by the <b>Initial state</b> check box on the <b>Data Import/Export</b> pane of the Configuration Parameters dialog box.                                                                                                                               | string — 'on'   {'off'} |
| Location              | For internal use.                                                                                                                                                                                                                                                                               |                         |
| Lock                  | Lock or unlock a block library. Setting this parameter to on prevents a user from inadvertently changing a library.                                                                                                                                                                             | string — 'on'   {'off'} |
| MaxConsecutiveMinStep | Maximum number of minimum step size violations allowed during simulation. This option appears when the solver type is <b>Variable-step</b> and the solver is an ode one.<br>Set by <b>Number of consecutive min steps</b> on the <b>Solver</b> pane of the Configuration Parameters dialog box. | string — {'1'}          |

## Model Parameters in Alphabetical Order (Continued)

| Parameter            | Description                                                                                                                                                                                                                                                                                                                                                                          | Values                                  |
|----------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------|
| MaxConsecutiveZCs    | <p>Maximum number of consecutive zero crossings allowed during simulation. This option appears when the solver type is <code>Variable-step</code> and the solver is an ode one.</p> <p>Set by <b>Number of consecutive zero crossings</b> on the <b>Solver</b> pane of the Configuration Parameters dialog box.</p>                                                                  | string — {'1000'}                       |
| MaxConsecutiveZCsMsg | <p>Specifies diagnostic action to take when Simulink software detects the maximum number of consecutive zero crossings allowed. This option appears when the solver type is <code>Variable-step</code> and the solver is an ode one.</p> <p>Set by <b>Consecutive zero crossings violation</b> on the <b>Solver Diagnostics</b> pane of the Configuration Parameters dialog box.</p> | string — 'none'   'warning'   {'error'} |
| MaxDataPoints        | <p>Maximum number of output data points to save.</p> <p>Set by the <b>Limit data points to last</b> field on the <b>Data Import/Export</b> pane of the Configuration Parameters dialog box.</p>                                                                                                                                                                                      | string — {'1000'}                       |

### Model Parameters in Alphabetical Order (Continued)

| Parameter                          | Description                                                                                                                                                                                                                                                                                                                 | Values                                  |
|------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------|
| MaxNumMinSteps                     | Maximum number of times the solver uses the minimum step size.                                                                                                                                                                                                                                                              | string — {'-1'}                         |
| MaxOrder                           | Maximum order for ode15s.<br>Set by <b>Maximum order</b> on the <b>Solver</b> pane of the Configuration Parameters dialog box.                                                                                                                                                                                              | string — '1'   '2'   '3'   '4'   {'5'}  |
| MaxStep                            | Maximum step size.<br>Set by <b>Max step size</b> on the <b>Solver</b> pane of the Configuration Parameters dialog box.                                                                                                                                                                                                     | string — {'auto'}                       |
| MdlSubVersion                      | For internal use                                                                                                                                                                                                                                                                                                            |                                         |
| MergeDetectMultiDriving-BlocksExec | Select the diagnostic action to take when the software detects a Merge block with more than one driving block executing at the same time step.<br><br>Set by <b>Detect multiple driving blocks executing at the same time step</b> on the <b>Data Validity Diagnostics</b> pane of the Configuration Parameters dialog box. | string — {'none'}   'warning'   'error' |
| MinMaxOverflowArchiveData          | For internal use                                                                                                                                                                                                                                                                                                            |                                         |
| MinMaxOverflowArchiveMode          | Logging type for fixed-point logging.<br>Set by <b>Overwrite or merge results</b> in the Fixed-Point Tool.                                                                                                                                                                                                                  | string — {'Overwrite'}   'Merge'        |

## Model Parameters in Alphabetical Order (Continued)

| Parameter              | Description                                                                                                                                                                  | Values                                                                                          |
|------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------|
| MinMaxOverflowLogging  | Setting for fixed-point logging.<br>Set by <b>Logging mode</b> in the Fixed-Point Tool.                                                                                      | string —<br>{ 'UseLocalSettings' }<br>  'MinMaxAndOverflow'<br>  'OverflowOnly'  <br>'ForceOff' |
| MinStep                | Minimum step size for the solver.<br>Set by <b>Min step size</b> on the <b>Solver</b> pane of the Configuration Parameters dialog box.                                       | string — {'auto'}                                                                               |
| MinStepSizeMsg         | Message shown when minimum step size is violated.<br>Set by <b>Min step size violation</b> on the <b>Solver Diagnostics</b> pane of the Configuration Parameters dialog box. | string — {'warning'}  <br>'error'                                                               |
| ModelBrowserVisibility | Show the Model Browser.<br>Set by <b>Model Browser</b> on the <b>View &gt; Model Browser Options</b> menu of the Model Editor.                                               | string — 'on'   {'off'}                                                                         |
| ModelBrowserWidth      | Width of the Model Browser pane in the model window.<br>To display the Model Browser pane, see the <code>ModelBrowserVisibility</code> parameter.                            | integer — {200}                                                                                 |
| ModelDataFile          | For internal use.                                                                                                                                                            | string — {''}                                                                                   |

**Model Parameters in Alphabetical Order (Continued)**

| <b>Parameter</b>                  | <b>Description</b>                                                                                                                                                                                                                                                                         | <b>Values</b>                           |
|-----------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------|
| ModelDependencies                 | List of model dependencies.<br>Set by <b>Model dependencies</b> on the <b>Model Referencing</b> pane of the Configuration Parameters dialog box.                                                                                                                                           | string — {' '}                          |
| ModelReferenceCS-MismatchMessage  | Message shown when there is a model configuration mismatch.<br>Set by <b>Model configuration mismatch</b> on the <b>Model Referencing Diagnostics</b> pane of the Configuration Parameters dialog box.                                                                                     | string — {'none'}   'warning'   'error' |
| ModelReferenceData-LoggingMessage | Message shown when there is unsupported data logging.<br>Set by <b>Unsupported data logging</b> on the <b>Model Referencing Diagnostics</b> pane of the Configuration Parameters dialog box.                                                                                               | string — '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.<br>Set by <b>Extraneous discrete derivative signals</b> on the <b>Solver Diagnostics</b> pane of the Configuration Parameters dialog box. | string — 'none'   'warning'   {'error'} |



**Model Parameters in Alphabetical Order (Continued)**

| <b>Parameter</b>                    | <b>Description</b>                                                                                                                                                                                                                                    | <b>Values</b>                           |
|-------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------|
| ModelReferenceIO-MismatchMessage    | <p>Message shown when there is a port and parameter mismatch.</p> <p>Set by <b>Port and parameter mismatch</b> on the <b>Model Referencing Diagnostics</b> pane of the Configuration Parameters dialog box.</p>                                       | string — {'none'}   'warning'   'error' |
| ModelReferenceIOMsg                 | <p>Message shown when there is an invalid root Inport or Outport block connection.</p> <p>Set by <b>Invalid root Inport/Outport block connection</b> on the <b>Model Referencing Diagnostics</b> pane of the Configuration Parameters dialog box.</p> | string — {'none'}   'warning'   'error' |
| ModelReferenceMinAlgLoopOccurrences | <p>Toggles the minimization of algebraic loop occurrences.</p> <p>Set by <b>Minimize algebraic loop occurrences</b> on the <b>Model Referencing</b> pane of the Configuration Parameters dialog box.</p>                                              | string — 'on'   {'off'}                 |

### Model Parameters in Alphabetical Order (Continued)

| Parameter                                | Description                                                                                                                                                                                                            | Values                                  |
|------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------|
| ModelReferenceNum-InstancesAllowed       | Total number of model reference instances allowed per top model.<br><br>Set by <b>Total number of instances allowed per top model</b> on the <b>Model Referencing</b> pane of the Configuration Parameters dialog box. | string — 'Zero'   'Single'   {'Multi'}  |
| ModelReferencePass-RootInputsByReference | Toggles the passing of scalar root inputs by value.<br><br>Set by <b>Pass scalar root inputs by value</b> on the <b>Model Referencing</b> pane of the Configuration Parameters dialog box.                             | string — {'on'}   'off'                 |
| ModelReferenceSim-TargetVerbose          | This parameter is deprecated and has no effect. Use <code>AccelVerboseBuild</code> instead.                                                                                                                            |                                         |
| ModelReferenceSymbol-NameMessage         | For internal use.                                                                                                                                                                                                      |                                         |
| ModelReferenceTargetType                 | For internal use.                                                                                                                                                                                                      |                                         |
| ModelReferenceVersion-MismatchMessage    | Message shown when there is a model block version mismatch.<br><br>Set by <b>Model block version mismatch</b> on the <b>Model Referencing Diagnostics</b> pane of the Configuration Parameters dialog box.             | string — {'none'}   'warning'   'error' |
| ModelVersion                             | Version number of model.                                                                                                                                                                                               | string — {'1.1'}                        |

### Model Parameters in Alphabetical Order (Continued)

| Parameter          | Description                                                                                                                                                                                                                                                                                                                                                                 | Values                                                               |
|--------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------|
| ModelVersionFormat | <p>Format of model's version number.</p> <p>Set by <b>Model version</b> on the <b>History</b> pane of the Model Properties dialog box.</p> <p>See “Model History Controls” in the Simulink User's Guide for more information.</p>                                                                                                                                           | <p>string —</p> <p>{ '1. %&lt;AutoIncrement: 0&gt;' }</p>            |
| ModelWorkspace     | <p>References this model's model workspace object.</p>                                                                                                                                                                                                                                                                                                                      | <p>an instance of the <code>Simulink.ModelWorkspace</code> class</p> |
| ModifiedBy         | <p>Last person to modify this model.</p>                                                                                                                                                                                                                                                                                                                                    | <p>string</p>                                                        |
| ModifiedByFormat   | <p>Format for the display of last modifier.</p> <p>Set by <b>Last saved by</b> on the <b>History</b> pane of the Model Properties dialog box.</p> <p>See “Model History Controls” in the Simulink User's Guide for more information.</p> <p>Can also be set by <b>Last saved by</b> on the <b>Model history</b> field on the <b>History</b> pane of the Model Explorer.</p> | <p>string — { '%&lt;Auto&gt;' }</p>                                  |
| ModifiedComment    | <p>Field for user comments.</p>                                                                                                                                                                                                                                                                                                                                             | <p>string — { '' }</p>                                               |

**Model Parameters in Alphabetical Order (Continued)**

| <b>Parameter</b>   | <b>Description</b>                                                                                                                                                                                                                                                                                                                                       | <b>Values</b>        |
|--------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|
| ModifiedDate       | Date of last model modification.                                                                                                                                                                                                                                                                                                                         | string               |
| ModifiedDateFormat | Format of modified date.<br>Set by <b>Last saved on</b> on the <b>History</b> pane of the Model Properties dialog box.<br>See “Model History Controls” in the Simulink User’s Guide for more information.                                                                                                                                                | string — {'%<Auto>'} |
| ModifiedHistory    | Area for keeping notes about the history of the model.<br>Set by the <b>Model history</b> field on the <b>History</b> pane of the Model Properties dialog box.<br>See “Model History Controls” in the Simulink User’s Guide for more information.<br>Can also be set by the <b>Model history</b> field on the <b>History</b> pane of the Model Explorer. | string — {' '}       |

## Model Parameters in Alphabetical Order (Continued)

| Parameter               | Description                                                                                                                                                                                                                                                                                                | Values                                  |
|-------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------|
| MultiTaskCondExecSysMsg | <p>Select the diagnostic action to take if Simulink software detects a subsystem that might cause data corruption or nondeterministic behavior.</p> <p>Set by <b>Multitask conditionally executed subsystem</b> on the <b>Sample Time Diagnostics</b> pane of the Configuration Parameters dialog box.</p> | string — 'none'   'warning'   {'error'} |
| MultiTaskDSMMsg         | <p>Specifies diagnostic action to take when one task reads data from a Data Store Memory block to which another task writes data.</p> <p>Set by <b>Multitask data store</b> on the <b>Data Validity Diagnostics</b> pane of the Configuration Parameters dialog box.</p>                                   | string — 'none'   'warning'   {'error'} |
| MultiTaskRateTransMsg   | <p>Specifies diagnostic action to take when an invalid rate transition takes place between two blocks operating in single-tasking mode.</p> <p>Set by <b>Multitask rate transition</b> on the <b>Sample Time Diagnostics</b> pane of the Configuration Parameters dialog box.</p>                          | string — 'warning'   {'error'}          |
| Name                    | Model name.                                                                                                                                                                                                                                                                                                | string                                  |

**Model Parameters in Alphabetical Order (Continued)**

| Parameter              | Description                                                                                                                                                                                                           | Values                                                                            |
|------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|
| NumberNewtonIterations | <p>Number of Newton's method iterations performed by the ode14x implicit fixed-step solver.</p> <p>Set by <b>Number Newton's iterations</b> on the <b>Solver</b> pane of the Configuration Parameters dialog box.</p> | integer — {1}                                                                     |
| ObjectParameters       | Names and attributes of model parameters.                                                                                                                                                                             | structure                                                                         |
| Open                   | For internal use.                                                                                                                                                                                                     |                                                                                   |
| OptimizeBlockIOStorage | <p>Enables signal storage reuse optimization.</p> <p>Set by <b>Signal storage reuse</b> on the <b>Optimization</b> pane of the Configuration Parameters dialog box.</p>                                               | string — {'on'}   'off'                                                           |
| OutputOption           | <p>Time step output options for variable-step solvers.</p> <p>Set by <b>Output options</b> on the <b>Data Import/Export</b> pane of the Configuration Parameters dialog box.</p>                                      | string — 'AdditionalOutputTimes'   {'RefineOutputTimes'}   'SpecifiedOutputTimes' |
| OutputSaveName         | <p>Workspace variable to store the model outputs.</p> <p>Set by the <b>Output</b> field on the <b>Data Import/Export</b> pane of the Configuration Parameters dialog box.</p>                                         | string — {'yout'}                                                                 |

## Model Parameters in Alphabetical Order (Continued)

| Parameter         | Description                                                                                                                                                                                                                                                                                                                                                     | Values                                          |
|-------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------|
| OutputTimes       | <p>Output times set when <b>Output options</b> on the <b>Data Import/Export</b> pane of the Configuration Parameters dialog box is set to <b>Produce additional output</b>.</p> <p>Set by <b>Output times</b> on the <b>Data Import/Export</b> pane of the Configuration Parameters dialog box.</p>                                                             | string — {'[]'}                                 |
| PaperOrientation  | Printing paper orientation.                                                                                                                                                                                                                                                                                                                                     | string — 'portrait'   {'landscape'}   'rotated' |
| PaperPosition     | When PaperPositionMode is set to manual, this parameter determines the position and size of a diagram on paper and the size of the diagram exported as a graphic file in the units specified by PaperUnits.                                                                                                                                                     | vector — [left, bottom, width, height]          |
| PaperPositionMode | <p>Paper position mode.</p> <ul style="list-style-type: none"> <li>• auto           <p>When printing, Simulink software sizes the diagram to fit the printed page.</p> <p>When exporting a diagram as a graphic image, Simulink software sizes the exported image to be the same size as the diagram's normal size on screen.</p> </li> <li>• manual</li> </ul> | string — {'auto'}   'manual'   'tiled'          |

### Model Parameters in Alphabetical Order (Continued)

| Parameter               | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Values                                                                                                                                                                                                               |
|-------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                         | <p>When printing, Simulink software positions and sizes the diagram on the page as indicated by <code>PaperPosition</code>. When exporting a diagram as a graphic image, Simulink software sizes the exported graphic to have the height and width specified by <code>PaperPosition</code>.</p> <ul style="list-style-type: none"> <li>• <code>tiled</code><br/>Enables tiled printing.<br/>See “Tiled Printing” in the Simulink User’s Guide for more information.</li> </ul> |                                                                                                                                                                                                                      |
| <code>PaperSize</code>  | Size of <code>PaperType</code> in <code>PaperUnits</code> .                                                                                                                                                                                                                                                                                                                                                                                                                    | vector — [width height] (read only)                                                                                                                                                                                  |
| <code>PaperType</code>  | Printing paper type.                                                                                                                                                                                                                                                                                                                                                                                                                                                           | string — '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' |
| <code>PaperUnits</code> | Printing paper size units.                                                                                                                                                                                                                                                                                                                                                                                                                                                     | string — 'normalized'   {'inches'}   'centimeters'   'points'                                                                                                                                                        |



**Model Parameters in Alphabetical Order (Continued)**

| <b>Parameter</b>          | <b>Description</b>                                                                                                                                                                                                                     | <b>Values</b>                           |
|---------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------|
| ParameterArgumentNames    | <p>List of parameters used as arguments when this model is called as a reference.</p> <p>Set by <b>Model arguments (for referencing this model)</b> in the <b>Model Workspace</b> pane of the Model Explorer.</p>                      | string — {' '}                          |
| ParameterDowncastMsg      | <p>Specifies diagnostic action to take when a parameter downcast occurs during simulation.</p> <p>Set by <b>Detect downcast</b> on the <b>Data Validity Diagnostics</b> pane of the Configuration Parameters dialog box.</p>           | string — 'none'   'warning'   {'error'} |
| ParameterOverflowMsg      | <p>Specifies diagnostic action to take when a parameter overflow occurs during simulation.</p> <p>Set by <b>Detect overflow</b> on the <b>Data Validity Diagnostics</b> pane of the Configuration Parameters dialog box.</p>           | string — 'none'   'warning'   {'error'} |
| ParameterPrecisionLossMsg | <p>Specifies diagnostic action to take when parameter precision loss occurs during simulation.</p> <p>Set by <b>Detect precision loss</b> on the <b>Data Validity Diagnostics</b> pane of the Configuration Parameters dialog box.</p> | string — 'none'   {'warning'}   'error' |

**Model Parameters in Alphabetical Order (Continued)**

| <b>Parameter</b>           | <b>Description</b>                                                                                                                                                                                                                                                      | <b>Values</b>                           |
|----------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------|
| ParameterTunabilityLossMsg | <p>Specifies diagnostic action to take when a parameter cannot be tuned because it uses unsupported functions or operators.</p> <p>Set by <b>Detect loss of tunability</b> on the <b>Data Validity Diagnostics</b> pane of the Configuration Parameters dialog box.</p> | string — 'none'   {'warning'}   'error' |
| ParameterUnderflowMsg      | <p>Specifies diagnostic action to take when a parameter underflow occurs during simulation.</p> <p>Set by <b>Detect underflow</b> on the <b>Data Validity Diagnostics</b> pane of the Configuration Parameters dialog box.</p>                                          | string — {'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 in Alphabetical Order (Continued)

| Parameter             | Description                                                                                                                                                                                                                                                                                                                                      | Values                  |
|-----------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------|
| PositivePriorityOrder | <p>Choose the appropriate priority ordering for the real-time system targeted by this model. The Real-Time Workshop software uses this information to implement asynchronous data transfers.</p> <p>Set by <b>Higher priority value indicates higher task priority</b> on the <b>Solver</b> pane of the Configuration Parameters dialog box.</p> | string — 'on'   {'off'} |
| PostLoadFcn           | <p>Function invoked just after this model is loaded.</p> <p>Set by <b>Model post-load function</b> on the <b>Callbacks</b> pane of the Model Properties dialog box.</p> <p>See “Creating Model Callback Functions” in the Simulink User’s Guide for more information.</p>                                                                        | string — {''}           |
| PostSaveFcn           | <p>Function invoked just after this model is saved to disk.</p> <p>Set by <b>Model post-save function</b> on the <b>Callbacks</b> pane of the Model Properties dialog box.</p> <p>See “Creating Model Callback Functions” in the Simulink User’s Guide for more information.</p>                                                                 | string — {''}           |

**Model Parameters in Alphabetical Order (Continued)**

| <b>Parameter</b> | <b>Description</b>                                                                                                                                                                                                                                                                  | <b>Values</b> |
|------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|
| PreLoadFcn       | <p>Preload callback.</p> <p>Set by <b>Model pre-load function</b> on the <b>Callbacks</b> pane of the Model Properties dialog box.</p> <p>See “Creating Model Callback Functions” in the Simulink User’s Guide for more information.</p>                                            | string — {''} |
| PreSaveFcn       | <p>Function invoked just before this model is saved to disk.</p> <p>Set by <b>Model pre-save function</b> on the <b>Callbacks</b> pane of the Model Properties dialog box.</p> <p>See “Creating Model Callback Functions” in the Simulink User’s Guide for more information.</p>    | string — {''} |
| ProdBitPerChar   | <p>Describes the length in bits of the C char data type supported by the production hardware to be used by this model.</p> <p>Set by <b>char</b> in the <b>Embedded hardware</b> section on the <b>Hardware Implementation</b> pane of the Configuration Parameters dialog box.</p> | integer — {8} |

### Model Parameters in Alphabetical Order (Continued)

| Parameter       | Description                                                                                                                                                                                                                                                                                        | Values         |
|-----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|
| ProdBitPerInt   | <p>Describes the length in bits of the C <code>int</code> data type supported by the production hardware to be used by this model.</p> <p>Set by <b>int</b> in the <b>Embedded hardware</b> section on the <b>Hardware Implementation</b> pane of the Configuration Parameters dialog box.</p>     | integer — {32} |
| ProdBitPerLong  | <p>Describes the length in bits of the C <code>long</code> data type supported by the production hardware to be used by this model.</p> <p>Set by <b>long</b> in the <b>Embedded hardware</b> section on the <b>Hardware Implementation</b> pane of the Configuration Parameters dialog box.</p>   | integer — {32} |
| ProdBitPerShort | <p>Describes the length in bits of the C <code>short</code> data type supported by the production hardware to be used by this model.</p> <p>Set by <b>short</b> in the <b>Embedded hardware</b> section on the <b>Hardware Implementation</b> pane of the Configuration Parameters dialog box.</p> | integer — {16} |

### Model Parameters in Alphabetical Order (Continued)

| Parameter        | Description                                                                                                                                                                                                                                                                                                          | Values                                                  |
|------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------|
| ProdEndianness   | <p>Describes the significance of the first byte of a data word of the production hardware to be used by this model.</p> <p>Set by <b>Byte ordering</b> in the <b>Embedded hardware</b> section on the <b>Hardware Implementation</b> pane of the Configuration Parameters dialog box.</p>                            | string — {'Unspecified'}   'LittleEndian'   'BigEndian' |
| ProdEqTarget     | <p>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.</p> <p>Set by <b>None</b> in the <b>Emulation hardware</b> section on the <b>Hardware Implementation</b> pane of the Configuration Parameters dialog box.</p> | string — {'on'}   'off'                                 |
| ProdHWDeviceType | <p>Predefined hardware device to specify the C language constraints for your microprocessor.</p> <p>Set by <b>Device type</b> in the <b>Embedded hardware</b> section on the <b>Hardware Implementation</b> pane of the Configuration Parameters dialog box.</p>                                                     | string — {'32-bit Generic'}                             |

### Model Parameters in Alphabetical Order (Continued)

| Parameter              | Description                                                                                                                                                                                                                                                                                                                                                                 | Values                                    |
|------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------|
| ProdIntDivRoundTo      | <p>Describes how the C compiler that will create production code for this model rounds the result of dividing one signed integer by another to produce a signed integer quotient.</p> <p>Set by <b>Signed integer division rounds to</b> in the <b>Embedded hardware</b> section on the <b>Hardware Implementation</b> pane of the Configuration Parameters dialog box.</p> | string — 'Floor'   'Zero'   {'Undefined'} |
| ProdShiftRightIntArith | <p>Describes whether the C compiler that will create production code for this model implements a signed integer right shift as an arithmetic right shift.</p> <p>Set by <b>Shift right on a signed integer as arithmetic shift</b> in the <b>Embedded hardware</b> section on the <b>Hardware Implementation</b> pane of the Configuration Parameters dialog box.</p>       | string — {'on'}   'off'                   |

### Model Parameters in Alphabetical Order (Continued)

| Parameter          | Description                                                                                                                                                                                                                                                                                  | Values                                                                                                 |
|--------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------|
| ProdWordSize       | <p>Describes the word length in bits of the production hardware to be used by this model.</p> <p>Set by <b>native word size</b> in the <b>Embedded hardware</b> section on the <b>Hardware Implementation</b> pane of the Configuration Parameters dialog box.</p>                           | integer — {32}                                                                                         |
| Profile            | <p>Enables the simulation profiler for this model.</p> <p>Set by <b>Profiler</b> on the <b>Tools</b> menu of the Model Editor.</p>                                                                                                                                                           | string — 'on'   {'off'}                                                                                |
| ReadBeforeWriteMsg | <p>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.</p> <p>Set by <b>Detect read before write</b> on the <b>Data Validity Diagnostics</b> pane of the Configuration Parameters dialog box.</p> | string —<br>{ 'UseLocalSettings' }<br>  'DisableAll'  <br>'EnableAllAsWarning'  <br>'EnableAllAsError' |



**Model Parameters in Alphabetical Order (Continued)**

| Parameter      | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Values                  |
|----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------|
| RecordCoverage | <p>A value of on causes Simulink software to gather and report model coverage data during simulation. The format of this report is controlled by the values of the following parameters:</p> <ul style="list-style-type: none"> <li>CovCompData</li> <li>CovCumulativeReport</li> <li>CovCumulativeVarName</li> <li>CovHTMLOptions</li> <li>CovHTMLReporting</li> <li>CovMetricSettings</li> <li>CovModelRefEnable</li> <li>CovModelRefExcluded</li> <li>CovNameIncrementing</li> <li>CovPath</li> <li>CovReportOnPause</li> <li>CovSaveCumulativeToWorkSpaceVar</li> <li>CovSaveName</li> <li>CovSaveSingleToWorkspaceVar</li> </ul> <p>If the value is off, no model coverage data is collected or reported and the preceding coverage report parameters have no effect.</p> | string — 'on'   {'off'} |

### Model Parameters in Alphabetical Order (Continued)

| Parameter       | Description                                                                                                                                                                                     | Values                            |
|-----------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------|
|                 | Set by <b>Coverage for this model</b> : <model name> on the <b>Coverage</b> pane of the Coverage Settings dialog box.                                                                           |                                   |
| Refine          | Refine factor.<br>Set by <b>Refine factor</b> on the <b>Data Import/Export</b> pane of the Configuration Parameters dialog box.                                                                 | string — {'1'}                    |
| RelTol          | Relative error tolerance.<br>Set by <b>Relative tolerance</b> on the <b>Solver</b> 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.<br>Set by <b>Highlight model</b> on the <b>Tools &gt; Requirements</b> menu of the Model Editor. | string — 'on'   {'off'}           |
| RequirementInfo | For internal use.                                                                                                                                                                               |                                   |

## Model Parameters in Alphabetical Order (Continued)

| Parameter                           | Description                                                                                                                                                                                                                                                                                            | Values                                  |
|-------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------|
| RootOutputportRequire-<br>BusObject | <p>Specifies diagnostic action to take when a bus enters a root model Outputport block for which a bus object has not been specified.</p> <p>Set by <b>Unspecified bus object at root Outputport block</b> on the <b>Connectivity Diagnostics</b> pane of the Configuration Parameters dialog box.</p> | string — 'none'   {'warning'}   'error' |
| RTPrefix                            | <p>Specifies diagnostic action to take when Simulink software encounters an object name that begins with rt.</p> <p>Set by <b>"rt" prefix for identifiers</b> on the <b>Data Validity Diagnostics</b> pane of the Configuration Parameters dialog box.</p>                                             | string — 'none'   'warning'   {'error'} |
| RTW...                              | See the Real-Time Workshop documentation for more information on parameters whose names begin with RTW.                                                                                                                                                                                                |                                         |
| SampleTimeAnnotations               | Set by <b>Annotations</b> on the <b>Format &gt; Sample Time Display</b> menu of the Model Editor.                                                                                                                                                                                                      | string — 'on'   {'off'}                 |
| SampleTimeColors                    | Set by <b>Colors</b> on the <b>Format &gt; Sample Time Display</b> menu of the Model Editor.                                                                                                                                                                                                           | string — 'on'   {'off'}                 |

### Model Parameters in Alphabetical Order (Continued)

| Parameter              | Description                                                                                                                                                                                                                                                                               | Values                                                                                  |
|------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------|
| SampleTimeConstraint   | This option appears when the solver type is <b>Fixed-step</b> .<br>Set by <b>Periodic sample time constraint</b> on the <b>Solver</b> pane of the Configuration Parameters dialog box.                                                                                                    | string — {'Unconstrained'}<br>  'STIndependent'  <br>'Specified'                        |
| SampleTimeProperty     | Specifies and assigns priorities to the sample times implemented by the model. This option appears when <b>Periodic sample time constraint</b> is set to <b>Specified</b> .<br>Set by <b>Sample time properties</b> on the <b>Solver</b> pane of the Configuration Parameters dialog box. | Structure containing the fields <b>SampleTime</b> , <b>Offset</b> , and <b>Priority</b> |
| SavedCharacterEncoding | Specifies the character set used to encode this model. See the <code>slCharacterEncoding</code> command for more information.                                                                                                                                                             | string                                                                                  |
| SaveDefaultBlockParams | For internal use.                                                                                                                                                                                                                                                                         |                                                                                         |
| SaveFinalState         | Save final states to workspace.<br>Set by the <b>Final states</b> check box on the <b>Data Import/Export</b> pane of the Configuration Parameters dialog box.                                                                                                                             | string — 'on'   {'off'}                                                                 |

### Model Parameters in Alphabetical Order (Continued)

| Parameter  | Description                                                                                                                                                             | Values                                                       |
|------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------|
| SaveFormat | <p>Format used to save data to the MATLAB workspace.</p> <p>Set by <b>Format</b> on the <b>Data Import/Export</b> pane of the Configuration Parameters dialog box.</p>  | string — {'Array'}<br>  'Structure'  <br>'StructureWithTime' |
| SaveOutput | <p>Save simulation output to workspace.</p> <p>Set by the <b>Output</b> check box on the <b>Data Import/Export</b> pane of the Configuration Parameters dialog box.</p> | string — {'on'}   'off'                                      |
| SaveState  | <p>Save states to workspace.</p> <p>Set by the <b>States</b> check box on the <b>Data Import/Export</b> pane of the Configuration Parameters dialog box.</p>            | string — 'on'   {'off'}                                      |
| SaveTime   | <p>Save simulation time to workspace.</p> <p>Set by the <b>Time</b> check box on the <b>Data Import/Export</b> pane of the Configuration Parameters dialog box.</p>     | string — {'on'}   'off'                                      |

### Model Parameters in Alphabetical Order (Continued)

| Parameter                      | Description                                                                                                                                                                                                                                                          | Values                                                                                                                                                                                                                                                                                           |
|--------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| SaveWithDisabledLinksMsg       | <p>Specifies diagnostic action to take when saving a block diagram having disabled library links.</p> <p>Set by <b>Block diagram contains disabled library links</b> on the <b>Saving Diagnostics</b> pane of the Configuration Parameters dialog box.</p>           | string — 'none'   {'warning'}   'error'                                                                                                                                                                                                                                                          |
| SaveWithParameterized-LinksMsg | <p>Specifies diagnostic action to take when saving a block diagram having parameterized library links.</p> <p>Set by <b>Block diagram contains parameterized library links</b> on the <b>Saving Diagnostics</b> pane of the Configuration Parameters dialog box.</p> | string — 'none'   {'warning'}   'error'                                                                                                                                                                                                                                                          |
| ScreenColor                    | <p>Background color of the model window.</p> <p>Set by <b>Screen Color</b> on the <b>Format</b> menu of the Model Editor.</p>                                                                                                                                        | string — '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.                                                                                                                                                                                                                                                    |                                                                                                                                                                                                                                                                                                  |

**Model Parameters in Alphabetical Order (Continued)**

| <b>Parameter</b>     | <b>Description</b>                                                                                                                                                                                                                                                                                                   | <b>Values</b>           |
|----------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------|
| SFcnCompatibilityMsg | See SfunCompatibilityCheckMsg parameter for more information.                                                                                                                                                                                                                                                        |                         |
| SFSimEcho            | Enables output to appear in the MATLAB Command Window during simulation of a model that contains Embedded MATLAB Function blocks, Stateflow charts, or Truth Table blocks.<br><br>Set by <b>Echo expressions without semicolons</b> on the <b>Simulation Target</b> pane of the Configuration Parameters dialog box. | string — {'on'}   'off' |
| SFSimEnableDebug     | Enables debugging and animation during simulation of a model that contains Embedded MATLAB Function blocks, Stateflow charts, or Truth Table blocks.<br><br>Set by <b>Enable debugging/animation</b> on the <b>Simulation Target</b> pane of the Configuration Parameters dialog box.                                | string — {'on'}   'off' |

### Model Parameters in Alphabetical Order (Continued)

| Parameter                 | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Values                                  |
|---------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------|
| SFSimOverflowDetection    | <p>Enables overflow detection of data during simulation of a model that contains Embedded MATLAB Function blocks, Stateflow charts, or Truth Table blocks. Overflow occurs for data when a value assigned to it exceeds the numeric capacity of the data type.</p> <hr/> <p><b>Note</b> To enable this option, you must also select the <b>Data Range</b> check box in the Stateflow Debugger window.</p> <hr/> <p>Set by <b>Enable overflow detection (with debugging)</b> on the <b>Simulation Target</b> pane of the Configuration Parameters dialog box.</p> | string — {'on'}   'off'                 |
| SfunCompatibilityCheckMsg | <p>Specifies diagnostic action to take when S-function upgrades are needed.</p> <p>Set by <b>S-function upgrades needed</b> on the <b>Compatibility Diagnostics</b> pane of the Configuration Parameters dialog box.</p>                                                                                                                                                                                                                                                                                                                                         | string — {'none'}   'warning'   'error' |



## Model Parameters in Alphabetical Order (Continued)

| Parameter                     | Description                                                                                                                                                                                  | Values                                |
|-------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------|
| ShapePreserveControl          | At each time step, use derivative information to improve integration accuracy.<br><br>Set by <b>Shape preservation</b> on the <b>Solver</b> pane of the Configuration Parameters dialog box. | string — 'EnableAll'   {'DisableAll'} |
| ShowGrid                      | Show the Model Editor grid.                                                                                                                                                                  | string — 'on'   {'off'}               |
| ShowLinearization-Annotations | Toggles linearization icons in the model.                                                                                                                                                    | string — {'on'}   'off'               |
| ShowLineDimensions            | Show signal dimensions on this model's block diagram.<br><br>Set by <b>Signal Dimensions</b> on the <b>Format &gt; Port/Signal Displays</b> menu of the Model Editor.                        | string — 'on'   {'off'}               |
| ShowLineDimensionsOnError     | For internal use.                                                                                                                                                                            |                                       |
| ShowLineWidths                | Deprecated. Use ShowLineDimensions instead.                                                                                                                                                  |                                       |
| ShowLoopsOnError              | Highlight invalid loops graphically.                                                                                                                                                         | string — {'on'}   'off'               |
| ShowModelReferenceBlockIO     | Toggles display of I/O mismatch on block.<br><br>Set by <b>Model Block I/O Mismatch</b> on the <b>Format &gt; Block Displays</b> menu of the Model Editor.                                   | string — 'on'   {'off'}               |

**Model Parameters in Alphabetical Order (Continued)**

| <b>Parameter</b>                | <b>Description</b>                                                                                                                                                         | <b>Values</b>           |
|---------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------|
| ShowModelReference-BlockVersion | Toggles display of version on block.<br><br>Set by <b>Model Block Version</b> on the <b>Format &gt; Block Displays</b> menu of the Model Editor.                           | string — 'on'   {'off'} |
| Shown                           | For internal use.                                                                                                                                                          |                         |
| ShowPageBoundaries              | Toggles display of page boundaries on the Model Editor's canvas.<br><br>Set by <b>Show Page Boundaries</b> on the <b>View</b> menu of the Model Editor.                    | string — 'on'   {'off'} |
| ShowPortDataTypes               | Show data types of ports on this model's block diagram.<br><br>Set by <b>Port Data Types</b> on the <b>Format &gt; Port/Signal Displays</b> menu of the Model Editor.      | string — 'on'   {'off'} |
| ShowPortDataTypesOnError        | For internal use.                                                                                                                                                          |                         |
| ShowStorageClass                | Show storage classes of signals on this model's block diagram.<br><br>Set by <b>Storage Class</b> on the <b>Format &gt; Port/Signal Displays</b> menu of the Model Editor. | string — 'on'   {'off'} |

### Model Parameters in Alphabetical Order (Continued)

| Parameter              | Description                                                                                                                                                                                                                                        | Values                                  |
|------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------|
| ShowTestPointIcons     | Show test point icons on this model's block diagram.<br><br>Set by <b>Testpoint/Logging Indicators</b> on the <b>Format &gt; Port/Signal Displays</b> menu of the Model Editor.                                                                    | string — {'on'}   'off'                 |
| ShowViewerIcons        | Show viewer icons on this model's block diagram.<br><br>Set by <b>Viewer Indicators</b> on the <b>Format &gt; Port/Signal Displays</b> menu of the Model Editor.                                                                                   | string — {'on'}   'off'                 |
| SignalInfNanChecking   | Specifies diagnostic action to take when the value of a block output is Inf or NaN at the current time step.<br><br>Set by <b>Inf or NaN block output</b> on the <b>Data Validity Diagnostics</b> pane of the Configuration Parameters dialog box. | string — {'none'}   'warning'   'error' |
| SignalLabelMismatchMsg | Specifies diagnostic action to take when a signal label mismatch occurs.<br><br>Set by <b>Signal label mismatch</b> on the <b>Connectivity Diagnostics</b> pane of the Configuration Parameters dialog box.                                        | string — {'none'}   'warning'   'error' |

**Model Parameters in Alphabetical Order (Continued)**

| <b>Parameter</b>        | <b>Description</b>                                                                                                                                                                                                                    | <b>Values</b>                                                                 |
|-------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------|
| SignalLogging           | Globally enable signal logging for this model.<br><br>Set by the <b>Signal logging</b> check box on the <b>Data Import/Export</b> pane of the Configuration Parameters dialog box.                                                    | string — {'on'}   'off'                                                       |
| SignalLoggingName       | Name for saving signal logging data to a workspace.<br><br>Set by the <b>Signal logging</b> field on the <b>Data Import/Export</b> pane of the Configuration Parameters dialog box.                                                   | string — {'logout'}                                                           |
| SignalRangeChecking     | Select the diagnostic action to take when signals exceed specified minimum or maximum values.<br><br>Set by <b>Simulation range checking</b> on the <b>Data Validity Diagnostics</b> pane of the Configuration Parameters dialog box. | string — {'none'}   'warning'   'error'                                       |
| SignalResolutionControl | Control which named states and signals get resolved to Simulink signal objects.<br><br>Set by <b>Signal resolution</b> on the <b>Data Validity Diagnostics</b> pane of the Configuration Parameters dialog box.                       | string — {'UseLocalSettings'}   'TryResolveAll'   'TryResolveAll-WithWarning' |

## Model Parameters in Alphabetical Order (Continued)

| Parameter                   | Description                                                                                                                                                                                                                                                                                                                                                    | Values                                                                                                                                  |
|-----------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------|
| SigSpecEnsureSample-TimeMsg | <p>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.</p> <p>Set by <b>Enforce sample times specified by Signal Specification blocks</b> on the <b>Sample Time Diagnostics</b> pane of the Configuration Parameters dialog box.</p> | string — 'none'   {'warning'}   'error'                                                                                                 |
| SimBuildMode                | <p>Specifies how you build the simulation target for a model that contains Embedded MATLAB Function blocks, Stateflow charts, or Truth Table blocks.</p> <p>Set by <b>Simulation target build mode</b> on the <b>Simulation Target</b> pane of the Configuration Parameters dialog box.</p>                                                                    | string —<br>{'sf_incremental_build'}<br> <br>'sf_nonincremental_build'<br>  'sf_make'  <br>'sf_make_clean'  <br>'sf_make_clean_objects' |
| SimCompilerOptimization     | <p>Specifies the compiler optimization level during acceleration code generation.</p> <p>Set by <b>Compiler optimization level</b> on the <b>Optimization</b> pane of the Configuration Parameters dialog box.</p>                                                                                                                                             | string — 'on'   {'off'}                                                                                                                 |

### Model Parameters in Alphabetical Order (Continued)

| Parameter            | Description                                                                                                                                                                                                                                                                                                              | Values         |
|----------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|
| SimCustomHeaderCode  | <p>Enter code lines to appear near the top of a generated header file for a model that contains Embedded MATLAB Function blocks, Stateflow charts, or Truth Table blocks.</p> <p>Set by <b>Header file</b> on the <b>Simulation Target &gt; Custom Code</b> pane of the Configuration Parameters dialog box.</p>         | string — {' '} |
| SimCustomInitializer | <p>Enter code statements that execute once at the start of simulation for a model that contains Embedded MATLAB Function blocks, Stateflow charts, or Truth Table blocks.</p> <p>Set by <b>Initialize function</b> on the <b>Simulation Target &gt; Custom Code</b> pane of the Configuration Parameters dialog box.</p> | string — {' '} |
| SimCustomSourceCode  | <p>Enter code lines to appear near the top of a generated source code file for a model that contains Embedded MATLAB Function blocks, Stateflow charts, or Truth Table blocks.</p> <p>Set by <b>Source file</b> on the <b>Simulation Target &gt; Custom Code</b> pane of the Configuration Parameters dialog box.</p>    | string — {' '} |

**Model Parameters in Alphabetical Order (Continued)**

| <b>Parameter</b>     | <b>Description</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | <b>Values</b>       |
|----------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|
| SimCustomTerminator  | <p>Enter code statements that execute at the end of simulation for a model that contains Embedded MATLAB Function blocks, Stateflow charts, or Truth Table blocks.</p> <p>Set by <b>Terminate function</b> on the <b>Simulation Target &gt; Custom Code</b> pane of the Configuration Parameters dialog box.</p>                                                                                                                                                                         | string — {' '}      |
| SimReservedNameArray | <p>Enter the names of variables or functions in the generated code that match the names of variables or functions specified in custom code. This action prevents naming conflicts between identifiers in the generated code and in custom code for a model that contains Embedded MATLAB Function blocks, Stateflow charts, or Truth Table blocks.</p> <p>Set by <b>Reserved names</b> on the <b>Simulation Target &gt; Symbols</b> pane of the Configuration Parameters dialog box.</p> | string array — {{}} |

**Model Parameters in Alphabetical Order (Continued)**

| Parameter         | Description                                                                                                                                                                                                                                             | Values                                                                                                                                                                               |
|-------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| SimulationCommand | <p>Executes a simulation command.</p> <hr/> <p><b>Note</b> You cannot use <code>set_param</code> to run a simulation in a MATLAB session that does not have a display, i.e., if you used <code>matlab -nodisplay</code> to start the session.</p> <hr/> | <p>string — 'start'   'stop'   'pause'   'continue'   'step'   'update'   'WriteDataLogs'   'SimParamDialog'   'connect'   'disconnect'   'WriteExtModeParamVect'   'AccelBuild'</p> |
| SimulationMode    | <p>Indicates whether Simulink software should run in Normal, Accelerator, Rapid Accelerator, or External mode.</p> <p>Set by the <b>Simulation</b> menu on the Model Editor.</p>                                                                        | <p>string — {'normal'}   'accelerator'   'rapid'   'external'</p>                                                                                                                    |
| SimulationStatus  | <p>Indicates simulation status.</p>                                                                                                                                                                                                                     | <p>string — {'stopped'}   'updating'   'initializing'   'running'   'paused'   'terminating'   'external'</p>                                                                        |
| SimulationTime    | <p>Current time value for the simulation.</p>                                                                                                                                                                                                           | <p>double — {0}</p>                                                                                                                                                                  |



**Model Parameters in Alphabetical Order (Continued)**

| <b>Parameter</b>   | <b>Description</b>                                                                                                                                                                                                                                                                                                                                          | <b>Values</b>  |
|--------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|
| SimUserIncludeDirs | <p>Enter a space-separated list of directory paths that contain files you include in the compiled target for a model that contains Embedded MATLAB Function blocks, Stateflow charts, or Truth Table blocks.</p> <p>Set by <b>Include directories</b> on the <b>Simulation Target &gt; Custom Code</b> pane of the Configuration Parameters dialog box.</p> | string — {' '} |
| SimUserLibraries   | <p>Enter a space-separated list of static libraries that contain custom object code to link into the target for a model that contains Embedded MATLAB Function blocks, Stateflow charts, or Truth Table blocks.</p> <p>Set by <b>Libraries</b> on the <b>Simulation Target &gt; Custom Code</b> pane of the Configuration Parameters dialog box.</p>        | string — {' '} |

### Model Parameters in Alphabetical Order (Continued)

| Parameter              | Description                                                                                                                                                                                                                                                                                                     | Values                                                                                                                                                                                                                 |
|------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| SimUserSources         | <p>Enter a list of source files to compile and link into the target for a model that contains Embedded MATLAB Function blocks, Stateflow charts, or Truth Table blocks.</p> <p>Set by <b>Source files</b> on the <b>Simulation Target &gt; Custom Code</b> pane of the Configuration Parameters dialog box.</p> | string — {' '}                                                                                                                                                                                                         |
| SingleTaskRateTransMsg | <p>Specifies diagnostic action to take when a rate transition takes place between two blocks operating in single-tasking mode.</p> <p>Set by <b>Single task rate transition</b> on the <b>Sample Time Diagnostics</b> pane of the Configuration Parameters dialog box.</p>                                      | string — {'none'}   'warning'   'error'                                                                                                                                                                                |
| Solver                 | <p>Solver used for the simulation.</p> <p>Set by the <b>Solver</b> drop-down list on the <b>Solver</b> pane of the Configuration Parameters dialog box.</p>                                                                                                                                                     | string —<br>'VariableStepDiscrete'<br>  {'ode45'}   'ode23'<br>  'ode113'   'ode15s'<br>  'ode23s'   'ode23t'<br>  'ode23tb'  <br>'FixedStepDiscrete'  <br>'ode5'   'ode4'   'ode3'<br>  'ode2'   'ode1'  <br>'ode14x' |

## Model Parameters in Alphabetical Order (Continued)

| Parameter         | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Values                                               |
|-------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------|
| SolverMode        | <p>Solver mode for this model. This option appears when the solver type is <b>Fixed-step</b>.</p> <p>Set by <b>Tasking mode for periodic sample times</b> on the <b>Solver</b> pane of the Configuration Parameters dialog box.</p>                                                                                                                                                                                                                                                                                                                     | string — {'Auto'}   'SingleTasking'   'MultiTasking' |
| SolverName        | <p>Solver used for the simulation. See <b>Solver</b> parameter for more information.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                      |
| SolverPrmCheckMsg | <p>Enables diagnostics to control when Simulink software automatically selects solver parameters. This option notifies you if:</p> <ul style="list-style-type: none"> <li>• Simulink software changes a user-modified parameter to make it consistent with other model settings</li> <li>• Simulink software automatically selects solver parameters for the model, such as <b>FixedStepSize</b></li> </ul> <p>Set by <b>Automatic solver parameter selection</b> on the <b>Solver Diagnostics</b> pane of the Configuration Parameters dialog box.</p> | string — 'none'   {'warning'}   'error'              |

### Model Parameters in Alphabetical Order (Continued)

| Parameter         | Description                                                                                                                                                                                                                                                                                                                                                                  | Values                                    |
|-------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------|
| SolverResetMethod | <p>This option appears when the solver type is <code>Variable-step</code> and the solver is <code>ode15s</code> (<code>stiff/NDF</code>), <code>ode23t</code> (<code>Mod.stiff/Trapezoidal</code>), or <code>ode23tb</code> (<code>stiff/TR-BDF2</code>).</p> <p>Set by <b>Solver reset method</b> on the <b>Solver</b> pane of the Configuration Parameters dialog box.</p> | string — {'Fast'}   'Robust'              |
| SolverType        | <p>Solver type used for the simulation.</p> <p>Set by <b>Type</b> on the <b>Solver</b> pane of the Configuration Parameters dialog box.</p>                                                                                                                                                                                                                                  | string — {'Variable-step'}   'Fixed-step' |
| SortedOrder       | <p>Show the sorted order of this model's blocks on the block diagram.</p> <p>Set by <b>Sorted Order</b> on the <b>Format &gt; Block Displays</b> menu of the Model Editor.</p>                                                                                                                                                                                               | string — 'on'   {'off'}                   |
| StartFcn          | <p>Start simulation callback.</p> <p>Set by <b>Simulation start function</b> on the <b>Callbacks</b> pane of the Model Properties dialog box.</p> <p>See “Creating Model Callback Functions” in the Simulink User's Guide for more information.</p>                                                                                                                          | string — {''}                             |

**Model Parameters in Alphabetical Order (Continued)**

| <b>Parameter</b>   | <b>Description</b>                                                                                                                                                                                                 | <b>Values</b>                 |
|--------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------|
| StartTime          | Simulation start time.<br>Set by <b>Start time</b> on the <b>Solver</b> pane of the Configuration Parameters dialog box.                                                                                           | string — {'0.0'}              |
| StateNameClashWarn | Select the diagnostic action to take when a name is used for more than one state in the model.<br>Set by <b>State name clash</b> on the <b>Solver Diagnostics</b> pane of the Configuration Parameters dialog box. | string — 'none'   {'warning'} |
| StateSaveName      | State output name to be saved to workspace.<br>Set by the <b>States</b> field on the <b>Data Import/Export</b> pane of the Configuration Parameters dialog box.                                                    | string — {'xout'}             |
| StatusBar          | Show or hide the status bar on the Model Editor window.<br>Set by <b>Status Bar</b> on the <b>View</b> menu of the Model Editor.                                                                                   | string — {'on'}   'off'       |

### Model Parameters in Alphabetical Order (Continued)

| Parameter    | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Values                                                                                                               |
|--------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------|
| StopFcn      | <p>Stop simulation callback.</p> <p>Set by <b>Simulation stop function</b> on the <b>Callbacks</b> pane of the Model Properties dialog box.</p> <p>See “Creating Model Callback Functions” in the Simulink User’s Guide for more information.</p>                                                                                                                                                                                                                | string — {''}                                                                                                        |
| StopTime     | <p>Simulation stop time.</p> <p>Set by <b>Stop time</b> on the <b>Solver</b> pane of the Configuration Parameters dialog box.</p>                                                                                                                                                                                                                                                                                                                                | string — {'10.0'}                                                                                                    |
| StrictBusMsg | <p>Specifies diagnostic action to take when Simulink software detects a signal that some blocks treat as a mux or vector, while other blocks treat the signal as a bus.</p> <p>Set by <b>Mux blocks used to create bus signals</b> and <b>Bus signal treated as vector</b> on the <b>Connectivity Diagnostics</b> pane of the Configuration Parameters dialog box.</p> <p>See “Avoiding Mux/Bus Mixtures” in the Simulink User’s Guide for more information.</p> | string — {'None'}  <br>'Warning'  <br>'ErrorLevel1'  <br>'WarnOnBusTreatedAsVector'  <br>'ErrorOnBusTreatedAsVector' |

**Model Parameters in Alphabetical Order (Continued)**

| <b>Parameter</b> | <b>Description</b>                                                                                                                                                                                                                                                             | <b>Values</b>  |
|------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|
| Tag              | User-specified text that is assigned to the model's Tag parameter and saved with the model.                                                                                                                                                                                    | string — {' '} |
| TargetBitPerChar | Describes the length in bits of the C char data type supported by the hardware that will be used to test this model.<br><br>Set by <b>char</b> in the <b>Emulation hardware</b> section of the <b>Hardware Implementation</b> pane of the Configuration Parameters dialog box. | integer — {8}  |
| TargetBitPerInt  | Describes the length in bits of the C int data type supported by the hardware that will be used to test this model.<br><br>Set by <b>int</b> in the <b>Emulation hardware</b> section of the <b>Hardware Implementation</b> pane of the Configuration Parameters dialog box.   | integer — {32} |
| TargetBitPerLong | Describes the length in bits of the C long data type supported by the hardware that will be used to test this model.<br><br>Set by <b>long</b> in the <b>Emulation hardware</b> section of the <b>Hardware Implementation</b> pane of the Configuration Parameters dialog box. | integer — {32} |

### Model Parameters in Alphabetical Order (Continued)

| Parameter          | Description                                                                                                                                                                                                                                                                                          | Values                                                  |
|--------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------|
| TargetBitPerShort  | <p>Describes the length in bits of the C <code>short</code> data type supported by the hardware that will be used to test this model.</p> <p>Set by <b>short</b> in the <b>Emulation hardware</b> section of the <b>Hardware Implementation</b> pane of the Configuration Parameters dialog box.</p> | integer — {16}                                          |
| TargetEndianness   | <p>Describes the significance of the first byte of a data word of the hardware that will be used to test.</p> <p>Set by <b>Byte ordering</b> in the <b>Emulation hardware</b> section of the <b>Hardware Implementation</b> pane of the Configuration Parameters dialog box.</p>                     | string — {'Unspecified'   'LittleEndian'   'BigEndian'} |
| TargetFcnLib       | For internal use.                                                                                                                                                                                                                                                                                    |                                                         |
| TargetHWDeviceType | <p>Describes the characteristics of the hardware that will be used to test this model.</p> <p>Set by <b>Device type</b> in the <b>Emulation hardware</b> section of the <b>Hardware Implementation</b> pane of the Configuration Parameters dialog box.</p>                                          | string — {'32-bit Generic'}                             |



## Model Parameters in Alphabetical Order (Continued)

| Parameter                            | Description                                                                                                                                                                                                                                                                                                                                                            | Values                                    |
|--------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------|
| TargetIntDivRoundTo                  | <p>Describes how the C compiler that will create test code for this model rounds the result of dividing one signed integer by another to produce a signed integer quotient.</p> <p>Set by <b>Signed integer division rounds to</b> in the <b>Emulation hardware</b> section of the <b>Hardware Implementation</b> pane of the Configuration Parameters dialog box.</p> | string — 'Floor'   'Zero'   {'Undefined'} |
| TargetShiftRightIntArith             | <p>Describes whether the C compiler that will create test code for this model implements a signed integer right shift as an arithmetic right shift.</p> <p>Set by <b>Shift right on a signed integer as arithmetic shift</b> in the <b>Emulation hardware</b> section of the <b>Hardware Implementation</b> pane of the Configuration Parameters dialog box.</p>       | string — {'on'}   'off'                   |
| TargetTypeEmulationWarnSuppressLevel | <p>Specifies whether Real-Time Workshop software displays or suppresses warning messages when emulating integer sizes in rapid prototyping environments.</p>                                                                                                                                                                                                           | integer — {0}                             |

**Model Parameters in Alphabetical Order (Continued)**

| <b>Parameter</b>         | <b>Description</b>                                                                                                                                                                                                                                                   | <b>Values</b>                           |
|--------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------|
| TargetWordSize           | <p>Describes the word length in bits of the hardware that will be used to test this model.</p> <p>Set by <b>native word size</b> in the <b>Emulation hardware</b> section of the <b>Hardware Implementation</b> pane of the Configuration Parameters dialog box.</p> | integer — {32}                          |
| TasksWithSamePriorityMsg | <p>Specifies diagnostic action to take when tasks have equal priority.</p> <p>Set by <b>Tasks with equal priority</b> on the <b>Sample Time Diagnostics</b> pane of the Configuration Parameters dialog box.</p>                                                     | string — '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.                                                                                                                             | vector — [left, top, right, bottom]     |

## Model Parameters in Alphabetical Order (Continued)

| Parameter         | Description                                                                                                                                                                                                                                                      | Values                        |
|-------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------|
| TimeAdjustmentMsg | Specifies diagnostic action to take if Simulink software makes a minor adjustment to a sample hit time while running the model.<br><br>Set by <b>Sample hit time adjusting</b> on the <b>Solver Diagnostics</b> pane of the Configuration Parameters dialog box. | string — {'none'}   'warning' |
| TimeSaveName      | Simulation time name.<br><br>Set by the <b>Time</b> field on the <b>Data Import/Export</b> 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 or hide the toolbar on the Model Editor window.<br><br>Set by <b>Toolbar</b> on the <b>View</b> menu of the Model Editor.                                                                                                                                   | string — {'on'}   'off'       |
| TryForcingSFcnDF  | This flag is used for backward compatibility with user S-functions that were written prior to R12.                                                                                                                                                               | string — 'on'   {'off'}       |

**Model Parameters in Alphabetical Order (Continued)**

| <b>Parameter</b>         | <b>Description</b>                                                                                                                                                         | <b>Values</b>                           |
|--------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------|
| TunableVars              | List of global (tunable) parameters.<br>Set in the Model Parameter Configuration dialog box.                                                                               | string — {''}                           |
| TunableVarsStorageClass  | List of storage classes for their respective tunable parameters.<br>Set in the Model Parameter Configuration dialog box.                                                   | string — {''}                           |
| TunableVarsTypeQualifier | List of storage type qualifiers for their respective tunable parameters.<br>Set in the Model Parameter Configuration dialog box.                                           | string — {''}                           |
| Type                     | Simulink object type (read only).                                                                                                                                          | string — {'block_diagram'}              |
| UnconnectedInputMsg      | Unconnected input ports diagnostic.<br>Set by <b>Unconnected block input ports</b> on the <b>Connectivity Diagnostics</b> pane of the Configuration Parameters dialog box. | string — 'none'   {'warning'}   'error' |
| UnconnectedLineMsg       | Unconnected lines diagnostic.<br>Set by <b>Unconnected line</b> on the <b>Connectivity Diagnostics</b> pane of the Configuration Parameters dialog box.                    | string — 'none'   {'warning'}   'error' |

### Model Parameters in Alphabetical Order (Continued)

| Parameter                             | Description                                                                                                                                                                                                                                                                                                                                              | Values                                  |
|---------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------|
| UnconnectedOutputMsg                  | <p>Unconnected block output ports diagnostic.</p> <p>Set by <b>Unconnected block output ports</b> on the <b>Connectivity Diagnostics</b> pane of the Configuration Parameters dialog box.</p>                                                                                                                                                            | string — 'none'   {'warning'}   'error' |
| UnderSpecifiedDataTypeMsg             | <p>Detect usage of heuristics to assign signal data types.</p> <p>Set by <b>Underspecified data types</b> on the <b>Data Validity Diagnostics</b> pane of the Configuration Parameters dialog box.</p>                                                                                                                                                   | string — {'none'}   'warning'   'error' |
| UnderspecifiedInitializationDetection | <p>Select how Simulink software handles initialization of initial conditions for conditionally executed subsystems, Merge blocks, subsystem elapsed time, and Discrete-Time Integrator blocks.</p> <p>Set by <b>Underspecified initialization detection</b> on the <b>Data Validity Diagnostics</b> pane of the Configuration Parameters dialog box.</p> | string — {'classic'}   'simplified'     |

**Model Parameters in Alphabetical Order (Continued)**

| <b>Parameter</b>            | <b>Description</b>                                                                                                                                                                                                                                                                   | <b>Values</b>                           |
|-----------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------|
| UniqueDataStoreMsg          | <p>Specifies diagnostic action to take when the model contains multiple Data Store Memory blocks that specify the same data store name.</p> <p>Set by <b>Duplicate data store names</b> on the <b>Data Validity Diagnostics</b> pane of the Configuration Parameters dialog box.</p> | string — {'none'}   'warning'   'error' |
| UnknownTsInhSupMsg          | <p>Detect blocks that have not set whether they allow the model containing them to inherit a sample time.</p> <p>Set by <b>Unspecified inheritability of sample time</b> on the <b>Solver Diagnostics</b> pane of the Configuration Parameters dialog box.</p>                       | string — 'none'   {'warning'}   'error' |
| UnnecessaryDatatype-ConvMsg | <p>Detect unnecessary data type conversion blocks.</p> <p>Set by <b>Unnecessary type conversions</b> on the <b>Type Conversion Diagnostics</b> pane of the Configuration Parameters dialog box.</p>                                                                                  | string — {'none'}   'warning'           |

## Model Parameters in Alphabetical Order (Continued)

| Parameter                    | Description                                                                                                                                                                                                                                                                                                                                                                    | Values                                                                                             |
|------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------|
| UpdateHistory                | <p>Specifies when to prompt the user about updating the model history.</p> <p>Set by <b>Prompt to update model history</b> on the <b>History</b> pane of the Model Properties dialog box or <b>Prompt to update model history</b> on the <b>History</b> pane of the Model Explorer.</p> <p>See “Model History Controls” in the Simulink User’s Guide for more information.</p> | string —<br>{ 'UpdateHistoryNever' }  <br>'UpdateHistoryWhenSave'                                  |
| UpdateModelReference-Targets | <p>Specify whether to rebuild simulation and Real-Time Workshop targets for referenced models before updating, simulating, or generating code from this model.</p> <p>Set by <b>Rebuild options</b> on the <b>Model Referencing</b> pane of the Configuration Parameters dialog box.</p>                                                                                       | string — 'IfOutOfDate'<br>  'Force'  <br>'AssumeUpToDate'  <br>{ 'IfOutOfDateOrStructuralChange' } |
| UseAnalysisPorts             | For internal use.                                                                                                                                                                                                                                                                                                                                                              |                                                                                                    |

### Model Parameters in Alphabetical Order (Continued)

| Parameter                 | Description                                                                                                                                                                                                                                                                                            | Values                                                                                   |
|---------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------|
| VectorMatrixConversionMsg | <p>Detect vector-to-matrix or matrix-to-vector conversions.</p> <p>Set by <b>Vector/matrix block input conversion</b> on the <b>Type Conversion Diagnostics</b> pane of the Configuration Parameters dialog box.</p>                                                                                   | string — {'none'}   'warning'   'error'                                                  |
| Version                   | Simulink version used to modify the model (read only).                                                                                                                                                                                                                                                 | release version number                                                                   |
| WideLines                 | <p>Draws lines that carry vector or matrix signals wider than lines that carry scalar signals.</p> <p>Set by <b>Wide Nonscalar Lines</b> on the <b>Format &gt; Port/Signal Displays</b> menu of the Model Editor.</p>                                                                                  | string — 'on'   {'off'}                                                                  |
| WideVectorLines           | Deprecated. Use WideLines instead.                                                                                                                                                                                                                                                                     |                                                                                          |
| WriteAfterReadMsg         | <p>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.</p> <p>Set by <b>Detect write after read</b> on the <b>Data Validity Diagnostics</b> pane of the Configuration Parameters dialog box.</p> | string — {'UseLocalSettings'}   'DisableAll'   'EnableAllAsWarning'   'EnableAllAsError' |



## Model Parameters in Alphabetical Order (Continued)

| Parameter          | Description                                                                                                                                                                                                                                                                           | Values                                                                                                   |
|--------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------|
| WriteAfterWriteMsg | <p>Specifies diagnostic action to take when the model attempts to store data in a data store twice in succession in the current time step.</p> <p>Set by <b>Detect write after write</b> on the <b>Data Validity Diagnostics</b> pane of the Configuration Parameters dialog box.</p> | <p>string —</p> <p>{ 'UseLocalSettings' }   'DisableAll'   'EnableAllAsWarning'   'EnableAllAsError'</p> |
| ZCThreshold        | <p>Specifies the deadband region used during the detection of zero crossings. Signals falling within this region are defined as having crossed through zero.</p> <p>Set by <b>Signal threshold</b> on the <b>Solver</b> pane of the Configuration Parameters dialog box.</p>          | <p>string — { 'auto' }   any real number greater than or equal to zero</p>                               |
| ZeroCross          | For internal use.                                                                                                                                                                                                                                                                     |                                                                                                          |
| ZeroCrossAlgorithm | <p>Specifies the algorithm to detect zero crossings when you select a variable-step solver.</p> <p>Set by <b>Algorithm</b> on the <b>Solver</b> pane of the Configuration Parameters dialog box.</p>                                                                                  | <p>string — { 'Nonadaptive' }   'Adaptive'</p>                                                           |

**Model Parameters in Alphabetical Order (Continued)**

| Parameter        | Description                                                                                                                                                                                                                             | Values                                                                |
|------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------|
| ZeroCrossControl | Enable zero-crossing detection.<br>Set by <b>Zero-crossing control</b> on the <b>Solver</b> pane of the Configuration Parameters dialog box.                                                                                            | string —<br>{ 'UseLocalSettings' }<br>  'EnableAll'  <br>'DisableAll' |
| ZoomFactor       | Zoom factor of the Model Editor window expressed as a percentage of normal (100%) or by the keywords <code>FitSystem</code> or <code>FitSelection</code> .<br><br>Set by the zoom commands on the <b>View</b> menu of the Model Editor. | string — { '100' }<br>  'FitSystem'  <br>'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

| In this section...                                  |
|-----------------------------------------------------|
| “About Common Block Parameters” on page 8-83        |
| “Examples of Setting Block Parameters” on page 8-94 |

### About 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 8-94).

#### 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 <b>Block Parameters</b> 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 <b>Block Properties</b> dialog box.                       | string                                                                                                                                                                          |

**Common Block Parameters (Continued)**

| <b>Parameter</b>            | <b>Description</b>                                                      | <b>Values</b>                     |
|-----------------------------|-------------------------------------------------------------------------|-----------------------------------|
| BlockType                   | Block type (read only).                                                 | string                            |
| ClipboardFcn                | Function called when block is copied to the clipboard ( <b>Ctrl+C</b> ) | string                            |
| CloseFcn                    | Function called when <code>close_system</code> is run on block.         | string                            |
| CompiledPort-ComplexSignals | Complexity of port signals after updating diagram.                      | structure array                   |
| CompiledPortDataTypes       | Data types of port signals after updating diagram.                      | structure array                   |
| CompiledPortDimensions      | Dimensions of port signals after updating diagram.                      | structure array                   |
| CompiledPortFrameData       | Frame mode of port signals after updating diagram.                      | structure array                   |
| CompiledPortWidths          | Structure of port widths after updating diagram.                        | structure array                   |
| CompiledSampleTime          | Block sample time after updating diagram.                               | vector [sample time, offset time] |
| CopyFcn                     | Function called when block is copied.                                   | string                            |
| DataTypeOverrideCompiled    | For internal use.                                                       |                                   |

**Common Block Parameters (Continued)**

| <b>Parameter</b> | <b>Description</b>                                                                                                                                                                                                                                                                                                                 | <b>Values</b>     |
|------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|
| DeleteFcn        | Function called when block is deleted. If a block is graphically deleted, you can still undo the operation and call the block's UndoDeleteFcn. In addition, for graphically deleted blocks, the block's DestroyFcn is still called when the model is closed or any subsystem containing the block is destroyed using delete_block. | MATLAB expression |
| DestroyFcn       | Function called when block is destroyed. If you run the delete_block command for a block, it first calls the block's DeleteFcn, then calls the DestroyFcn for that block; no undo is possible. The DestroyFcn is also called when you close the model or invoke delete_block on a subsystem containing the block.                  | MATLAB expression |
| Description      | Description of block. Set by the <b>Description</b> field in the <b>General</b> pane of the <b>Block Properties</b> dialog box.                                                                                                                                                                                                    | text and tokens   |
| Diagnostics      | For internal use.                                                                                                                                                                                                                                                                                                                  |                   |
| DialogParameters | Names/attributes of parameters in block's parameter dialog box.                                                                                                                                                                                                                                                                    | structure         |
| DropShadow       | Display drop shadow.                                                                                                                                                                                                                                                                                                               | {'off'}   'on'    |

## Common Block Parameters (Continued)

| Parameter               | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Values                                          |
|-------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------|
| ExtModeLoggingSupported | Enable a block to support uploading of signal data in external mode (for example, with a scope block).                                                                                                                                                                                                                                                                                                                                                                          | { 'off' }   'on'                                |
| ExtModeLoggingTrig      | Enable a block to act as the trigger block for external mode signal uploading.                                                                                                                                                                                                                                                                                                                                                                                                  | { 'off' }   'on'                                |
| ExtModeUploadOption     | Enable a block to upload signal data in external mode when the <b>Select all</b> check box on the External Signal & Triggering dialog box is not selected. A value of <b>log</b> indicates the block uploads signals. A value of <b>none</b> indicates the block does not upload signals. The value <b>monitor</b> is currently not in use. If the <b>Select all</b> check box on the External Signal & Triggering dialog box is selected, it overrides this parameter setting. | { 'none' }   'log'   'monitor'                  |
| 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 <code>DefaultBlockFontSize</code> model parameter.                                                                                                                                                                                                                                                                                                                                   | real {'-1'}                                     |
| FontWeight              | Font weight.                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | 'light'   'normal'   'demi'   'bold'   {'auto'} |

**Common Block Parameters (Continued)**

| <b>Parameter</b>                | <b>Description</b>                                                                                                                                                                                                        | <b>Values</b>                                                                                                                                                             |
|---------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 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                                                                                                                                                                      |
| HiliteAncestors                 | For internal use.                                                                                                                                                                                                         |                                                                                                                                                                           |
| InitFcn                         | Initialization function for a masked block. Created on the <b>Callbacks</b> 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                          | Signal & Scope Manager type.                                                                                                                                                                                              | {'none'}   'viewer'   'sigen'                                                                                                                                             |
| LineHandles                     | Handles of lines connected to block.                                                                                                                                                                                      | struct                                                                                                                                                                    |
| LinkStatus                      | Link status of block. Updates out-of-date reference blocks when queried using get_param.                                                                                                                                  | {'none'}   'resolved'   'unresolved'   'implicit'   'inactive'   'restore'   'propagate'                                                                                  |
| LoadFcn                         | Function called when block is loaded.                                                                                                                                                                                     | MATLAB expression                                                                                                                                                         |
| MinMaxOverflow-Logging_Compiled | For internal use.                                                                                                                                                                                                         |                                                                                                                                                                           |

**Common Block Parameters (Continued)**

| <b>Parameter</b>    | <b>Description</b>                                                                                                                            | <b>Values</b>                      |
|---------------------|-----------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------|
| ModelCloseFcn       | Function called when model is closed. The ModelCloseFcn is called prior to the block's DeleteFcn and DestroyFcn callbacks, if either are set. | MATLAB expression                  |
| ModelParamTableInfo | 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 <b>Block Parameters</b> 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. The ParentCloseFcn of blocks at the root model level is not called when the model is closed. | MATLAB expression                  |



## Common Block Parameters (Continued)

| Parameter        | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Values          |
|------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|
| PortConnectivity | <p>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:</p> <ul style="list-style-type: none"> <li>• <b>Type</b> <p>Specifies the port's type and/or number. The value of this field can be:</p> <ul style="list-style-type: none"> <li>▪ <math>n</math>, where <math>n</math> is the number of the port for data ports</li> <li>▪ 'enable' if the port is an enable port</li> <li>▪ 'trigger' if the port is a trigger port</li> <li>▪ 'state' for state ports</li> <li>▪ 'ifaction' for action ports</li> <li>▪ 'LConn#' for a left connection port where # is the port's number</li> <li>▪ 'RConn#' for a right connection port where # is the port's number</li> </ul> </li> <li>• <b>Position</b> <p>The value of this field is a two-element vector, <math>[x\ y]</math>, that specifies the port's position.</p> </li> </ul> | structure array |

**Common Block Parameters (Continued)**

| Parameter   | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Values          |
|-------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|
|             | <ul style="list-style-type: none"> <li>• SrcBlock<br/>Handle of the block connected to this port. This field is null for output ports.</li> <li>• SrcPort<br/>Number of the port connected to this port. This field is null for output ports.</li> <li>• DstBlock<br/>Handle of the block to which this port is connected. This field is null for input ports.</li> <li>• DstPort<br/>Number of the port to which this port is connected. This field is null for input ports.</li> </ul> |                 |
| PortHandles | <p>The value of this parameter is a structure that specifies the handles of the block's ports. The structure has the following fields:</p> <ul style="list-style-type: none"> <li>• Inport<br/>Handles of the block's input ports.</li> <li>• Outport<br/>Handles of the block's output ports.</li> </ul>                                                                                                                                                                                | structure array |

**Common Block Parameters (Continued)**

| Parameter | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Values |
|-----------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|
|           | <ul style="list-style-type: none"> <li>• Enable<br/>Handle of the block's enable port.</li> <li>• Trigger<br/>Handle of the block's trigger port.</li> <li>• State<br/>Handle of the block's state port.</li> <li>• LConn<br/>Handles of the block's left connection ports.</li> <li>• RConn<br/>Handles of the block's right connection ports.</li> <li>• Ifaction<br/>Handle of the block's action port.</li> </ul> |        |

**Common Block Parameters (Continued)**

| <b>Parameter</b> | <b>Description</b>                                                                                                                                                                                                                                                                                                                                                    | <b>Values</b>                                                                                                   |
|------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------|
| Ports            | <p>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:</p> <ul style="list-style-type: none"> <li>• Inport</li> <li>• Outport</li> <li>• Enable</li> <li>• Trigger</li> <li>• State</li> <li>• LConn</li> <li>• RConn</li> <li>• Ifaction</li> </ul> | vector                                                                                                          |
| Position         | Position of block in model window.                                                                                                                                                                                                                                                                                                                                    | vector [left top right bottom]<br>not enclosed in quotation marks. The maximum value for a coordinate is 32767. |
| PostSaveFcn      | Function called after the block is saved. Created on the <b>Callbacks</b> pane of the Model Properties dialog box. See "Creating Model Callback Functions" in the Using Simulink documentation for further information.                                                                                                                                               | MATLAB expression                                                                                               |

**Common Block Parameters (Continued)**

| <b>Parameter</b> | <b>Description</b>                                                                                                                                                                          | <b>Values</b>     |
|------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|
| PreCopyFcn       | Function called before the block is copied. See “Block Callback Parameters” in the Using Simulink documentation for details.                                                                | MATLAB expression |
| PreDeleteFcn     | Function called before the block is deleted. See “Block Callback Parameters” in the Using Simulink documentation for details.                                                               | MATLAB expression |
| PreSaveFcn       | Function called before the block is saved.                                                                                                                                                  | MATLAB expression |
| Priority         | Specifies the block’s order of execution relative to other blocks in the same model. Set by the <b>Priority</b> field on the <b>General</b> pane of the <b>Block Properties</b> 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 software.                                                                                                                                   |                   |
| SampleTime       | Value of the sample time parameter.                                                                                                                                                         | string            |
| Selected         | Status of whether or not block is selected.                                                                                                                                                 | { 'on' }   'off'  |
| ShowName         | Display block name.                                                                                                                                                                         | { 'on' }   'off'  |

**Common Block Parameters (Continued)**

| <b>Parameter</b>              | <b>Description</b>                                                                                                                                                          | <b>Values</b>                                                                            |
|-------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------|
| StartFcn                      | Function called at the start of a simulation.                                                                                                                               | MATLAB expression                                                                        |
| StatePerturbation-ForJacobian | State perturbation size to use during linearization. See “Linearizing Individual Blocks Using Block Perturbation” in the Simulink Control Design documentation for details. | string                                                                                   |
| StaticLinkStatus              | Link status of block. Does not update out-of-date reference blocks when queried using <code>get_param</code> .                                                              | {'none'   'resolved'   'unresolved'   'implicit'   'inactive'   'restore'   'propagate'} |
| StopFcn                       | Function called at the termination of a simulation.                                                                                                                         | MATLAB expression                                                                        |
| Tag                           | Text that appears in the block label that Simulink software generates. Set by the <b>Tag</b> field on the <b>General</b> pane of the <b>Block Properties</b> dialog box.    | string { ' ' }                                                                           |
| 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 <code>UserData</code> 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 (see "Common Block Parameters" on page 8-83); the type listed for masked blocks is the value of the block's `MaskType` parameter (see "Mask Parameters" on page 8-218).

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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
- Discontinuities Library Block Parameters
- Discrete Library Block Parameters
- Logic and Bit Operations Library Block Parameters
- Lookup Tables Block Parameters
- Math Operations Library Block Parameters
- Model Verification Library Block Parameters
- Model-Wide Utilities Library Block Parameters
- Ports & Subsystems Library Block Parameters
- Signal Attributes Library Block Parameters
- Signal Routing Library Block Parameters
- Sinks Library Block Parameters
- Sources Library Block Parameters
- User-Defined Functions Library Block Parameters



- Additional Discrete Block Library Parameters
- Additional Math: Increment - Decrement Block Parameters

### Continuous Library Block Parameters

| Block (Type)/Parameter    | Dialog Box Prompt                            | Values                                                                                |
|---------------------------|----------------------------------------------|---------------------------------------------------------------------------------------|
| Derivative (Derivative)   |                                              |                                                                                       |
| LinearizePole             | Linearization Time Constant<br>$s/(N_s + 1)$ | string — {'inf'}                                                                      |
| Integrator (Integrator)   |                                              |                                                                                       |
| ExternalReset             | External reset                               | string — {'none'}  <br>'rising'   'falling'  <br>'either'   'level'  <br>'level hold' |
| InitialConditionSource    | Initial condition source                     | string — {'internal'}  <br>'external'                                                 |
| InitialCondition          | Initial condition                            | scalar or vector — {'0'}                                                              |
| LimitOutput               | Limit output                                 | string — {'off'}   'on'                                                               |
| UpperSaturationLimit      | Upper saturation limit                       | scalar or vector — {'inf'}                                                            |
| LowerSaturationLimit      | Lower saturation limit                       | scalar or vector — {'-inf'}                                                           |
| ShowSaturationPort        | Show saturation port                         | string — {'off'}   'on'                                                               |
| ShowStatePort             | Show state port                              | string — {'off'}   'on'                                                               |
| AbsoluteTolerance         | Absolute tolerance                           | scalar — {'auto'}                                                                     |
| IgnoreLimit               | Ignore limit and reset when<br>linearizing   | string — {'off'}   'on'                                                               |
| ZeroCross                 | Enable zero-crossing detection               | string — 'off'   {'on'}                                                               |
| ContinuousStateAttributes | State Name                                   | string — {''}   variable                                                              |
| State-Space (StateSpace)  |                                              |                                                                                       |
| A                         | A                                            | matrix — {'1'}                                                                        |
| B                         | B                                            | matrix — {'1'}                                                                        |

**Continuous Library Block Parameters (Continued)**

| <b>Block (Type)/Parameter</b>           | <b>Dialog Box Prompt</b>                         | <b>Values</b>                                                         |
|-----------------------------------------|--------------------------------------------------|-----------------------------------------------------------------------|
| C                                       | C                                                | matrix — {'1'}                                                        |
| D                                       | D                                                | matrix — {'1'}                                                        |
| X0                                      | Initial conditions                               | vector — {'0'}                                                        |
| AbsoluteTolerance                       | Absolute tolerance                               | scalar — {'auto'}                                                     |
| ContinuousStateAttributes               | State Name                                       | string — {' '}   variable                                             |
| Transfer Fcn (TransferFcn)              |                                                  |                                                                       |
| Numerator                               | Numerator coefficient                            | vector or matrix — {'[1]'}<br>vector — {'[1 1]'}<br>scalar — {'auto'} |
| Denominator                             | Denominator coefficient                          | vector — {'[1 1]'}<br>scalar — {'auto'}                               |
| AbsoluteTolerance                       | Absolute tolerance                               | scalar — {'auto'}                                                     |
| ContinuousStateAttributes               | State Name                                       | string — {' '}   variable                                             |
| 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                            | string — {'off'}   'on'                                               |
| TransDelayFeedthrough                   | Direct feedthrough of input during linearization | string — {'off'}   'on'                                               |
| PadeOrder                               | Pade order (for linearization)                   | string — {'0'}                                                        |
| Variable Time Delay (VariableTimeDelay) |                                                  |                                                                       |
| VariableDelayType                       | Select delay type                                | string — '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'}                                                     |

**Continuous Library Block Parameters (Continued)**

| <b>Block (Type)/Parameter</b>                            | <b>Dialog Box Prompt</b>                         | <b>Values</b>                                                 |
|----------------------------------------------------------|--------------------------------------------------|---------------------------------------------------------------|
| FixedBuffer                                              | Use fixed buffer size                            | string — {'off'}   'on'                                       |
| ZeroDelay                                                | Handle zero delay                                | string — {'off'}   'on'                                       |
| TransDelayFeedthrough                                    | Direct feedthrough of input during linearization | string — {'off'}   'on'                                       |
| PadeOrder                                                | Pade order (for linearization)                   | string — {'0'}                                                |
| ContinuousStateAttributes                                | State Name                                       | string — {''}   variable                                      |
| <b>Variable Transport Delay (VariableTransportDelay)</b> |                                                  |                                                               |
| VariableDelayType                                        | Select delay type                                | string — {'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                            | string — {'off'}   'on'                                       |
| TransDelayFeedthrough                                    | Direct feedthrough of input during linearization | string — {'off'}   'on'                                       |
| PadeOrder                                                | Pade order (for linearization)                   | string — {'0'}                                                |
| AbsoluteTolerance                                        | Absolute tolerance                               | scalar — {'auto'}                                             |
| ContinuousStateAttributes                                | State Name                                       | string — {''}   variable                                      |
| <b>Zero-Pole (ZeroPole)</b>                              |                                                  |                                                               |
| Zeros                                                    | Zeros                                            | vector — {'[1]'}<br>'[1]'                                     |
| Poles                                                    | Poles                                            | vector — {'[0 -1]'}<br>'[0 -1]'                               |
| Gain                                                     | Gain                                             | vector — {'[1]'}<br>'[1]'                                     |
| AbsoluteTolerance                                        | Absolute tolerance                               | scalar — {'auto'}                                             |
| ContinuousStateAttributes                                | State Name                                       | string — {''}   variable                                      |

**Discontinuities Library Block Parameters**

| <b>Block (Type)/Parameter</b>                                                  | <b>Dialog Box Prompt</b>               | <b>Values</b>                              |
|--------------------------------------------------------------------------------|----------------------------------------|--------------------------------------------|
| Backlash (Backlash)                                                            |                                        |                                            |
| BacklashWidth                                                                  | Deadband width                         | scalar or vector — {'1'}                   |
| InitialOutput                                                                  | Initial output                         | scalar or vector — {'0'}                   |
| ZeroCross                                                                      | Enable zero-crossing detection         | string — '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           | string — 'off'   {'on'}                    |
| LinearizeAsGain                                                                | Treat as gain when linearizing         | string — 'off'   {'on'}                    |
| ZeroCross                                                                      | Enable zero-crossing detection         | string — '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'}                   |
| HitCrossingDirection                                                           | Hit crossing direction                 | string — 'rising'   'falling'   {'either'} |
| ShowOutputPort                                                                 | Show output port                       | string — 'off'   {'on'}                    |
| ZeroCross                                                                      | Enable zero-crossing detection         | string — 'off'   {'on'}                    |
| SampleTime                                                                     | Sample time (-1 for inherited)         | string — {'-1'}                            |

**Discontinuities Library Block Parameters (Continued)**

| <b>Block (Type)/Parameter</b>                                  | <b>Dialog Box Prompt</b>       | <b>Values</b>                         |
|----------------------------------------------------------------|--------------------------------|---------------------------------------|
| Quantizer (Quantizer)                                          |                                |                                       |
| QuantizationInterval                                           | Quantization interval          | scalar or vector — {'0.5'}            |
| LinearizeAsGain                                                | Treat as gain when linearizing | string — '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               | string — 'continuous'   {'inherited'} |
| InitialCondition                                               | Initial condition              | string — {'0'}                        |
| LinearizeAsGain                                                | Treat as gain when linearizing | string — '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'}                        |
| ZeroCross                                                      | Enable zero-crossing detection | string — 'off'   {'on'}               |
| SampleTime                                                     | Sample time (-1 for inherited) | string — {'-1'}                       |
| OutMin                                                         | Output minimum                 | string — {'[]'}                       |
| OutMax                                                         | Output maximum                 | string — {'[]'}                       |

**Discontinuities Library Block Parameters (Continued)**

| <b>Block (Type)/Parameter</b> | <b>Dialog Box Prompt</b>                                    | <b>Values</b>                                                                                                                                                                                                                      |
|-------------------------------|-------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| OutDataTypeStr                | Output data type                                            | string — 'Inherit: Inherit via back propagation'   {'Inherit: All ports same datatype'}   'double'   'single'   'int8'   'uint8'   'int16'   'uint16'   'int32'   'uint32'   'fixdt(1,16)'   'fixdt(1,16,0)'   'fixdt(1,16,2^0,0)' |
| LockScale                     | Lock output scaling against changes by the autoscaling tool | string — {'off'}   'on'                                                                                                                                                                                                            |
| Saturation (Saturate)         |                                                             |                                                                                                                                                                                                                                    |
| UpperLimit                    | Upper limit                                                 | scalar or vector — {'0.5'}                                                                                                                                                                                                         |
| LowerLimit                    | Lower limit                                                 | scalar or vector — {'-0.5'}                                                                                                                                                                                                        |
| LinearizeAsGain               | Treat as gain when linearizing                              | string — 'off'   {'on'}                                                                                                                                                                                                            |
| ZeroCross                     | Enable zero-crossing detection                              | string — 'off'   {'on'}                                                                                                                                                                                                            |
| SampleTime                    | Sample time (-1 for inherited)                              | string — {'-1'}                                                                                                                                                                                                                    |
| OutMin                        | Output minimum                                              | string — {'[]'}                                                                                                                                                                                                                    |
| OutMax                        | Output maximum                                              | string — {'[]'}                                                                                                                                                                                                                    |

**Discontinuities Library Block Parameters (Continued)**

| <b>Block (Type)/Parameter</b>                              | <b>Dialog Box Prompt</b>                                          | <b>Values</b>                                                                                                                                                                                                                       |
|------------------------------------------------------------|-------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| OutDataTypeStr                                             | Output data type                                                  | string — 'Inherit:<br>Inherit via back<br>propagation'   {'Inherit:<br>Same as input'}  <br>'double'   'single'<br>  'int8'   'uint8'<br>  'int16'   'uint16'<br>  'int32'   'uint32'<br>  'fixdt(1,16,0)'  <br>'fixdt(1,16,2^0,0)' |
| LockScale                                                  | Lock output scaling against<br>changes by the autoscaling<br>tool | string — {'off'}   'on'                                                                                                                                                                                                             |
| RndMeth                                                    | Integer rounding mode                                             | string — 'Ceiling'  <br>'Convergent'   {'Floor'}<br>  'Nearest'   'Round'  <br>'Simplest'   'Zero'                                                                                                                                  |
| Saturation Dynamic (Saturation Dynamic) (masked subsystem) |                                                                   |                                                                                                                                                                                                                                     |
| OutMin                                                     | Output minimum                                                    | string — {'[]'}                                                                                                                                                                                                                     |
| OutMax                                                     | Output maximum                                                    | string — {'[]'}                                                                                                                                                                                                                     |
| OutDataTypeStr                                             | Output data type                                                  | string — {'Inherit:<br>Same as second input'}<br>  'double'   'single'<br>  'int8'   'uint8'<br>  'int16'   'uint16'<br>  'int32'   'uint32'<br>  'fixdt(1,16,0)'  <br>'fixdt(1,16,2^0,0)'                                          |
| OutputDataTypeScaling<br>Mode                              | Deprecated                                                        |                                                                                                                                                                                                                                     |
| OutDataType                                                | Deprecated                                                        |                                                                                                                                                                                                                                     |
| OutScaling                                                 | Deprecated                                                        |                                                                                                                                                                                                                                     |

**Discontinuities Library Block Parameters (Continued)**

| Block (Type)/Parameter                         | Dialog Box Prompt                                           | Values                                                                                    |
|------------------------------------------------|-------------------------------------------------------------|-------------------------------------------------------------------------------------------|
| LockScale                                      | Lock output scaling against changes by the autoscaling tool | string — {'off'}   'on'                                                                   |
| RndMeth                                        | Integer rounding mode                                       | string — 'Ceiling'   'Convergent'   {'Floor'}   'Nearest'   'Round'   'Simplest'   'Zero' |
| DoSatur                                        | Saturate on integer overflow                                | string — {'off'}   'on'                                                                   |
| 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'}                                                                                                                                                                                                     |
| OutMin                                     | Output minimum                       | string — {'[]'}                                                                                                                                                                                                      |
| OutMax                                     | Output maximum                       | string — {'[]'}                                                                                                                                                                                                      |
| OutDataTypeStr                             | Output data type                     | string — {'Inherit: Inherit via internal rule'}   'Inherit: Inherit via back propagation'   'double'   'single'   'int8'   'uint8'   'int16'   'uint16'   'int32'   'uint32'   'fixdt(1,16,0)'   'fixdt(1,16,2^0,0)' |



**Discrete Library Block Parameters (Continued)**

| <b>Block (Type)/Parameter</b>                                | <b>Dialog Box Prompt</b>                                    | <b>Values</b>                                                                                                                                                                                                        |
|--------------------------------------------------------------|-------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| OutputDataTypeScaling Mode                                   | Deprecated                                                  |                                                                                                                                                                                                                      |
| OutDataType                                                  | Deprecated                                                  |                                                                                                                                                                                                                      |
| OutScaling                                                   | Deprecated                                                  |                                                                                                                                                                                                                      |
| LockScale                                                    | Lock output scaling against changes by the autoscaling tool | string — {'off'}   'on'                                                                                                                                                                                              |
| RndMeth                                                      | Integer rounding mode                                       | string — 'Ceiling'   'Convergent'   {'Floor'}   'Nearest'   'Round'   'Simplest'   'Zero'                                                                                                                            |
| DoSatur                                                      | Saturate to max or min when overflows occur                 | string — {'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'}                                                                                                                                                                                                     |
| OutMin                                                       | Output minimum                                              | string — {'[]'}                                                                                                                                                                                                      |
| OutMax                                                       | Output maximum                                              | string — {'[]'}                                                                                                                                                                                                      |
| OutDataTypeStr                                               | Output data type                                            | string — {'Inherit: Inherit via internal rule'}   'Inherit: Inherit via back propagation'   'double'   'single'   'int8'   'uint8'   'int16'   'uint16'   'int32'   'uint32'   'fixdt(1,16,0)'   'fixdt(1,16,2^0,0)' |

**Discrete Library Block Parameters (Continued)**

| <b>Block (Type)/Parameter</b>             | <b>Dialog Box Prompt</b>                                    | <b>Values</b>                                                                                                                                                                                                                                      |
|-------------------------------------------|-------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| OutputDataTypeScaling Mode                | Deprecated                                                  |                                                                                                                                                                                                                                                    |
| OutDataType                               | Deprecated                                                  |                                                                                                                                                                                                                                                    |
| OutScaling                                | Deprecated                                                  |                                                                                                                                                                                                                                                    |
| LockScale                                 | Lock output scaling against changes by the autoscaling tool | string — {'off'}   'on'                                                                                                                                                                                                                            |
| RndMeth                                   | Integer rounding mode                                       | string — 'Ceiling'   'Convergent'   {'Floor'}   'Nearest'   'Round'   'Simplest'   'Zero'                                                                                                                                                          |
| DoSatur                                   | Saturate to max or min when overflows occur                 | string — {'off'}   'on'                                                                                                                                                                                                                            |
| Discrete FIR Filter (Discrete FIR Filter) |                                                             |                                                                                                                                                                                                                                                    |
| CoefSource                                | Coefficient source                                          | string — {'Dialog parameters'}   'Input port'                                                                                                                                                                                                      |
| FirFiltStruct                             | Filter structure                                            | string — {'Direct form'}   'Direct form symmetric'   'Direct form antisymmetric'   'Direct form transposed'   'Lattice MA'<br><br><b>Note</b> You must have a Signal Processing Blockset license to use a filter structure other than Direct form. |
| NumCoeffs                                 | Numerator coefficient                                       | vector — {'[0.5 0.5]'}<br><hr/>                                                                                                                                                                                                                    |

**Discrete Library Block Parameters (Continued)**

| <b>Block (Type)/Parameter</b> | <b>Dialog Box Prompt</b>       | <b>Values</b>                                                                                                                                                                  |
|-------------------------------|--------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| IC                            | Initial states                 | scalar or vector — {'0'}                                                                                                                                                       |
| SampleTime                    | Sample time (-1 for inherited) | string — {'-1'}                                                                                                                                                                |
| CoefMin                       | Coefficient minimum            | string — {'[]'}                                                                                                                                                                |
| CoefMax                       | Coefficient maximum            | string — {'[]'}                                                                                                                                                                |
| OutMin                        | Output minimum                 | string — {'[]'}                                                                                                                                                                |
| OutMax                        | Output maximum                 | string — {'[]'}                                                                                                                                                                |
| CoefDataTypeStr               | Coefficient data type          | string — {'Inherit:<br>Same word length as<br>input'}   'int8'  <br>'uint8'   'int16'  <br>'uint16'   'int32'  <br>'uint32'   'fixdt(1,16)'<br>  'fixdt(1,16,0)'               |
| ProductDataTypeStr            | Product output data type       | string — {'Inherit:<br>Inherit via internal<br>rule'}   'Inherit:<br>Same as input'  <br>'int8'   'uint8'  <br>'int16'   'uint16'  <br>'int32'   'uint32'  <br>'fixdt(1,16,0)' |
| AccumDataTypeStr              | Accumulator data type          | string — 'Inherit: Same<br>as input'   {'Inherit:<br>Same as product output'}<br>  'int8'   'uint8'  <br>'int16'   'uint16'  <br>'int32'   'uint32'  <br>'fixdt(1,16,0)'       |

**Discrete Library Block Parameters (Continued)**

| <b>Block (Type)/Parameter</b>    | <b>Dialog Box Prompt</b>                             | <b>Values</b>                                                                                                                                       |
|----------------------------------|------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------|
| OutDataTypeStr                   | Output data type                                     | string — 'Inherit: Same as input'   {'Inherit: Same as accumulator'}   'int8'   'uint8'   'int16'   'uint16'   'int32'   'uint32'   'fixdt(1,16,0)' |
| LockScale                        | Lock scaling against changes by the autoscaling tool | string — {'off'}   'on'                                                                                                                             |
| RndMeth                          | Integer rounding mode                                | string — 'Ceiling'   'Convergent'   {'Floor'}   'Nearest'   'Round'   'Simplest'   'Zero'                                                           |
| SaturateOnInteger Overflow       | Saturate on integer overflow                         | string — {'off'}   'on'                                                                                                                             |
| Discrete Filter (DiscreteFilter) |                                                      |                                                                                                                                                     |
| Numerator                        | Numerator coefficient                                | vector — {'[1]'}                                                                                                                                    |
| Denominator                      | Denominator coefficient                              | vector — {'[1 0.5]'}                                                                                                                                |
| IC                               | Initial states                                       | string — {'0'}                                                                                                                                      |
| SampleTime                       | Sample time (-1 for inherited)                       | string — {'1'}                                                                                                                                      |
| a0EqualsOne                      | Leading denominator coefficient equals 1             | string — {'off'}   'on'                                                                                                                             |
| NumCoefMin                       | Numerator coefficient minimum                        | string — {'[]'}                                                                                                                                     |
| NumCoefMax                       | Numerator coefficient maximum                        | string — {'[]'}                                                                                                                                     |
| DenCoefMin                       | Denominator coefficient minimum                      | string — {'[]'}                                                                                                                                     |
| DenCoefMax                       | Denominator coefficient maximum                      | string — {'[]'}                                                                                                                                     |

**Discrete Library Block Parameters (Continued)**

| <b>Block (Type)/Parameter</b> | <b>Dialog Box Prompt</b>             | <b>Values</b>                                                                                                             |
|-------------------------------|--------------------------------------|---------------------------------------------------------------------------------------------------------------------------|
| OutMin                        | Output minimum                       | string — {'[]'}                                                                                                           |
| OutMax                        | Output maximum                       | string — {'[]'}                                                                                                           |
| StateDataTypeStr              | State data type                      | string — {'Inherit: Same as input'}   'int8'   'int16'   'int32'   'fixdt(1,16,0)'                                        |
| NumCoefDataTypeStr            | Numerator coefficient data type      | string — {'Inherit: Inherit via internal rule'}   'int8'   'int16'   'int32'   'fixdt(1,16)'   'fixdt(1,16,0)'            |
| DenCoefDataTypeStr            | Denominator coefficient data type    | string — {'Inherit: Inherit via internal rule'}   'int8'   'int16'   'int32'   'fixdt(1,16)'   'fixdt(1,16,0)'            |
| NumProductDataTypeStr         | Numerator product output data type   | string — {'Inherit: Inherit via internal rule'}   'Inherit: Same as input'   'int8'   'int16'   'int32'   'fixdt(1,16,0)' |
| DenProductDataTypeStr         | Denominator product output data type | string — {'Inherit: Inherit via internal rule'}   'Inherit: Same as input'   'int8'   'int16'   'int32'   'fixdt(1,16,0)' |

**Discrete Library Block Parameters (Continued)**

| <b>Block (Type)/Parameter</b>  | <b>Dialog Box Prompt</b>                             | <b>Values</b>                                                                                                                                                 |
|--------------------------------|------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------|
| NumAccumDataTypeStr            | Numerator accumulator data type                      | string — {'Inherit: Inherit via internal rule'}   'Inherit: Same as input'   'Inherit: Same as product output'   'int8'   'int16'   'int32'   'fixdt(1,16,0)' |
| DenAccumDataTypeStr            | Denominator accumulator data type                    | string — {'Inherit: Inherit via internal rule'}   'Inherit: Same as input'   'Inherit: Same as product output'   'int8'   'int16'   'int32'   'fixdt(1,16,0)' |
| OutDataTypeStr                 | Output data type                                     | string — {'Inherit: Inherit via internal rule'}   'Inherit: Same as input'   'int8'   'int16'   'int32'   'fixdt(1,16,0)'                                     |
| LockScale                      | Lock scaling against changes by the autoscaling tool | string — {'off'}   'on'                                                                                                                                       |
| RndMeth                        | Integer rounding mode                                | string — 'Ceiling'   'Convergent'   {'Floor'}   'Nearest'   'Round'   'Simplest'   'Zero'                                                                     |
| SaturateOnIntegerOverflow      | Saturate on integer overflow                         | string — {'off'}   'on'                                                                                                                                       |
| StateIdentifier                | State name                                           | string — {''}                                                                                                                                                 |
| StateMustResolveToSignalObject | State name must resolve to Simulink signal object    | string — {'off'}   'on'                                                                                                                                       |

**Discrete Library Block Parameters (Continued)**

| <b>Block (Type)/Parameter</b>                      | <b>Dialog Box Prompt</b>                          | <b>Values</b>                                                                     |
|----------------------------------------------------|---------------------------------------------------|-----------------------------------------------------------------------------------|
| RTWStateStorageClass                               | Real-Time Workshop storage class                  | string — {'Auto'}   'ExportedGlobal'   'ImportedExtern'   'ImportedExternPointer' |
| RTWStateStorageType Qualifier                      | Real-Time Workshop storage type qualifier         | string — {' '}                                                                    |
| <b>Discrete State-Space (DiscreteStateSpace)</b>   |                                                   |                                                                                   |
| A                                                  | A                                                 | matrix — {'1'}                                                                    |
| B                                                  | B                                                 | matrix — {'1'}                                                                    |
| C                                                  | C                                                 | matrix — {'1'}                                                                    |
| D                                                  | D                                                 | matrix — {'1'}                                                                    |
| X0                                                 | Initial conditions                                | vector — {'0'}                                                                    |
| SampleTime                                         | Sample time (-1 for inherited)                    | string — {'1'}                                                                    |
| StateIdentifier                                    | State name                                        | string — {' '}                                                                    |
| StateMustResolveTo SignalObject                    | State name must resolve to Simulink signal object | string — {'off'}   'on'                                                           |
| RTWStateStorageClass                               | Real-Time Workshop storage class                  | string — {'Auto'}   'ExportedGlobal'   'ImportedExtern'   'ImportedExternPointer' |
| RTWStateStorageType Qualifier                      | Real-Time Workshop storage type qualifier         | string — {' '}                                                                    |
| <b>Discrete Transfer Fcn (DiscreteTransferFcn)</b> |                                                   |                                                                                   |
| Numerator                                          | Numerator coefficient                             | vector — {'[1]'}                                                                  |
| Denominator                                        | Denominator coefficient                           | vector — {'[1 0.5]'}                                                              |
| SampleTime                                         | Sample time (-1 for inherited)                    | string {'1'}                                                                      |
| StateIdentifier                                    | State name                                        | string — {' '}                                                                    |

**Discrete Library Block Parameters (Continued)**

| <b>Block (Type)/Parameter</b>                        | <b>Dialog Box Prompt</b>                             | <b>Values</b>                                                                              |
|------------------------------------------------------|------------------------------------------------------|--------------------------------------------------------------------------------------------|
| StateMustResolveTo<br>SignalObject                   | State name must resolve to<br>Simulink signal object | string — {'off'}   'on'                                                                    |
| RTWStateStorageClass                                 | Real-Time Workshop storage<br>class                  | string — {'Auto'}  <br>'ExportedGlobal'  <br>'ImportedExtern'  <br>'ImportedExternPointer' |
| RTWStateStorageType<br>Qualifier                     | Real-Time Workshop storage<br>type qualifier         | string — {''}                                                                              |
| <b>Discrete Zero-Pole (DiscreteZeroPole)</b>         |                                                      |                                                                                            |
| Zeros                                                | Zeros                                                | vector — {'[1]'}                                                                           |
| Poles                                                | Poles                                                | vector — {'[0 0.5]'}<br>'[0 0.5]'                                                          |
| Gain                                                 | Gain                                                 | string — {'1'}                                                                             |
| SampleTime                                           | Sample time (-1 for inherited)                       | string — {'1'}                                                                             |
| StateIdentifier                                      | State name                                           | string — {''}                                                                              |
| StateMustResolveTo<br>SignalObject                   | State name must resolve to<br>Simulink signal object | string — {'off'}   'on'                                                                    |
| RTWStateStorageClass                                 | Real-Time Workshop storage<br>class                  | string — {'Auto'}  <br>'ExportedGlobal'  <br>'ImportedExtern'  <br>'ImportedExternPointer' |
| RTWStateStorageType<br>Qualifier                     | Real-Time Workshop storage<br>type qualifier         | string — {''}                                                                              |
| <b>Discrete-Time Integrator (DiscreteIntegrator)</b> |                                                      |                                                                                            |



**Discrete Library Block Parameters (Continued)**

| <b>Block (Type)/Parameter</b> | <b>Dialog Box Prompt</b>                             | <b>Values</b>                                                                                                                                                                                       |
|-------------------------------|------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| IntegratorMethod              | Integrator method                                    | string — {'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                                       | string — {'none'}   'rising'   'falling'   'either'   'level'   'sampled level'                                                                                                                     |
| InitialConditionSource        | Initial condition source                             | string — {'internal'}   'external'                                                                                                                                                                  |
| InitialCondition              | Initial condition                                    | scalar or vector — {'0'}                                                                                                                                                                            |
| InitialConditionMode          | Use initial condition as initial and reset value for | string — 'State only (most efficient)'   {'State and output'}                                                                                                                                       |
| SampleTime                    | Sample time (-1 for inherited)                       | string — {'1'}                                                                                                                                                                                      |
| LimitOutput                   | Limit output                                         | string — {'off'}   'on'                                                                                                                                                                             |
| UpperSaturationLimit          | Upper saturation limit                               | scalar or vector — {'inf'}                                                                                                                                                                          |
| LowerSaturationLimit          | Lower saturation limit                               | scalar or vector — {'-inf'}                                                                                                                                                                         |
| ShowSaturationPort            | Show saturation port                                 | string — {'off'}   'on'                                                                                                                                                                             |
| ShowStatePort                 | Show state port                                      | string — {'off'}   'on'                                                                                                                                                                             |
| IgnoreLimit                   | Ignore limit and reset when linearizing              | string — {'off'}   'on'                                                                                                                                                                             |

**Discrete Library Block Parameters (Continued)**

| <b>Block (Type)/Parameter</b>      | <b>Dialog Box Prompt</b>                                          | <b>Values</b>                                                                                                                                                                                                                                      |
|------------------------------------|-------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| OutMin                             | Output minimum                                                    | string — {'[]'}                                                                                                                                                                                                                                    |
| OutMax                             | Output maximum                                                    | string — {'[]'}                                                                                                                                                                                                                                    |
| OutDataTypeStr                     | Output data type                                                  | string — {'Inherit:<br>Inherit via internal<br>rule'}   'Inherit:<br>Inherit via back<br>propagation'  <br>'double'   'single'<br>  'int8'   'uint8'<br>  'int16'   'uint16'<br>  'int32'   'uint32'<br>  'fixdt(1,16,0)'  <br>'fixdt(1,16,2^0,0)' |
| LockScale                          | Lock output scaling against<br>changes by the autoscaling<br>tool | string — {'off'}   'on'                                                                                                                                                                                                                            |
| RndMeth                            | Integer rounding mode                                             | string — 'Ceiling'  <br>'Convergent'   {'Floor'}<br>  'Nearest'   'Round'  <br>'Simplest'   'Zero'                                                                                                                                                 |
| SaturateOnInteger<br>Overflow      | Saturate on integer overflow                                      | string — {'off'}   'on'                                                                                                                                                                                                                            |
| StateIdentifier                    | State name                                                        | string — {''}                                                                                                                                                                                                                                      |
| StateMustResolveTo<br>SignalObject | State name must resolve to<br>Simulink signal object              | string — {'off'}   'on'                                                                                                                                                                                                                            |
| RTWStateStorageClass               | Real-Time Workshop storage<br>class                               | string — {'Auto'}  <br>'ExportedGlobal'  <br>'ImportedExtern'  <br>'ImportedExternPointer'                                                                                                                                                         |
| RTWStateStorageType<br>Qualifier   | Real-Time Workshop storage<br>type qualifier                      | string — {''}                                                                                                                                                                                                                                      |

**Discrete Library Block Parameters (Continued)**

| <b>Block (Type)/Parameter</b>                                    | <b>Dialog Box Prompt</b>                                         | <b>Values</b>                                                                     |
|------------------------------------------------------------------|------------------------------------------------------------------|-----------------------------------------------------------------------------------|
| 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                                              | string — {'off'}   'on'                                                           |
| LinearizeMemory                                                  | Direct feedthrough of input during linearization                 | string — {'off'}   'on'                                                           |
| LinearizeAsDelay                                                 | Treat as a unit delay when linearizing with discrete sample time | string — {'off'}   'on'                                                           |
| StateIdentifier                                                  | State name                                                       | string — {''}                                                                     |
| StateMustResolveToSignalObject                                   | State name must resolve to Simulink signal object                | string — {'off'}   'on'                                                           |
| RTWStateStorageClass                                             | Real-Time Workshop storage class                                 | string — {'Auto'}   'ExportedGlobal'   'ImportedExtern'   'ImportedExternPointer' |
| RTWStateStorageTypeQualifier                                     | Real-Time Workshop storage type qualifier                        | string — {''}                                                                     |
| Tapped Delay (S-Function) (Tapped Delay Line) (masked subsystem) |                                                                  |                                                                                   |
| vinit                                                            | Initial condition                                                | string — {'0.0'}                                                                  |
| samptime                                                         | Sample time                                                      | string — {'-1'}                                                                   |
| NumDelays                                                        | Number of delays                                                 | string — {'4'}                                                                    |

**Discrete Library Block Parameters (Continued)**

| <b>Block (Type)/Parameter</b>                                          | <b>Dialog Box Prompt</b>                    | <b>Values</b>                                                                             |
|------------------------------------------------------------------------|---------------------------------------------|-------------------------------------------------------------------------------------------|
| DelayOrder                                                             | Order output vector starting with           | string — {'Oldest'}   'Newest'                                                            |
| includeCurrent                                                         | Include current input in output vector      | string — {'off'}   'on'                                                                   |
| Transfer Fcn First Order (First Order Transfer Fcn) (masked subsystem) |                                             |                                                                                           |
| PoleZ                                                                  | Pole (in Z plane)                           | string — {'0.95'}                                                                         |
| ICPrevOutput                                                           | Initial condition for previous output       | string — {'0.0'}                                                                          |
| RndMeth                                                                | Integer rounding mode                       | string — 'Ceiling'   'Convergent'   {'Floor'}   'Nearest'   'Round'   'Simplest'   'Zero' |
| DoSatur                                                                | Saturate to max or min when overflows occur | string — {'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                                                                | Integer rounding mode                       | string — 'Ceiling'   'Convergent'   {'Floor'}   'Nearest'   'Round'   'Simplest'   'Zero' |
| DoSatur                                                                | Saturate to max or min when overflows occur | string — {'off'}   'on'                                                                   |

**Discrete Library Block Parameters (Continued)**

| <b>Block (Type)/Parameter</b>                                      | <b>Dialog Box Prompt</b>                          | <b>Values</b>                                                                             |
|--------------------------------------------------------------------|---------------------------------------------------|-------------------------------------------------------------------------------------------|
| Transfer Fcn Real Zero (Transfer Fcn Real Zero) (masked subsystem) |                                                   |                                                                                           |
| ZeroZ                                                              | Zero (in Z plane)                                 | string — {'0.75'}                                                                         |
| ICPrevInput                                                        | Initial condition for previous input              | string — {'0.0'}                                                                          |
| RndMeth                                                            | Integer rounding mode                             | string — 'Ceiling'   'Convergent'   {'Floor'}   'Nearest'   'Round'   'Simplest'   'Zero' |
| DoSatur                                                            | Saturate to max or min when overflows occur       | string — {'off'}   'on'                                                                   |
| Unit Delay (UnitDelay)                                             |                                                   |                                                                                           |
| X0                                                                 | Initial conditions                                | scalar or vector — {'0'}                                                                  |
| SampleTime                                                         | Sample time                                       | string — {'-1'}                                                                           |
| StateIdentifier                                                    | State name                                        | string — {''}                                                                             |
| StateMustResolveToSignalObject                                     | State name must resolve to Simulink signal object | string — {'off'}   'on'                                                                   |
| RTWStateStorageClass                                               | Real-Time Workshop storage class                  | string — {'Auto'}   'ExportedGlobal'   'ImportedExtern'   'ImportedExternPointer'         |
| RTWStateStorageTypeQualifier                                       | Real-Time Workshop storage type qualifier         | string — {''}                                                                             |
| Zero-Order Hold (ZeroOrderHold)                                    |                                                   |                                                                                           |
| SampleTime                                                         | Sample time (-1 for inherited)                    | string — {'1'}                                                                            |

**Logic and Bit Operations Library Block Parameters**

| <b>Block (Type)/Parameter</b>            | <b>Dialog Box Prompt</b> | <b>Values</b> |
|------------------------------------------|--------------------------|---------------|
| Bit Clear (Bit Clear) (masked subsystem) |                          |               |

**Logic and Bit Operations Library Block Parameters (Continued)**

| <b>Block (Type)/Parameter</b>                                       | <b>Dialog Box Prompt</b>              | <b>Values</b>                                            |
|---------------------------------------------------------------------|---------------------------------------|----------------------------------------------------------|
| 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                              | string — {'AND'}   'OR'   'NAND'   'NOR'   'XOR'   'NOT' |
| UseBitMask                                                          | Use bit mask ...                      | string — 'off'   {'on'}                                  |
| NumInputPorts                                                       | Number of input ports                 | string — {'1'}                                           |
| BitMask                                                             | Bit Mask                              | string — {'bin2dec('11011001')} }                        |
| BitMaskRealWorld                                                    | Treat mask as                         | string — '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                              | string — '=='   '~='   '<'   {'<='}   '>='   '>'         |
| const                                                               | Constant value                        | string — {'3.0'}                                         |
| LogicOutDataTypeMode                                                | Output data type mode                 | string — {'uint8'}   'boolean'                           |
| ZeroCross                                                           | Enable zero-crossing detection        | string — {'off'}   'on'                                  |
| Compare To Zero (Compare To Zero) (masked subsystem)                |                                       |                                                          |

**Logic and Bit Operations Library Block Parameters (Continued)**

| <b>Block (Type)/Parameter</b>                                        | <b>Dialog Box Prompt</b>       | <b>Values</b>                                                                                                                                     |
|----------------------------------------------------------------------|--------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------|
| relop                                                                | Operator                       | string — '='   '~='   '<'   {'<='}   '>='   '>'                                                                                                   |
| LogicOutDataTypeMode                                                 | Output data type mode          | string — {'uint8'}   'boolean'                                                                                                                    |
| ZeroCross                                                            | Enable zero-crossing detection | string — {'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)                       |                                |                                                                                                                                                   |
| bitsToExtract                                                        | Bits to extract                | string — {'Upper half'}   'Lower half'   'Range starting with most significant bit'   'Range ending with least significant bit'   'Range of bits' |

**Logic and Bit Operations Library Block Parameters (Continued)**

| <b>Block (Type)/Parameter</b>                                    | <b>Dialog Box Prompt</b>                           | <b>Values</b>                                                               |
|------------------------------------------------------------------|----------------------------------------------------|-----------------------------------------------------------------------------|
| numBits                                                          | Number of bits                                     | string — {'8'}                                                              |
| bitIdxRange                                                      | Bit indices ([start end], 0-based relative to LSB) | string — {'[0 7]'}                                                          |
| outScalingMode                                                   | Output scaling mode                                | string — {'Preserve fixed-point scaling'   'Treat bit field as an integer'} |
| Interval Test (Interval Test) (masked subsystem)                 |                                                    |                                                                             |
| IntervalClosedRight                                              | Interval closed on right                           | string — 'off'   {'on'}                                                     |
| uplimit                                                          | Upper limit                                        | string — {'0.5'}                                                            |
| IntervalClosedLeft                                               | Interval closed on left                            | string — 'off'   {'on'}                                                     |
| lowlimit                                                         | Lower limit                                        | string — {'-0.5'}                                                           |
| LogicOutDataTypeMode                                             | Output data type mode                              | string — 'uint8'   {'boolean'}                                              |
| Interval Test Dynamic (Interval Test Dynamic) (masked subsystem) |                                                    |                                                                             |
| IntervalClosedRight                                              | Interval closed on right                           | string — 'off'   {'on'}                                                     |
| IntervalClosedLeft                                               | Interval closed on left                            | string — 'off'   {'on'}                                                     |
| LogicOutDataTypeMode                                             | Output data type mode                              | string — 'uint8'   {'boolean'}                                              |
| Logical Operator (Logic)                                         |                                                    |                                                                             |
| Operator                                                         | Operator                                           | string — {'AND'}   'OR'   'NAND'   'NOR'   'XOR'   'NXOR'   'NOT'           |
| Inputs                                                           | Number of input ports                              | string — {'2'}                                                              |
| IconShape                                                        | Icon shape                                         | string — {'rectangular'}   'distinctive'                                    |
| SampleTime                                                       | Sample time (-1 for inherited)                     | string — {'-1'}                                                             |



**Logic and Bit Operations Library Block Parameters (Continued)**

| <b>Block (Type)/Parameter</b>                          | <b>Dialog Box Prompt</b>                                                               | <b>Values</b>                                                                                                         |
|--------------------------------------------------------|----------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------|
| AllPortsSameDT                                         | Require all inputs and output to have the same data type                               | string — {'off'}   'on'                                                                                               |
| OutDataTypeStr                                         | Output data type                                                                       | string — 'Inherit:<br>Logical (see<br>Configuration Parameters:<br>Optimization)'<br>  {'boolean'}  <br>'fixdt(1,16)' |
| Relational Operator (RelationalOperator)               |                                                                                        |                                                                                                                       |
| Operator                                               | Relational operator                                                                    | string — '=='   '~='   '<'  <br>  {'<='}   '>='   '>'                                                                 |
| ZeroCross                                              | Enable zero-crossing detection                                                         | string — 'off'   {'on'}                                                                                               |
| SampleTime                                             | Sample time (-1 for inherited)                                                         | string — {'-1'}                                                                                                       |
| InputSameDT                                            | Require all inputs to have the same data type                                          | string — {'off'}   'on'                                                                                               |
| OutDataTypeStr                                         | Output data type                                                                       | string — 'Inherit:<br>Logical (see<br>Configuration Parameters:<br>Optimization)'<br>  {'boolean'}  <br>'fixdt(1,16)' |
| Shift Arithmetic (Shift Arithmetic) (masked subsystem) |                                                                                        |                                                                                                                       |
| nBitShiftRight                                         | Number of bits to shift right (use negative value to shift left)                       | string — {'8'}                                                                                                        |
| 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                         | string — 'sin(2*pi*u)'<br>  {'cos(2*pi*u)'}  <br>'exp(j*2*pi*u)'  <br>'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             | string — '1'   {'2'}   '3'  <br>'4'   'More...'                                                     |
| explicitNumDims                                                            | Explicit number of table dimensions    | string — {'1'}                                                                                      |
| outDims                                                                    | Inputs select this object from table   | string — {'Element'}   'Column'<br>  '2-D Matrix'                                                   |
| tabIsInput                                                                 | Make table an input                    | string — {'off'}   'on'                                                                             |
| mxTable                                                                    | Table data                             | string — {'[4 5 6;16 19 20;10<br>18 23]'}                                                           |
| clipFlag                                                                   | Action for out of range input          | string — 'None'   {'Warning'}  <br>'Error'                                                          |
| samptime                                                                   | Sample time                            | string — {'-1'}                                                                                     |
| Interpolation Using Prelookup (Interpolation_n-D)                          |                                        |                                                                                                     |
| NumberOfTableDimensions                                                    | Number of table dimensions             | string — '1'   {'2'}   '3'  <br>'4'                                                                 |
| Table                                                                      | Table data                             | string — {'sqrt([1:11]' *<br>[1:11])'}                                                              |
| InterpMethod                                                               | Interpolation method                   | string — 'None - Flat'  <br>{'Linear'}                                                              |

**Lookup Tables Block Parameters (Continued)**

| <b>Block (Type)/Parameter</b> | <b>Dialog Box Prompt</b>                             | <b>Values</b>                                                                                                                                                                                                      |
|-------------------------------|------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| ExtrapMethod                  | Extrapolation method                                 | string — 'None - Clip'   {'Linear'}                                                                                                                                                                                |
| RangeErrorMode                | Action for out of range input                        | string — {'None'}   'Warning'   'Error'                                                                                                                                                                            |
| CheckIndexInCode              | Check index in generated code                        | string — 'off'   {'on'}                                                                                                                                                                                            |
| ValidIndexMayReachLast        | Valid index input may reach last index               | string — {'off'}   'on'                                                                                                                                                                                            |
| NumSelectionDims              | Number of sub-table selection dimensions             | string — {'0'}                                                                                                                                                                                                     |
| SampleTime                    | Sample time (-1 for inherited)                       | string — {'-1'}                                                                                                                                                                                                    |
| OutMin                        | Output minimum                                       | string — {'[]'}                                                                                                                                                                                                    |
| OutMax                        | Output maximum                                       | string — {'[]'}                                                                                                                                                                                                    |
| OutDataTypeStr                | Output data type                                     | string — 'Inherit: Inherit via back propagation'   {'Inherit: Inherit from table data'}   'double'   'single'   'int8'   'uint8'   'int16'   'uint16'   'int32'   'uint32'   'fixdt(1,16,0)'   'fixdt(1,16,2^0,0)' |
| LockScale                     | Lock scaling against changes by the autoscaling tool | string — {'off'}   'on'                                                                                                                                                                                            |
| RndMeth                       | Integer rounding mode                                | string — 'Ceiling'   'Convergent'   {'Floor'}   'Nearest'   'Round'   'Simplest'   'Zero'                                                                                                                          |
| SaturateOnIntegerOverflow     | Saturate on integer overflow                         | string — {'off'}   'on'                                                                                                                                                                                            |

**Lookup Tables Block Parameters (Continued)**

| <b>Block (Type)/Parameter</b>  | <b>Dialog Box Prompt</b>       | <b>Values</b>                                                                                                                                                                                                         |
|--------------------------------|--------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| TableMin                       | Table minimum                  | string — {'[]'}                                                                                                                                                                                                       |
| TableMax                       | Table maximum                  | string — {'[]'}                                                                                                                                                                                                       |
| TableDataTypeStr               | Table data type                | string — 'Inherit: Inherit from 'Table data'   {'Inherit: Same as output'}   'double'   'single'   'int8'   'uint8'   'int16'   'uint16'   'int32'   'uint32'   'fixdt(1,16)'   'fixdt(1,16,0)'   'fixdt(1,16,2^0,0)' |
| IntermediateResultsDataTypeStr | Intermediate results data type | string — {'Inherit: Inherit via internal rule'}   'Inherit: Same as output'   'double'   'single'   'int8'   'uint8'   'int16'   'uint16'   'int32'   'uint32'   'fixdt(1,16,0)'   'fixdt(1,16,2^0,0)'                |
| Lookup Table (Lookup)          |                                |                                                                                                                                                                                                                       |
| InputValues                    | Vector of input values         | vector — {'[-5:5]}'}                                                                                                                                                                                                  |
| Table                          | Table data                     | vector — {'tanh([-5:5])}'}                                                                                                                                                                                            |
| LookUpMeth                     | Lookup method                  | string — {'Interpolation-Extrapolation'}   'Interpolation-Use End Values'   'Use Input Nearest'   'Use Input Below'   'Use Input Above'                                                                               |
| SampleTime                     | Sample time (-1 for inherited) | string — {'-1'}                                                                                                                                                                                                       |
| OutMin                         | Output minimum                 | string — {'[]'}                                                                                                                                                                                                       |

**Lookup Tables Block Parameters (Continued)**

| <b>Block (Type)/Parameter</b> | <b>Dialog Box Prompt</b>                                    | <b>Values</b>                                                                                                                                                                                            |
|-------------------------------|-------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| OutMax                        | Output maximum                                              | string — {'[]'}                                                                                                                                                                                          |
| OutDataTypeStr                | Output data type                                            | string — 'Inherit: Inherit via back propagation'   {'Inherit: Same as input'}   'double'   'single'   'int8'   'uint8'   'int16'   'uint16'   'int32'   'uint32'   'fixdt(1,16,0)'   'fixdt(1,16,2^0,0)' |
| LockScale                     | Lock output scaling against changes by the autoscaling tool | string — {'off'}   'on'                                                                                                                                                                                  |
| RndMeth                       | Integer rounding mode                                       | string — 'Ceiling'   'Convergent'   {'Floor'}   'Nearest'   'Round'   'Simplest'   'Zero'                                                                                                                |
| SaturateOnInteger Overflow    | Saturate on integer overflow                                | string — {'off'}   'on'                                                                                                                                                                                  |
| Lookup Table (2-D) (Lookup2D) |                                                             |                                                                                                                                                                                                          |
| RowIndex                      | Row index input values                                      | string — {'[1:3]'}<br>string — {'[1:3]'}<br>string — {'[4 5 6;16 19 20;10 18 23]'}                                                                                                                       |
| ColumnIndex                   | Column index input values                                   |                                                                                                                                                                                                          |
| Table                         | Table data                                                  |                                                                                                                                                                                                          |
| LookUpMeth                    | Lookup method                                               | string — {'Interpolation-Extrapolation'}   'Interpolation-Use End Values'   'Use Input Nearest'   'Use Input Below'   'Use Input Above'                                                                  |
| SampleTime                    | Sample time (-1 for inherited)                              | string — {'-1'}                                                                                                                                                                                          |

**Lookup Tables Block Parameters (Continued)**

| <b>Block (Type)/Parameter</b>   | <b>Dialog Box Prompt</b>                                    | <b>Values</b>                                                                                                                                                                                                  |
|---------------------------------|-------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| OutMin                          | Output minimum                                              | string — {'[]'}                                                                                                                                                                                                |
| OutMax                          | Output maximum                                              | string — {'[]'}                                                                                                                                                                                                |
| InputSameDT                     | Require all inputs to have the same data type               | string — {'off'}   'on'                                                                                                                                                                                        |
| OutDataTypeStr                  | Output data type                                            | string — 'Inherit: Inherit via back propagation'   {'Inherit: Same as first input'}   'double'   'single'   'int8'   'uint8'   'int16'   'uint16'   'int32'   'uint32'   'fixdt(1,16,0)'   'fixdt(1,16,2^0,0)' |
| LockScale                       | Lock output scaling against changes by the autoscaling tool | string — {'off'}   'on'                                                                                                                                                                                        |
| RndMeth                         | Integer rounding mode                                       | string — 'Ceiling'   'Convergent'   {'Floor'}   'Nearest'   'Round'   'Simplest'   'Zero'                                                                                                                      |
| SaturateOnInteger Overflow      | Saturate on integer overflow                                | string — {'off'}   'on'                                                                                                                                                                                        |
| Lookup Table (n-D) (Lookup_n-D) |                                                             |                                                                                                                                                                                                                |
| NumberOfTableDimensions         | Number of table dimensions                                  | string — '1'   {'2'}   '3'   '4'                                                                                                                                                                               |
| BreakpointsForDimension1        | Breakpoints for dimension 1                                 | string — {'[10,22,31]'}   '1'                                                                                                                                                                                  |
| BreakpointsForDimension2        | Breakpoints for dimension 2                                 | string — {'[10,22,31]'}   '2'                                                                                                                                                                                  |
| BreakpointsForDimension3        | Breakpoints for dimension 3                                 | string — {'[1:3]'}   '3'                                                                                                                                                                                       |

**Lookup Tables Block Parameters (Continued)**

| <b>Block (Type)/Parameter</b>                | <b>Dialog Box Prompt</b>                                    | <b>Values</b>                                                         |
|----------------------------------------------|-------------------------------------------------------------|-----------------------------------------------------------------------|
| BreakpointsForDimension4                     | Breakpoints for dimension 4                                 | string — {'[1:3]'}                                                    |
| BreakpointsForDimension5                     | Breakpoints for dimension 5                                 | string — {'[1:3]'}                                                    |
| IndexSearchMethod                            | Index search method                                         | string — 'Evenly spaced points'   'Linear search'   {'Binary search'} |
| BeginIndexSearchUsing<br>PreviousIndexResult | Begin index search using previous index result              | string — {'off'}   'on'                                               |
| UseOneInputPortForAll<br>InputData           | Use one input port for all input data                       | string — {'off'}   'on'                                               |
| ProcessOutOfRangeInput                       | Process out-of-range input                                  | string — {'None'}   'Warning'   'Error'                               |
| Table                                        | Table data                                                  | string — {'[4 5 6;16 19 20;10 18 23]'}                                |
| InterpMethod                                 | Interpolation method                                        | string — 'None - Flat'   {'Linear'}   'Cubic spline'                  |
| ExtrapMethod                                 | Extrapolation method                                        | string — 'None - Clip'   {'Linear'}   'Cubic spline'                  |
| UseLastTableValue                            | Use last table value for inputs at or above last breakpoint | string — {'off'}   'on'                                               |
| SampleTime                                   | Sample time (-1 for inherited)                              | string — {'-1'}                                                       |
| InputSameDT                                  | Require all inputs to have the same data type               | string — 'off'   {'on'}                                               |
| OutMin                                       | Output minimum                                              | string — {'[]'}                                                       |
| OutMax                                       | Output maximum                                              | string — {'[]'}                                                       |

**Lookup Tables Block Parameters (Continued)**

| <b>Block (Type)/Parameter</b>                                  | <b>Dialog Box Prompt</b>                                    | <b>Values</b>                                                                                                                                                                                                                                       |
|----------------------------------------------------------------|-------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| OutDataTypeStr                                                 | Output data type                                            | string — 'Inherit: Inherit via back propagation'   'Inherit: Inherit from table data'   {'Inherit: Same as first input'}   'double'   'single'   'int8'   'uint8'   'int16'   'uint16'   'int32'   'uint32'   'fixdt(1,16,0)'   'fixdt(1,16,2^0,0)' |
| LockScale                                                      | Lock output scaling against changes by the autoscaling tool | string — {'off'}   'on'                                                                                                                                                                                                                             |
| RndMeth                                                        | Integer rounding mode                                       | string — 'Ceiling'   'Convergent'   {'Floor'}   'Nearest'   'Round'   'Simplest'   'Zero'                                                                                                                                                           |
| FractionDataTypeStr                                            | Fraction data type                                          | string — {'Inherit: Inherit via internal rule'}   'double'   'single'   'fixdt(1,16,0)'                                                                                                                                                             |
| Lookup Table Dynamic (Lookup Table Dynamic) (masked subsystem) |                                                             |                                                                                                                                                                                                                                                     |
| LookUpMeth                                                     | Lookup Method                                               | string — 'Interpolation-Extrapolation'   {'Interpolation-Use End Values'}   'Use Input Nearest'   'Use Input Below'   'Use Input Above'                                                                                                             |
| OutDataTypeStr                                                 | Output data type                                            | string — {'fixdt('double')}   'Inherit: Inherit via back propagation'   'fixdt(1,16,0)'   'fixdt(1,16,2^0,0)'                                                                                                                                       |



**Lookup Tables Block Parameters (Continued)**

| <b>Block (Type)/Parameter</b>             | <b>Dialog Box Prompt</b>                                    | <b>Values</b>                                                                             |
|-------------------------------------------|-------------------------------------------------------------|-------------------------------------------------------------------------------------------|
| OutputDataTypeScaling Mode                | Deprecated                                                  |                                                                                           |
| OutDataType                               | Deprecated                                                  |                                                                                           |
| OutScaling                                | Deprecated                                                  |                                                                                           |
| LockScale                                 | Lock output scaling against changes by the autoscaling tool | string — {'off'}   'on'                                                                   |
| RndMeth                                   | Integer rounding mode                                       | string — 'Ceiling'   'Convergent'   {'Floor'}   'Nearest'   'Round'   'Simplest'   'Zero' |
| DoSatur                                   | Saturate to max or min when overflows occur                 | string — {'off'}   'on'                                                                   |
| Prelookup (PreLookup)                     |                                                             |                                                                                           |
| BreakpointsData                           | Breakpoint data                                             | string — {'[10:10:110]'}                                                                  |
| IndexSearchMethod                         | Index search method                                         | string — 'Evenly spaced points'   'Linear search'   {'Binary search'}                     |
| BeginIndexSearchUsing PreviousIndexResult | Begin index search using previous index result              | string — {'off'}   'on'                                                                   |
| OutputOnlyTheIndex                        | Output only the index                                       | string — {'off'}   'on'                                                                   |
| ProcessOutOfRangeInput                    | Process out-of-range input                                  | string — 'Clip to range'   {'Linear extrapolation'}                                       |
| UseLastBreakpoint                         | Use last breakpoint for input at or above upper limit       | string — {'off'}   'on'                                                                   |
| ActionForOutOfRangeInput                  | Action for out of range input                               | string — {'None'}   'Warning'   'Error'                                                   |
| SampleTime                                | Sample time (-1 for inherited)                              | string — {'-1'}                                                                           |

**Lookup Tables Block Parameters (Continued)**

| <b>Block (Type)/Parameter</b>  | <b>Dialog Box Prompt</b>                                    | <b>Values</b>                                                                                                                                                                                                              |
|--------------------------------|-------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| IndexDataTypeStr               | Index data type                                             | string — 'int8'   'uint8'   'int16'   'uint16'   'int32'   {'uint32'}   'fixdt(1,16)'                                                                                                                                      |
| FractionDataTypeStr            | Fraction data type                                          | string — {'Inherit: Inherit via internal rule'}   'double'   'single'   'fixdt(1,16,0)'                                                                                                                                    |
| LockScale                      | Lock output scaling against changes by the autoscaling tool | string — {'off'}   'on'                                                                                                                                                                                                    |
| RndMeth                        | Integer rounding mode                                       | string — 'Ceiling'   'Convergent'   {'Floor'}   'Nearest'   'Round'   'Simplest'   'Zero'                                                                                                                                  |
| BreakpointMin                  | Breakpoint minimum                                          | string — {'[]'}                                                                                                                                                                                                            |
| BreakpointMax                  | Breakpoint maximum                                          | string — {'[]'}                                                                                                                                                                                                            |
| BreakpointDataTypeStr          | Breakpoint data type                                        | string — {'Inherit: Same as input'}   'Inherit: Inherit from 'Breakpoint data''   'double'   'single'   'int8'   'uint8'   'int16'   'uint16'   'int32'   'uint32'   'fixdt(1,16)'   'fixdt(1,16,0)'   'fixdt(1,16,2^0,0)' |
| Sine (Sine) (masked subsystem) |                                                             |                                                                                                                                                                                                                            |
| Formula                        | Output formula                                              | string — {'sin(2*pi*u)'}   'cos(2*pi*u)'   'exp(j*2*pi*u)'   'sin(2*pi*u) and cos(2*pi*u)'                                                                                                                                 |

**Lookup Tables Block Parameters (Continued)**

| Block (Type)/Parameter | Dialog Box Prompt                      | Values                 |
|------------------------|----------------------------------------|------------------------|
| 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)              |                                                             |                                                                                                                                                                                                                                                 |
| ZeroCross              | Enable zero-crossing detection                              | string — 'off'   {'on'}                                                                                                                                                                                                                         |
| SampleTime             | Sample time (-1 for inherited)                              | string — $\{-1\}$                                                                                                                                                                                                                               |
| OutMax                 | Output maximum                                              | string — $\{[]\}$                                                                                                                                                                                                                               |
| OutDataTypeStr         | Output data type                                            | string — 'Inherit: Inherit via internal rule'   'Inherit: Inherit via back propagation'   {'Inherit: Same as input'}   'double'   'single'   'int8'   'uint8'   'int16'   'uint16'   'int32'   'uint32'   'fixdt(1,16,0)'   'fixdt(1,16,2^0,0)' |
| LockScale              | Lock output scaling against changes by the autoscaling tool | string — {'off'}   'on'                                                                                                                                                                                                                         |
| RndMeth                | Integer rounding mode                                       | string — 'Ceiling'   'Convergent'   {'Floor'}   'Nearest'   'Round'   'Simplest'   'Zero'                                                                                                                                                       |

**Math Operations Library Block Parameters (Continued)**

| <b>Block (Type)/Parameter</b> | <b>Dialog Box Prompt</b>                      | <b>Values</b>                                                                                                                                                                                               |
|-------------------------------|-----------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| SaturateOnIntegerOverflow     | Saturate on integer overflow                  | string — {'off'}   'on'                                                                                                                                                                                     |
| Add (Sum)                     |                                               |                                                                                                                                                                                                             |
| IconShape                     | Icon shape                                    | string — {'rectangular'}   'round'                                                                                                                                                                          |
| Inputs                        | List of signs                                 | string — {'++'}                                                                                                                                                                                             |
| CollapseMode                  | Sum over                                      | string — {'All dimensions'}   'Specified dimension'                                                                                                                                                         |
| CollapseDim                   | Dimension                                     | string — {'1'}                                                                                                                                                                                              |
| SampleTime                    | Sample time (-1 for inherited)                | string — {'-1'}                                                                                                                                                                                             |
| InputSameDT                   | Require all inputs to have the same data type | string — {'off'}   'on'                                                                                                                                                                                     |
| AccumDataTypeStr              | Accumulator data type                         | string — {'Inherit: Inherit via internal rule'}   'Inherit: Same as first input'   'double'   'single'   'int8'   'uint8'   'int16'   'uint16'   'int32'   'uint32'   'fixdt(1,16,0)'   'fixdt(1,16,2^0,0)' |
| OutMin                        | Output minimum                                | string — {'[]'}                                                                                                                                                                                             |
| OutMax                        | Output maximum                                | string — {'[]'}                                                                                                                                                                                             |

**Math Operations Library Block Parameters (Continued)**

| <b>Block (Type)/Parameter</b>                                  | <b>Dialog Box Prompt</b>                                    | <b>Values</b>                                                                                                                                                                                                                                                                          |
|----------------------------------------------------------------|-------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| OutDataTypeStr                                                 | Output data type                                            | string — {'Inherit: Inherit via internal rule'}   'Inherit: Inherit via back propagation'   'Inherit: Same as first input'   'Inherit: Same as accumulator'   'double'   'single'   'int8'   'uint8'   'int16'   'uint16'   'int32'   'uint32'   'fixdt(1,16,0)'   'fixdt(1,16,2^0,0)' |
| LockScale                                                      | Lock output scaling against changes by the autoscaling tool | string — {'off'}   'on'                                                                                                                                                                                                                                                                |
| RndMeth                                                        | Integer rounding mode                                       | string — 'Ceiling'   'Convergent'   {'Floor'}   'Nearest'   'Round'   'Simplest'   'Zero'                                                                                                                                                                                              |
| SaturateOnInteger Overflow                                     | Saturate on integer overflow                                | string — {'off'}   'on'                                                                                                                                                                                                                                                                |
| Algebraic Constraint (Algebraic Constraint) (masked subsystem) |                                                             |                                                                                                                                                                                                                                                                                        |
| z0                                                             | Initial guess                                               | string — {'0'}                                                                                                                                                                                                                                                                         |
| Assignment (Assignment)                                        |                                                             |                                                                                                                                                                                                                                                                                        |
| NumberOfDimensions                                             | Number of output dimensions                                 | string — {'1'}                                                                                                                                                                                                                                                                         |
| IndexMode                                                      | Index mode                                                  | string — 'Zero-based'   {'One-based'}                                                                                                                                                                                                                                                  |

**Math Operations Library Block Parameters (Continued)**

| <b>Block (Type)/Parameter</b>                               | <b>Dialog Box Prompt</b>                             | <b>Values</b>                                                                                                                   |
|-------------------------------------------------------------|------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------|
| OutputInitialize                                            | Initialize output (Y)                                | string — {'Initialize using input port <Y0>'}   'Specify size for each dimension in table'                                      |
| IndexOptionArray                                            | Index Option                                         | string — 'Assign all'   {'Index vector (dialog)'}   'Index vector (port)'   'Starting index (dialog)'   'Starting index (port)' |
| IndexParamArray                                             | Index                                                | cell array                                                                                                                      |
| OutputSizeArray                                             | Output Size                                          | cell array                                                                                                                      |
| DiagnosticForDimensions                                     | Action if any output element is not assigned         | string — 'Error'   'Warning'   {'None'}                                                                                         |
| SampleTime                                                  | Sample time (-1 for inherited)                       | string — {'-1'}                                                                                                                 |
| IndexOptions                                                | See IndexOptionArray parameter for more information. |                                                                                                                                 |
| Indices                                                     | See IndexParamArray parameter for more information.  |                                                                                                                                 |
| OutputSizes                                                 | See OutputSizeArray parameter for more information.  |                                                                                                                                 |
| <b>Bias (Bias)</b>                                          |                                                      |                                                                                                                                 |
| Bias                                                        | Bias                                                 | string — {'0.0'}                                                                                                                |
| SaturateOnInteger Overflow                                  | Saturate on integer overflow                         | string — {'off'}   'on'                                                                                                         |
| <b>Complex to Magnitude-Angle (ComplexToMagnitudeAngle)</b> |                                                      |                                                                                                                                 |

**Math Operations Library Block Parameters (Continued)**

| <b>Block (Type)/Parameter</b>                   | <b>Dialog Box Prompt</b>                  | <b>Values</b>                                                                                                                                                                                                                                         |
|-------------------------------------------------|-------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Output                                          | Output                                    | string — 'Magnitude'   'Angle'   {'Magnitude and angle'}                                                                                                                                                                                              |
| SampleTime                                      | Sample time (-1 for inherited)            | string — {'-1'}                                                                                                                                                                                                                                       |
| <b>Complex to Real-Imag (ComplexToRealImag)</b> |                                           |                                                                                                                                                                                                                                                       |
| Output                                          | Output                                    | string — 'Real'   'Imag'   {'Real and imag'}                                                                                                                                                                                                          |
| SampleTime                                      | Sample time (-1 for inherited)            | string — {'-1'}                                                                                                                                                                                                                                       |
| <b>Divide (Product)</b>                         |                                           |                                                                                                                                                                                                                                                       |
| Inputs                                          | Number of inputs                          | string — {'*/'}                                                                                                                                                                                                                                       |
| Multiplication                                  | Multiplication                            | string — {'Element-wise(*)'}   'Matrix(*)'                                                                                                                                                                                                            |
| SampleTime                                      | Sample time (-1 for inherited)            | string {'-1'}                                                                                                                                                                                                                                         |
| InputSameDT                                     | Require all inputs to have same data type | string — {'off'}   'on'                                                                                                                                                                                                                               |
| OutMin                                          | Output minimum                            | string — {'[]'}                                                                                                                                                                                                                                       |
| OutMax                                          | Output maximum                            | string — {'[]'}                                                                                                                                                                                                                                       |
| OutDataTypeStr                                  | Output data type                          | string — {'Inherit: Inherit via internal rule'}   'Inherit: Inherit via back propagation'   'Inherit: Same as first input'   'double'   'single'   'int8'   'uint8'   'int16'   'uint16'   'int32'   'uint32'   'fixdt(1,16,0)'   'fixdt(1,16,2^0,0)' |

**Math Operations Library Block Parameters (Continued)**

| <b>Block (Type)/Parameter</b> | <b>Dialog Box Prompt</b>                                    | <b>Values</b>                                                                                                                                                                                                                                         |
|-------------------------------|-------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| LockScale                     | Lock output scaling against changes by the autoscaling tool | string — {'off'}   'on'                                                                                                                                                                                                                               |
| RndMeth                       | Integer rounding mode                                       | string — 'Ceiling'   'Convergent'   {'Floor'}   'Nearest'   'Round'   'Simplest'   'Zero'                                                                                                                                                             |
| SaturateOnInteger Overflow    | Saturate on integer overflow                                | string — {'off'}   'on'                                                                                                                                                                                                                               |
| Dot Product (Dot Product)     |                                                             |                                                                                                                                                                                                                                                       |
| SampleTime                    | Sample time (-1 for inherited)                              | string — {'-1'}                                                                                                                                                                                                                                       |
| InputSameDT                   | Require all inputs to have same data type                   | string — 'off'   {'on'}                                                                                                                                                                                                                               |
| OutMin                        | Output minimum                                              | string — {'[]'}                                                                                                                                                                                                                                       |
| OutMax                        | Output maximum                                              | string — {'[]'}                                                                                                                                                                                                                                       |
| OutDataTypeStr                | Output data type                                            | string — {'Inherit: Inherit via internal rule'}   'Inherit: Inherit via back propagation'   'Inherit: Same as first input'   'double'   'single'   'int8'   'uint8'   'int16'   'uint16'   'int32'   'uint32'   'fixdt(1,16,0)'   'fixdt(1,16,2^0,0)' |
| OutputDataTypeScaling Mode    | Deprecated                                                  |                                                                                                                                                                                                                                                       |
| OutDataType                   | Deprecated                                                  |                                                                                                                                                                                                                                                       |
| OutScaling                    | Deprecated                                                  |                                                                                                                                                                                                                                                       |



**Math Operations Library Block Parameters (Continued)**

| <b>Block (Type)/Parameter</b> | <b>Dialog Box Prompt</b>                                    | <b>Values</b>                                                                                                                                                                                                                                   |
|-------------------------------|-------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| LockScale                     | Lock output scaling against changes by the autoscaling tool | string — {'off'}   'on'                                                                                                                                                                                                                         |
| RndMeth                       | Integer rounding mode                                       | string — 'Ceiling'   'Convergent'   {'Floor'}   'Nearest'   'Round'   'Simplest'   'Zero'                                                                                                                                                       |
| SaturateOnInteger Overflow    | Saturate on integer overflow                                | string — {'off'}   'on'                                                                                                                                                                                                                         |
| Gain (Gain)                   |                                                             |                                                                                                                                                                                                                                                 |
| Gain                          | Gain                                                        | string — {'1'}                                                                                                                                                                                                                                  |
| Multiplication                | Multiplication                                              | string — {'Element-wise(K.*u)'}   'Matrix(K*u)'   'Matrix(u*K)'   'Matrix(K*u) (u vector)'                                                                                                                                                      |
| SampleTime                    | Sample time (-1 for inherited)                              | string — {'-1'}                                                                                                                                                                                                                                 |
| OutMin                        | Output minimum                                              | string — {'[]'}                                                                                                                                                                                                                                 |
| OutMax                        | Output maximum                                              | string — {'[]'}                                                                                                                                                                                                                                 |
| OutDataTypeStr                | Output data type                                            | string — {'Inherit: Inherit via internal rule'}   'Inherit: Inherit via back propagation'   'Inherit: Same as input'   'double'   'single'   'int8'   'uint8'   'int16'   'uint16'   'int32'   'uint32'   'fixdt(1,16,0)'   'fixdt(1,16,2^0,0)' |

**Math Operations Library Block Parameters (Continued)**

| <b>Block (Type)/Parameter</b>                               | <b>Dialog Box Prompt</b>                                    | <b>Values</b>                                                                                                                                                                                                         |
|-------------------------------------------------------------|-------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| LockScale                                                   | Lock output scaling against changes by the autoscaling tool | string — {'off'}   'on'                                                                                                                                                                                               |
| RndMeth                                                     | Integer rounding mode                                       | string — 'Ceiling'   'Convergent'   {'Floor'}   'Nearest'   'Round'   'Simplest'   'Zero'                                                                                                                             |
| SaturateOnInteger Overflow                                  | Saturate on integer overflow                                | string — {'off'}   'on'                                                                                                                                                                                               |
| ParamMin                                                    | Parameter minimum                                           | string — {'[]'}                                                                                                                                                                                                       |
| ParamMax                                                    | Parameter maximum                                           | string — {'[]'}                                                                                                                                                                                                       |
| ParamDataTypeStr                                            | Parameter data type                                         | string — {'Inherit: Inherit via internal rule'}   'Inherit: Same as input'   'double'   'single'   'int8'   'uint8'   'int16'   'uint16'   'int32'   'uint32'   'fixdt(1,16)'   'fixdt(1,16,0)'   'fixdt(1,16,2^0,0)' |
| <b>Magnitude-Angle to Complex (MagnitudeAngleToComplex)</b> |                                                             |                                                                                                                                                                                                                       |
| Input                                                       | Input                                                       | string — 'Magnitude'   'Angle'   {'Magnitude and angle'}                                                                                                                                                              |
| ConstantPart                                                | Magnitude or Angle                                          | string — {'0'}                                                                                                                                                                                                        |
| SampleTime                                                  | Sample time (-1 for inherited)                              | string — {'-1'}                                                                                                                                                                                                       |
| <b>Math Function (Math)</b>                                 |                                                             |                                                                                                                                                                                                                       |

**Math Operations Library Block Parameters (Continued)**

| <b>Block (Type)/Parameter</b> | <b>Dialog Box Prompt</b>                                          | <b>Values</b>                                                                                                                                                                                                                                                                          |
|-------------------------------|-------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Operator                      | Function                                                          | string — {'exp'}   'log'<br>  '10^u'   'log10'  <br>'magnitude^2'   'square'<br>  'sqrt'   'pow'  <br>'conj'   'reciprocal'  <br>'hypot'   'rem'   'mod'  <br>'transpose'   'hermitian'                                                                                                |
| OutputSignalType              | Output signal type                                                | string — {'auto'}   'real'<br>  'complex'                                                                                                                                                                                                                                              |
| SampleTime                    | Sample time (-1 for inherited)                                    | string — {'-1'}                                                                                                                                                                                                                                                                        |
| OutMin                        | Output minimum                                                    | string — {'[]'}                                                                                                                                                                                                                                                                        |
| OutMax                        | Output maximum                                                    | string — {'[]'}                                                                                                                                                                                                                                                                        |
| OutDataTypeStr                | Output data type                                                  | string — 'Inherit: Inherit<br>via internal rule'  <br>'Inherit: Inherit<br>via back propagation'<br>  {'Inherit: Same<br>as first input'}  <br>'double'   'single'<br>  'int8'   'uint8'<br>  'int16'   'uint16'<br>  'int32'   'uint32'<br>  'fixdt(1,16,0)'  <br>'fixdt(1,16,2^0,0)' |
| LockScale                     | Lock output scaling against<br>changes by the autoscaling<br>tool | string — {'off'}   'on'                                                                                                                                                                                                                                                                |
| RndMeth                       | Integer rounding mode                                             | string — 'Ceiling'  <br>'Convergent'   {'Floor'}<br>  'Nearest'   'Round'  <br>'Simplest'   'Zero'                                                                                                                                                                                     |

**Math Operations Library Block Parameters (Continued)**

| <b>Block (Type)/Parameter</b>    | <b>Dialog Box Prompt</b>                      | <b>Values</b>                                                                                                                                                                                                        |
|----------------------------------|-----------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| SaturateOnInteger Overflow       | Saturate on integer overflow                  | string — 'off'   {'on'}                                                                                                                                                                                              |
| Matrix Concatenate (Concatenate) |                                               |                                                                                                                                                                                                                      |
| NumInputs                        | Number of inputs                              | string — {'2'}                                                                                                                                                                                                       |
| Mode                             | Mode                                          | string — 'Vector'   {'Multidimensional array'}                                                                                                                                                                       |
| ConcatenateDimension             | Concatenate dimension                         | string — {'2'}                                                                                                                                                                                                       |
| MinMax (MinMax)                  |                                               |                                                                                                                                                                                                                      |
| Function                         | Function                                      | string — {'min'}   'max'                                                                                                                                                                                             |
| Inputs                           | Number of input ports                         | string — {'1'}                                                                                                                                                                                                       |
| ZeroCross                        | Enable zero-crossing detection                | string — 'off'   {'on'}                                                                                                                                                                                              |
| SampleTime                       | Sample time (-1 for inherited)                | string — {'-1'}                                                                                                                                                                                                      |
| InputSameDT                      | Require all inputs to have the same data type | string — {'off'}   'on'                                                                                                                                                                                              |
| OutMin                           | Output minimum                                | string — {'[]'}                                                                                                                                                                                                      |
| OutMax                           | Output maximum                                | string — {'[]'}                                                                                                                                                                                                      |
| OutDataTypeStr                   | Output data type                              | string — {'Inherit: Inherit via internal rule'}   'Inherit: Inherit via back propagation'   'double'   'single'   'int8'   'uint8'   'int16'   'uint16'   'int32'   'uint32'   'fixdt(1,16,0)'   'fixdt(1,16,2^0,0)' |

**Math Operations Library Block Parameters (Continued)**

| <b>Block (Type)/Parameter</b>                                          | <b>Dialog Box Prompt</b>                                    | <b>Values</b>                                                                                                                                       |
|------------------------------------------------------------------------|-------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------|
| LockScale                                                              | Lock output scaling against changes by the autoscaling tool | string — {'off'}   'on'                                                                                                                             |
| RndMeth                                                                | Integer rounding mode                                       | string — 'Ceiling'   'Convergent'   {'Floor'}   'Nearest'   'Round'   'Simplest'   'Zero'                                                           |
| SaturateOnInteger Overflow                                             | Saturate on integer overflow                                | string — {'off'}   'on'                                                                                                                             |
| MinMax Running Resetable (MinMax Running Resetable) (masked subsystem) |                                                             |                                                                                                                                                     |
| Function                                                               | Function                                                    | string — {'min'}   'max'                                                                                                                            |
| vinit                                                                  | Initial condition                                           | string — {'0.0'}                                                                                                                                    |
| Permute Dimensions (PermuteDimensions)                                 |                                                             |                                                                                                                                                     |
| Order                                                                  | Order                                                       | string — {'[2,1]'}                                                                                                                                  |
| Polynomial (Polyval)                                                   |                                                             |                                                                                                                                                     |
| coefs                                                                  | Polynomial Coefficients                                     | string — {'[<br>+2.081618890e-019,<br>-1.441693666e-014,<br>+4.719686976e-010,<br>-8.536869453e-006,<br>+1.621573104e-001,<br>-8.087801117e+001 ]'} |
| Product (Product)                                                      |                                                             |                                                                                                                                                     |
| Inputs                                                                 | Number of inputs                                            | string — {'2'}                                                                                                                                      |
| Multiplication                                                         | Multiplication                                              | string — {'Element-wise(*)'}   'Matrix(*)'                                                                                                          |
| CollapseMode                                                           | Multiply over                                               | string — {'All dimensions'}   'Specified dimension'                                                                                                 |
| CollapseDim                                                            | Dimension                                                   | string — {'1'}                                                                                                                                      |

**Math Operations Library Block Parameters (Continued)**

| <b>Block (Type)/Parameter</b> | <b>Dialog Box Prompt</b>                                    | <b>Values</b>                                                                                                                                                                                                                                         |
|-------------------------------|-------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| SampleTime                    | Sample time (-1 for inherited)                              | string — {'-1'}                                                                                                                                                                                                                                       |
| InputSameDT                   | Require all inputs to have same data type                   | string — {'off'}   'on'                                                                                                                                                                                                                               |
| OutMin                        | Output minimum                                              | string — {'[]'}                                                                                                                                                                                                                                       |
| OutMax                        | Output maximum                                              | string — {'[]'}                                                                                                                                                                                                                                       |
| OutDataTypeStr                | Output data type                                            | string — {'Inherit: Inherit via internal rule'}   'Inherit: Inherit via back propagation'   'Inherit: Same as first input'   'double'   'single'   'int8'   'uint8'   'int16'   'uint16'   'int32'   'uint32'   'fixdt(1,16,0)'   'fixdt(1,16,2^0,0)' |
| LockScale                     | Lock output scaling against changes by the autoscaling tool | string — {'off'}   'on'                                                                                                                                                                                                                               |
| RndMeth                       | Integer rounding mode                                       | string — 'Ceiling'   'Convergent'   'Floor'   'Nearest'   'Round'   'Simplest'   {'Zero'}                                                                                                                                                             |
| SaturateOnInteger Overflow    | Saturate on integer overflow                                | string — {'off'}   'on'                                                                                                                                                                                                                               |
| Product of Elements (Product) |                                                             |                                                                                                                                                                                                                                                       |
| Inputs                        | Number of inputs                                            | string — {'*'}                                                                                                                                                                                                                                        |
| Multiplication                | Multiplication                                              | string — {'Element-wise(*)'}   'Matrix(*)'                                                                                                                                                                                                            |

**Math Operations Library Block Parameters (Continued)**

| <b>Block (Type)/Parameter</b>            | <b>Dialog Box Prompt</b>                                    | <b>Values</b>                                                                                                                                                                                                                                                                          |
|------------------------------------------|-------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| CollapseMode                             | Multiply over                                               | string — {'All dimensions'}<br>  'Specified dimension'                                                                                                                                                                                                                                 |
| CollapseDim                              | Dimension                                                   | string — {'1'}                                                                                                                                                                                                                                                                         |
| SampleTime                               | Sample time (-1 for inherited)                              | string — {'-1'}                                                                                                                                                                                                                                                                        |
| InputSameDT                              | Require all inputs to have same data type                   | string — {'off'}   'on'                                                                                                                                                                                                                                                                |
| OutMin                                   | Output minimum                                              | string — {'[]'}                                                                                                                                                                                                                                                                        |
| OutMax                                   | Output maximum                                              | string — {'[]'}                                                                                                                                                                                                                                                                        |
| OutDataTypeStr                           | Output data type                                            | string — {'Inherit:<br>Inherit via internal<br>rule'}   'Inherit:<br>Inherit via back<br>propagation'   'Inherit:<br>Same as first input'<br>  'double'   'single'<br>  'int8'   'uint8'<br>  'int16'   'uint16'<br>  'int32'   'uint32'<br>  'fixdt(1,16,0)'  <br>'fixdt(1,16,2^0,0)' |
| LockScale                                | Lock output scaling against changes by the autoscaling tool | string — {'off'}   'on'                                                                                                                                                                                                                                                                |
| RndMeth                                  | Integer rounding mode                                       | string — 'Ceiling'  <br>'Convergent'   {'Floor'}<br>  'Nearest'   'Round'  <br>'Simplest'   'Zero'                                                                                                                                                                                     |
| SaturateOnInteger Overflow               | Saturate on integer overflow                                | string — {'off'}   'on'                                                                                                                                                                                                                                                                |
| Real-Imag to Complex (RealImagToComplex) |                                                             |                                                                                                                                                                                                                                                                                        |

**Math Operations Library Block Parameters (Continued)**

| <b>Block (Type)/Parameter</b>       | <b>Dialog Box Prompt</b>       | <b>Values</b>                                                                                                          |
|-------------------------------------|--------------------------------|------------------------------------------------------------------------------------------------------------------------|
| Input                               | Input                          | string — 'Real'   'Imag'   {'Real and imag'}                                                                           |
| ConstantPart                        | Real part or Imag part         | string — {'0'}                                                                                                         |
| SampleTime                          | Sample time (-1 for inherited) | string — {'-1'}                                                                                                        |
| <b>Reshape (Reshape)</b>            |                                |                                                                                                                        |
| OutputDimensionality                | Output dimensionality          | string — {'1-D array'   'Column vector (2-D)'   'Row vector (2-D)'   'Customize'   'Derive from reference input port'} |
| OutputDimensions                    | Output dimensions              | string — {'[1,1]'}                                                                                                     |
| <b>Rounding Function (Rounding)</b> |                                |                                                                                                                        |
| Operator                            | Function                       | string — {'floor'}   'ceil'   'round'   'fix'                                                                          |
| SampleTime                          | Sample time (-1 for inherited) | string — {'-1'}                                                                                                        |
| <b>Sign (Signum)</b>                |                                |                                                                                                                        |
| ZeroCross                           | Enable zero-crossing detection | string — 'off'   {'on'}                                                                                                |
| SampleTime                          | Sample time (-1 for inherited) | string — {'-1'}                                                                                                        |
| <b>Sine Wave Function (Sin)</b>     |                                |                                                                                                                        |
| SineType                            | Sine type                      | string — {'Time based'}   'Sample based'                                                                               |
| TimeSource                          | Time (t)                       | string — 'Use simulation time'   {'Use external signal'}                                                               |
| Amplitude                           | Amplitude                      | string — {'1'}                                                                                                         |
| Bias                                | Bias                           | string — {'0'}                                                                                                         |
| Frequency                           | Frequency (rad/sec)            | string — {'1'}                                                                                                         |



**Math Operations Library Block Parameters (Continued)**

| <b>Block (Type)/Parameter</b>                       | <b>Dialog Box Prompt</b>                      | <b>Values</b>                                       |
|-----------------------------------------------------|-----------------------------------------------|-----------------------------------------------------|
| 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            | string — 'off'   {'on'}                             |
| <b>Slider Gain (Slider Gain) (masked subsystem)</b> |                                               |                                                     |
| low                                                 | Low                                           | string — {'0'}                                      |
| gain                                                | Gain                                          | string — {'1'}                                      |
| high                                                | High                                          | string — {'2'}                                      |
| <b>Squeeze (Squeeze) (masked subsystem)</b>         |                                               |                                                     |
| None                                                | None                                          | None                                                |
| <b>Subtract (Sum)</b>                               |                                               |                                                     |
| IconShape                                           | Icon shape                                    | string — {'rectangular'}   'round'                  |
| Inputs                                              | List of signs                                 | string — {'+-'}                                     |
| CollapseMode                                        | Sum over                                      | string — {'All dimensions'}   'Specified dimension' |
| CollapseDim                                         | Dimension                                     | string — {'1'}                                      |
| SampleTime                                          | Sample time (-1 for inherited)                | string — {'-1'}                                     |
| InputSameDT                                         | Require all inputs to have the same data type | string — {'off'}   'on'                             |

**Math Operations Library Block Parameters (Continued)**

| <b>Block (Type)/Parameter</b> | <b>Dialog Box Prompt</b>                                    | <b>Values</b>                                                                                                                                                                                                                                                                          |
|-------------------------------|-------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| AccumDataTypeStr              | Accumulator data type                                       | string — {'Inherit: Inherit via internal rule'}   'Inherit: Same as first input'   'double'   'single'   'int8'   'uint8'   'int16'   'uint16'   'int32'   'uint32'   'fixdt(1,16,0)'   'fixdt(1,16,2^0,0)'                                                                            |
| OutMin                        | Output minimum                                              | string — {'[]'}                                                                                                                                                                                                                                                                        |
| OutMax                        | Output maximum                                              | string — {'[]'}                                                                                                                                                                                                                                                                        |
| OutDataTypeStr                | Output data type                                            | string — {'Inherit: Inherit via internal rule'}   'Inherit: Inherit via back propagation'   'Inherit: Same as first input'   'Inherit: Same as accumulator'   'double'   'single'   'int8'   'uint8'   'int16'   'uint16'   'int32'   'uint32'   'fixdt(1,16,0)'   'fixdt(1,16,2^0,0)' |
| LockScale                     | Lock output scaling against changes by the autoscaling tool | string — {'off'}   'on'                                                                                                                                                                                                                                                                |
| RndMeth                       | Integer rounding mode                                       | string — 'Ceiling'   'Convergent'   {'Floor'}   'Nearest'   'Round'   'Simplest'   'Zero'                                                                                                                                                                                              |

**Math Operations Library Block Parameters (Continued)**

| <b>Block (Type)/Parameter</b> | <b>Dialog Box Prompt</b>                      | <b>Values</b>                                                                                                                                                                                               |
|-------------------------------|-----------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| SaturateOnInteger Overflow    | Saturate on integer overflow                  | string — {'off'}   'on'                                                                                                                                                                                     |
| Sum (Sum)                     |                                               |                                                                                                                                                                                                             |
| IconShape                     | Icon shape                                    | string — 'rectangular'   {'round'}                                                                                                                                                                          |
| Inputs                        | List of signs                                 | string — {' ++'}                                                                                                                                                                                            |
| CollapseMode                  | Sum over                                      | string — {'All dimensions'}   'Specified dimension'                                                                                                                                                         |
| CollapseDim                   | Dimension                                     | string — {'1'}                                                                                                                                                                                              |
| SampleTime                    | Sample time (-1 for inherited)                | string — {'-1'}                                                                                                                                                                                             |
| InputSameDT                   | Require all inputs to have the same data type | string — {'off'}   'on'                                                                                                                                                                                     |
| AccumDataTypeStr              | Accumulator data type                         | string — {'Inherit: Inherit via internal rule'}   'Inherit: Same as first input'   'double'   'single'   'int8'   'uint8'   'int16'   'uint16'   'int32'   'uint32'   'fixdt(1,16,0)'   'fixdt(1,16,2^0,0)' |
| OutMin                        | Output minimum                                | string — {'[]'}                                                                                                                                                                                             |
| OutMax                        | Output maximum                                | string — {'[]'}                                                                                                                                                                                             |

**Math Operations Library Block Parameters (Continued)**

| <b>Block (Type)/Parameter</b> | <b>Dialog Box Prompt</b>                                    | <b>Values</b>                                                                                                                                                                                                                                                                          |
|-------------------------------|-------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| OutDataTypeStr                | Output data type                                            | string — {'Inherit: Inherit via internal rule'}   'Inherit: Inherit via back propagation'   'Inherit: Same as first input'   'Inherit: Same as accumulator'   'double'   'single'   'int8'   'uint8'   'int16'   'uint16'   'int32'   'uint32'   'fixdt(1,16,0)'   'fixdt(1,16,2^0,0)' |
| LockScale                     | Lock output scaling against changes by the autoscaling tool | string — {'off'}   'on'                                                                                                                                                                                                                                                                |
| RndMeth                       | Integer rounding mode                                       | string — 'Ceiling'   'Convergent'   {'Floor'}   'Nearest'   'Round'   'Simplest'   'Zero'                                                                                                                                                                                              |
| SaturateOnInteger Overflow    | Saturate on integer overflow                                | string — {'off'}   'on'                                                                                                                                                                                                                                                                |
| Sum of Elements (Sum)         |                                                             |                                                                                                                                                                                                                                                                                        |
| IconShape                     | Icon shape                                                  | string — {'rectangular'}   'round'                                                                                                                                                                                                                                                     |
| Inputs                        | List of signs                                               | string — {'+'}                                                                                                                                                                                                                                                                         |
| CollapseMode                  | Sum over                                                    | string — {'All dimensions'}   'Specified dimension'                                                                                                                                                                                                                                    |
| CollapseDim                   | Dimension                                                   | string — {'1'}                                                                                                                                                                                                                                                                         |
| SampleTime                    | Sample time (-1 for inherited)                              | string — {'-1'}                                                                                                                                                                                                                                                                        |

**Math Operations Library Block Parameters (Continued)**

| <b>Block (Type)/Parameter</b> | <b>Dialog Box Prompt</b>                                    | <b>Values</b>                                                                                                                                                                                                                                                                          |
|-------------------------------|-------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| InputSameDT                   | Require all inputs to have the same data type               | string — {'off'}   'on'                                                                                                                                                                                                                                                                |
| AccumDataTypeStr              | Accumulator data type                                       | string — {'Inherit: Inherit via internal rule'}   'Inherit: Same as first input'   'double'   'single'   'int8'   'uint8'   'int16'   'uint16'   'int32'   'uint32'   'fixdt(1,16,0)'   'fixdt(1,16,2^0,0)'                                                                            |
| OutMin                        | Output minimum                                              | string — {'[]'}                                                                                                                                                                                                                                                                        |
| OutMax                        | Output maximum                                              | string — {'[]'}                                                                                                                                                                                                                                                                        |
| OutDataTypeStr                | Output data type                                            | string — {'Inherit: Inherit via internal rule'}   'Inherit: Inherit via back propagation'   'Inherit: Same as first input'   'Inherit: Same as accumulator'   'double'   'single'   'int8'   'uint8'   'int16'   'uint16'   'int32'   'uint32'   'fixdt(1,16,0)'   'fixdt(1,16,2^0,0)' |
| LockScale                     | Lock output scaling against changes by the autoscaling tool | string — {'off'}   'on'                                                                                                                                                                                                                                                                |

**Math Operations Library Block Parameters (Continued)**

| <b>Block (Type)/Parameter</b>                                   | <b>Dialog Box Prompt</b>                    | <b>Values</b>                                                                                                                             |
|-----------------------------------------------------------------|---------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------|
| RndMeth                                                         | Integer rounding mode                       | string — 'Ceiling'   'Convergent'   {'Floor'}   'Nearest'   'Round'   'Simplest'   'Zero'                                                 |
| SaturateOnInteger Overflow                                      | Saturate on integer overflow                | string — {'off'}   'on'                                                                                                                   |
| Trigonometric Function (Trigonometry)                           |                                             |                                                                                                                                           |
| Operator                                                        | Function                                    | string — {'sin'}   'cos'   'tan'   'asin'   'acos'   'atan'   'atan2'   'sinh'   'cosh'   'tanh'   'asinh'   'acosh'   'atanh'   'sincos' |
| OutputSignalType                                                | Output signal type                          | string — {'auto'}   'real'   'complex'                                                                                                    |
| SampleTime                                                      | Sample time (-1 for inherited)              | string — {'-1'}                                                                                                                           |
| Unary Minus (Unary Minus) (masked subsystem)                    |                                             |                                                                                                                                           |
| DoSatur                                                         | Saturate to max or min when overflows occur | string — {'off'}   'on'                                                                                                                   |
| Vector Concatenate (Concatenate)                                |                                             |                                                                                                                                           |
| NumInputs                                                       | Number of inputs                            | string — {'2'}                                                                                                                            |
| Mode                                                            | Mode                                        | string — {'Vector'}   'Multidimensional array'                                                                                            |
| Weighted Sample Time Math (Sample Time Math) (masked subsystem) |                                             |                                                                                                                                           |
| TsampMathOp                                                     | Operation                                   | string — {'+'}   '-'   '*'   '/'   'Ts Only'   '1/Ts Only'                                                                                |
| weightValue                                                     | Weight value                                | string — {'1.0'}                                                                                                                          |

**Math Operations Library Block Parameters (Continued)**

| <b>Block (Type)/Parameter</b> | <b>Dialog Box Prompt</b>                    | <b>Values</b>                                                                             |
|-------------------------------|---------------------------------------------|-------------------------------------------------------------------------------------------|
| TsampMathImp                  | Implement using                             | string — {'Online Calculations'}   'Offline Scaling Adjustment'                           |
| OutputDataTypeScaling Mode    | Output data type mode                       | string — {'Inherit via internal rule'}   'Inherit via back propagation'                   |
| RndMeth                       | Integer rounding mode                       | string — 'Ceiling'   'Convergent'   {'Floor'}   'Nearest'   'Round'   'Simplest'   'Zero' |
| DoSatur                       | Saturate to max or min when overflows occur | string — {'off'}   'on'                                                                   |

**Model Verification Library Block Parameters**

| <b>Block (Type)/Parameter</b>                       | <b>Dialog Box Prompt</b>                            | <b>Values</b>           |
|-----------------------------------------------------|-----------------------------------------------------|-------------------------|
| Assertion (Assertion)                               |                                                     |                         |
| Enabled                                             | Enable assertion                                    | string — 'off'   {'on'} |
| AssertionFailFcn                                    | Simulation callback when assertion fails            | string — {''}           |
| StopWhenAssertionFail                               | Stop simulation when assertion fails                | string — 'off'   {'on'} |
| SampleTime                                          | Sample time (-1 for inherited)                      | string — {'-1'}         |
| Check Dynamic Gap (Checks_DGgap) (masked subsystem) |                                                     |                         |
| enabled                                             | Enable assertion                                    | string — 'off'   {'on'} |
| callback                                            | Simulation callback when assertion fails (optional) | string — {''}           |
| stopWhenAssertionFail                               | Stop simulation when assertion fails                | string — 'off'   {'on'} |

**Model Verification Library Block Parameters (Continued)**

| <b>Block (Type)/Parameter</b>                          | <b>Dialog Box Prompt</b>                            | <b>Values</b>                 |
|--------------------------------------------------------|-----------------------------------------------------|-------------------------------|
| export                                                 | Output assertion signal                             | string — {'off'}   'on'       |
| icon                                                   | Select icon type                                    | string — {'graphic'}   'text' |
| Check Dynamic Range (Checks_DRange) (masked subsystem) |                                                     |                               |
| enabled                                                | Enable assertion                                    | string — 'off'   {'on'}       |
| callback                                               | Simulation callback when assertion fails (optional) | string — {''}                 |
| stopWhenAssertionFail                                  | Stop simulation when assertion fails                | string — 'off'   {'on'}       |
| export                                                 | Output assertion signal                             | string — {'off'}   'on'       |
| icon                                                   | Select icon type                                    | string — {'graphic'}   'text' |
| Check Static Gap (Checks_SGap) (masked subsystem)      |                                                     |                               |
| max                                                    | Upper bound                                         | string — {'100'}              |
| max_included                                           | Inclusive upper bound                               | string — 'off'   {'on'}       |
| min                                                    | Lower bound                                         | string — {'0'}                |
| min_included                                           | Inclusive lower bound                               | string — 'off'   {'on'}       |
| enabled                                                | Enable assertion                                    | string — 'off'   {'on'}       |
| callback                                               | Simulation callback when assertion fails (optional) | string — {''}                 |
| stopWhenAssertionFail                                  | Stop simulation when assertion fails                | string — 'off'   {'on'}       |
| export                                                 | Output assertion signal                             | string — {'off'}   'on'       |
| icon                                                   | Select icon type                                    | string — {'graphic'}   'text' |
| Check Static Range (Checks_SRange) (masked subsystem)  |                                                     |                               |
| max                                                    | Upper bound                                         | string — {'100'}              |



**Model Verification Library Block Parameters (Continued)**

| <b>Block (Type)/Parameter</b>                                | <b>Dialog Box Prompt</b>                            | <b>Values</b>                 |
|--------------------------------------------------------------|-----------------------------------------------------|-------------------------------|
| max_included                                                 | Inclusive upper bound                               | string — 'off'   {'on'}       |
| min                                                          | Lower bound                                         | string — {'0'}                |
| min_included                                                 | Inclusive lower bound                               | string — 'off'   {'on'}       |
| enabled                                                      | Enable assertion                                    | string — 'off'   {'on'}       |
| callback                                                     | Simulation callback when assertion fails (optional) | string — {''}                 |
| stopWhenAssertionFail                                        | Stop simulation when assertion fails                | string — 'off'   {'on'}       |
| export                                                       | Output assertion signal                             | string — {'off'}   'on'       |
| icon                                                         | Select icon type                                    | string — {'graphic'}   'text' |
| Check Discrete Gradient (Checks_Gradient) (masked subsystem) |                                                     |                               |
| gradient                                                     | Maximum gradient                                    | string — {'1'}                |
| enabled                                                      | Enable assertion                                    | string — 'off'   {'on'}       |
| callback                                                     | Simulation callback when assertion fails (optional) | string — {''}                 |
| stopWhenAssertionFail                                        | Stop simulation when assertion fails                | string — 'off'   {'on'}       |
| export                                                       | Output assertion signal                             | string — {'off'}   'on'       |
| icon                                                         | Select icon type                                    | string — {'graphic'}   'text' |
| Check Dynamic Lower Bound (Checks_DMin) (masked subsystem)   |                                                     |                               |
| Enabled                                                      | Enable assertion                                    | string — 'off'   {'on'}       |
| callback                                                     | Simulation callback when assertion fails (optional) | string — {''}                 |
| stopWhenAssertionFail                                        | Stop simulation when assertion fails                | string — 'off'   {'on'}       |

**Model Verification Library Block Parameters (Continued)**

| <b>Block (Type)/Parameter</b>                                 | <b>Dialog Box Prompt</b>                            | <b>Values</b>                 |
|---------------------------------------------------------------|-----------------------------------------------------|-------------------------------|
| export                                                        | Output assertion signal                             | string — {'off'}   'on'       |
| icon                                                          | Select icon type                                    | string — {'graphic'}   'text' |
| Check Dynamic Upper Bound (Checks_DMax) (masked subsystem)    |                                                     |                               |
| enabled                                                       | Enable assertion                                    | string — 'off'   {'on'}       |
| callback                                                      | Simulation callback when assertion fails (optional) | string — {''}                 |
| stopWhenAssertionFail                                         | Stop simulation when assertion fails                | string — 'off'   {'on'}       |
| export                                                        | Output assertion signal                             | string — {'off'}   'on'       |
| icon                                                          | Select icon type                                    | string — {'graphic'}   'text' |
| Check Input Resolution (Checks_Resolution) (masked subsystem) |                                                     |                               |
| resolution                                                    | Resolution                                          | string — {'1'}                |
| enabled                                                       | Enable assertion                                    | string — 'off'   {'on'}       |
| callback                                                      | Simulation callback when assertion fails (optional) | string — {''}                 |
| stopWhenAssertionFail                                         | Stop simulation when assertion fails                | string — 'off'   {'on'}       |
| export                                                        | Output assertion signal                             | string — {'off'}   'on'       |
| Check Static Lower Bound (Checks_SMin) (masked subsystem)     |                                                     |                               |
| min                                                           | Lower bound                                         | string — {'0'}                |
| min_included                                                  | Inclusive boundary                                  | string — 'off'   {'on'}       |
| enabled                                                       | Enable assertion                                    | string — 'off'   {'on'}       |
| callback                                                      | Simulation callback when assertion fails (optional) | string — {''}                 |

**Model Verification Library Block Parameters (Continued)**

| <b>Block (Type)/Parameter</b>                             | <b>Dialog Box Prompt</b>                            | <b>Values</b>                 |
|-----------------------------------------------------------|-----------------------------------------------------|-------------------------------|
| stopWhenAssertionFail                                     | Stop simulation when assertion fails                | string — 'off'   {'on'}       |
| export                                                    | Output assertion signal                             | string — {'off'}   'on'       |
| icon                                                      | Select icon type                                    | string — {'graphic'}   'text' |
| Check Static Upper Bound (Checks_SMax) (masked subsystem) |                                                     |                               |
| max                                                       | Upper bound                                         | string — {'0'}                |
| max_included                                              | Inclusive boundary                                  | string — 'off'   {'on'}       |
| enabled                                                   | Enable assertion                                    | string — 'off'   {'on'}       |
| callback                                                  | Simulation callback when assertion fails (optional) | string — {''}                 |
| stopWhenAssertionFail                                     | Stop simulation when assertion fails                | string — 'off'   {'on'}       |
| export                                                    | Output assertion signal                             | string — {'off'}   'on'       |
| icon                                                      | Select icon type                                    | string — {'graphic'}   'text' |

**Model-Wide Utilities Library Block Parameters**

| <b>Block (Type)/Parameter</b>                                | <b>Dialog Box Prompt</b>               | <b>Values</b>                      |
|--------------------------------------------------------------|----------------------------------------|------------------------------------|
| Block Support Table (Block Support Table) (masked subsystem) |                                        |                                    |
| DocBlock (DocBlock) (masked subsystem)                       |                                        |                                    |
| ECoderFlag                                                   | Real-Time Workshop Embedded Coder Flag | string — {''}                      |
| DocumentType                                                 | Document Type                          | string — {'Text'}   'RTF'   'HTML' |
| Model Info (CMBlock) (masked subsystem)                      |                                        |                                    |
| InitialSaveTempField                                         | InitialSaveTempField                   | string — {''}                      |

**Model-Wide Utilities Library Block Parameters (Continued)**

| <b>Block (Type)/Parameter</b> | <b>Dialog Box Prompt</b>  | <b>Values</b>           |
|-------------------------------|---------------------------|-------------------------|
| InitialBlockCM                | InitialBlockCM            | string — {'None'}       |
| BlockCM                       | BlockCM                   | string — {'None'}       |
| Frame                         | Show block frame          | string — 'off'   {'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 — {''}           |
| CMTag14                       | CMTag14                   | string — {''}           |
| CMTag15                       | CMTag15                   | string — {''}           |

**Model-Wide Utilities Library Block Parameters (Continued)**

| <b>Block (Type)/Parameter</b>                                            | <b>Dialog Box Prompt</b>          | <b>Values</b>                                                |
|--------------------------------------------------------------------------|-----------------------------------|--------------------------------------------------------------|
| 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                      | string — {'rising'}   'falling'   'either'   'function-call' |
| SampleTime                                                               | Sample time (of linearized model) | string — {'0'}                                               |

**Ports & Subsystems Library Block Parameters**

| <b>Block (Type)/Parameter</b> | <b>Dialog Box Prompt</b>         | <b>Values</b>               |
|-------------------------------|----------------------------------|-----------------------------|
| Action Port (ActionPort)      |                                  |                             |
| InitializeStates              | States when execution is resumed | string — {'held'}   'reset' |
| Atomic Subsystem (SubSystem)  |                                  |                             |

## Ports &amp; Subsystems Library Block Parameters (Continued)

| Block (Type)/Parameter           | Dialog Box Prompt                                                                                                                                                        | Values                                                                                 |
|----------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------|
| ShowPortLabels                   | Show port labels<br><br><b>Note</b> The values 'off' and 'on' are for backward compatibility only and should not be used in new models or when updating existing models. | string — 'none'   {'FromPortIcon'}   'FromPortBlockName'   'SignalName'   'off'   'on' |
| BlockChoice                      | Block choice                                                                                                                                                             | string — {''}                                                                          |
| TemplateBlock                    | Template block                                                                                                                                                           | string — {''}                                                                          |
| MemberBlocks                     | Member blocks                                                                                                                                                            | string — {''}                                                                          |
| Permissions                      | Read/Write permissions                                                                                                                                                   | string — {'ReadWrite'}   'ReadOnly'   'NoReadOrWrite'                                  |
| ErrorFcn                         | Name of error callback function                                                                                                                                          | string — {''}                                                                          |
| PermitHierarchical Resolution    | Permit hierarchical resolution                                                                                                                                           | string — {'All'}   'ExplicitOnly'   'None'                                             |
| TreatAsAtomicUnit                | Treat as atomic unit                                                                                                                                                     | string — 'off'   {'on'}                                                                |
| MinAlgLoopOccurrences            | Minimize algebraic loop occurrences                                                                                                                                      | string — {'off'}   'on'                                                                |
| PropExecContext OutsideSubsystem | Propagate execution context across subsystem boundary                                                                                                                    | string — {'off'}   'on'                                                                |
| CheckFcnCallInp InsideContextMsg | Warn if function-call inputs are context-specific                                                                                                                        | string — {'off'}   'on'                                                                |
| SystemSampleTime                 | Sample time (-1 for inherited)                                                                                                                                           | string — {'-1'}                                                                        |

**Ports & Subsystems Library Block Parameters (Continued)**

| <b>Block (Type)/Parameter</b>    | <b>Dialog Box Prompt</b>                                                                                               | <b>Values</b>                                                                                |
|----------------------------------|------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------|
| RTWSystemCode                    | Real-Time Workshop system code                                                                                         | string — {'Auto'}   'Inline'   'Function'   'Reusable function'                              |
| RTWFcnNameOpts                   | Real-Time Workshop function name options                                                                               | string — {'Auto'}   'Use subsystem name'   'User specified'                                  |
| RTWFcnName                       | Real-Time Workshop function name                                                                                       | string — {' '}                                                                               |
| RTWFileNameOpts                  | Real-Time Workshop filename options                                                                                    | string — {'Auto'}   'Use subsystem name'   'Use function name'   'User specified'            |
| RTWFileName                      | Real-Time Workshop filename (no extension)                                                                             | string — {' '}                                                                               |
| DataTypeOverride                 | Specifies data type used to override fixed-point data types. Set by <b>Data type override</b> on the Fixed-Point Tool. | string — {'UseLocalSettings'}   'ScaledDoubles'   'TrueDoubles'   'TrueSingles'   'ForceOff' |
| MinMaxOverflowLogging            | Setting for fixed-point logging. Set by <b>Logging mode</b> on the Fixed-Point Tool.                                   | string — {'UseLocalSettings'}   'MinMaxAndOverflow'   'OverflowOnly'   'ForceOff'            |
| IsSubsystemVirtual               |                                                                                                                        | boolean — {'off'}   'on'<br>Read-only                                                        |
| Code Reuse Subsystem (SubSystem) |                                                                                                                        |                                                                                              |

## Ports &amp; Subsystems Library Block Parameters (Continued)

| Block (Type)/Parameter           | Dialog Box Prompt                                                                                                                                                        | Values                                                                                 |
|----------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------|
| ShowPortLabels                   | Show port labels<br><br><b>Note</b> The values 'off' and 'on' are for backward compatibility only and should not be used in new models or when updating existing models. | string — 'none'   {'FromPortIcon'}   'FromPortBlockName'   'SignalName'   'off'   'on' |
| BlockChoice                      | Block choice                                                                                                                                                             | string — {''}                                                                          |
| TemplateBlock                    | Template block                                                                                                                                                           | string — {''}                                                                          |
| MemberBlocks                     | Member blocks                                                                                                                                                            | string — {''}                                                                          |
| Permissions                      | Read/Write permissions                                                                                                                                                   | string — {'ReadWrite'}   'ReadOnly'   'NoReadOrWrite'                                  |
| ErrorFcn                         | Name of error callback function                                                                                                                                          | string — {''}                                                                          |
| PermitHierarchical Resolution    | Permit hierarchical resolution                                                                                                                                           | string — {'All'}   'ExplicitOnly'   'None'                                             |
| TreatAsAtomicUnit                | Treat as atomic unit                                                                                                                                                     | string — 'off'   {'on'}                                                                |
| MinAlgLoopOccurrences            | Minimize algebraic loop occurrences                                                                                                                                      | string — {'off'}   'on'                                                                |
| PropExecContext OutsideSubsystem | Propagate execution context across subsystem boundary                                                                                                                    | string — {'off'}   'on'                                                                |
| CheckFcnCallInp InsideContextMsg | Warn if function-call inputs are context-specific                                                                                                                        | string — {'off'}   'on'                                                                |
| SystemSampleTime                 | Sample time (-1 for inherited)                                                                                                                                           | string — {'-1'}                                                                        |



**Ports & Subsystems Library Block Parameters (Continued)**

| <b>Block (Type)/Parameter</b>      | <b>Dialog Box Prompt</b>                                                                                               | <b>Values</b>                                                                                |
|------------------------------------|------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------|
| RTWSystemCode                      | Real-Time Workshop system code                                                                                         | string — 'Auto'   'Inline'   'Function'   {'Reusable function'}                              |
| RTWFcnNameOpts                     | Real-Time Workshop function name options                                                                               | string — 'Auto'   {'Use subsystem name'}   'User specified'                                  |
| RTWFcnName                         | Real-Time Workshop function name                                                                                       | string — {''}                                                                                |
| RTWFileNameOpts                    | Real-Time Workshop filename options                                                                                    | string — 'Auto'   'Use subsystem name'   {'Use function name'}   'User specified'            |
| RTWFileName                        | Real-Time Workshop filename (no extension)                                                                             | string — {''}                                                                                |
| DataTypeOverride                   | Specifies data type used to override fixed-point data types. Set by <b>Data type override</b> on the Fixed-Point Tool. | string — {'UseLocalSettings'}   'ScaledDoubles'   'TrueDoubles'   'TrueSingles'   'ForceOff' |
| MinMaxOverflowLogging              | Setting for fixed-point logging. Set by <b>Logging mode</b> on the Fixed-Point Tool.                                   | string — {'UseLocalSettings'}   'MinMaxAndOverflow'   'OverflowOnly'   'ForceOff'            |
| IsSubsystemVirtual                 |                                                                                                                        | boolean — {'off'}   'on'<br>Read-only                                                        |
| Configurable Subsystem (SubSystem) |                                                                                                                        |                                                                                              |

## Ports &amp; Subsystems Library Block Parameters (Continued)

| Block (Type)/Parameter           | Dialog Box Prompt                                                                                                                                                        | Values                                                                                               |
|----------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------|
| ShowPortLabels                   | Show port labels<br><br><b>Note</b> The values 'off' and 'on' are for backward compatibility only and should not be used in new models or when updating existing models. | string — 'none'  <br>{ 'FromPortIcon' }  <br>'FromPortBlockName'  <br>'SignalName'   'off'  <br>'on' |
| BlockChoice                      | Block choice                                                                                                                                                             | string — { '' }                                                                                      |
| TemplateBlock                    | Template block                                                                                                                                                           | string — { 'self' }                                                                                  |
| MemberBlocks                     | Member blocks                                                                                                                                                            | string — { '' }                                                                                      |
| Permissions                      | Read/Write permissions                                                                                                                                                   | string — { 'ReadWrite' }<br>  'ReadOnly'  <br>'NoReadOrWrite'                                        |
| ErrorFcn                         | Name of error callback function                                                                                                                                          | string — { '' }                                                                                      |
| PermitHierarchical Resolution    | Permit hierarchical resolution                                                                                                                                           | string — { 'All' }  <br>'ExplicitOnly'   'None'                                                      |
| TreatAsAtomicUnit                | Treat as atomic unit                                                                                                                                                     | string — { 'off' }   'on'                                                                            |
| MinAlgLoopOccurrences            | Minimize algebraic loop occurrences                                                                                                                                      | string — { 'off' }   'on'                                                                            |
| PropExecContext OutsideSubsystem | Propagate execution context across subsystem boundary                                                                                                                    | string — { 'off' }   'on'                                                                            |
| CheckFcnCallInp InsideContextMsg | Warn if function-call inputs are context-specific                                                                                                                        | string — { 'off' }   'on'                                                                            |
| SystemSampleTime                 | Sample time (-1 for inherited)                                                                                                                                           | string — { '-1' }                                                                                    |

**Ports & Subsystems Library Block Parameters (Continued)**

| <b>Block (Type)/Parameter</b> | <b>Dialog Box Prompt</b>                                                                                               | <b>Values</b>                                                                                |
|-------------------------------|------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------|
| RTWSystemCode                 | Real-Time Workshop system code                                                                                         | string — {'Auto'}   'Inline'   'Function'   'Reusable function'                              |
| RTWFcnNameOpts                | Real-Time Workshop function name options                                                                               | string — {'Auto'}   'Use subsystem name'   'User specified'                                  |
| RTWFcnName                    | Real-Time Workshop function name                                                                                       | string — {' '}                                                                               |
| RTWFileNameOpts               | Real-Time Workshop filename options                                                                                    | string — {'Auto'}   'Use subsystem name'   'Use function name'   'User specified'            |
| RTWFileName                   | Real-Time Workshop Workshop (no extension)                                                                             | string — {' '}                                                                               |
| DataTypeOverride              | Specifies data type used to override fixed-point data types. Set by <b>Data type override</b> on the Fixed-Point Tool. | string — {'UseLocalSettings'}   'ScaledDoubles'   'TrueDoubles'   'TrueSingles'   'ForceOff' |
| MinMaxOverflowLogging         | Setting for fixed-point logging. Set by <b>Logging mode</b> on the Fixed-Point Tool.                                   | string — {'UseLocalSettings'}   'MinMaxAndOverflow'   'OverflowOnly'   'ForceOff'            |
| IsSubsystemVirtual            |                                                                                                                        | boolean — {'on'}   'off'<br>Read-only                                                        |
| Enable (EnablePort)           |                                                                                                                        |                                                                                              |
| StatesWhenEnabling            | States when enabling                                                                                                   | string — {'held'}   'reset'                                                                  |
| ShowOutputPort                | Show output port                                                                                                       | string — {'off'}   'on'                                                                      |

## Ports &amp; Subsystems Library Block Parameters (Continued)

| Block (Type)/Parameter                      | Dialog Box Prompt                                                                                                                                                        | Values                                                                                 |
|---------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------|
| ZeroCross                                   | Enable zero-crossing detection                                                                                                                                           | string — 'off'   {'on'}                                                                |
| Enabled and Triggered Subsystem (SubSystem) |                                                                                                                                                                          |                                                                                        |
| ShowPortLabels                              | Show port labels<br><br><b>Note</b> The values 'off' and 'on' are for backward compatibility only and should not be used in new models or when updating existing models. | string — 'none'   {'FromPortIcon'}   'FromPortBlockName'   'SignalName'   'off'   'on' |
| BlockChoice                                 | Block choice                                                                                                                                                             | string — {''}                                                                          |
| TemplateBlock                               | Template block                                                                                                                                                           | string — {''}                                                                          |
| MemberBlocks                                | Member blocks                                                                                                                                                            | string — {''}                                                                          |
| Permissions                                 | Read/Write permissions                                                                                                                                                   | string — {'ReadWrite'}   'ReadOnly'   'NoReadOrWrite'                                  |
| ErrorFcn                                    | Name of error callback function                                                                                                                                          | string — {''}                                                                          |
| PermitHierarchicalResolution                | Permit hierarchical resolution                                                                                                                                           | string — {'All'}   'ExplicitOnly'   'None'                                             |
| TreatAsAtomicUnit                           | Treat as atomic unit                                                                                                                                                     | string — 'off'   {'on'}                                                                |
| MinAlgLoopOccurrences                       | Minimize algebraic loop occurrences                                                                                                                                      | string — {'off'}   'on'                                                                |
| PropExecContextOutsideSubsystem             | Propagate execution context across subsystem boundary                                                                                                                    | string — {'off'}   'on'                                                                |
| CheckFcnCallInpInsideContextMsg             | Warn if function-call inputs are context-specific                                                                                                                        | string — {'off'}   'on'                                                                |
| SystemSampleTime                            | Sample time (-1 for inherited)                                                                                                                                           | string — {'-1'}                                                                        |

**Ports & Subsystems Library Block Parameters (Continued)**

| <b>Block (Type)/Parameter</b> | <b>Dialog Box Prompt</b>                                                                                               | <b>Values</b>                                                                                |
|-------------------------------|------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------|
| RTWSystemCode                 | Real-Time Workshop system code                                                                                         | string — {'Auto'}   'Inline'   'Function'   'Reusable function'                              |
| RTWFcnNameOpts                | Real-Time Workshop function name options                                                                               | string — {'Auto'}   'Use subsystem name'   'User specified'                                  |
| RTWFcnName                    | Real-Time Workshop function name                                                                                       | string — {' '}                                                                               |
| RTWFileNameOpts               | Real-Time Workshop filename options                                                                                    | string — {'Auto'}   'Use subsystem name'   'Use function name'   'User specified'            |
| RTWFileName                   | Real-Time Workshop filename (no extension)                                                                             | string — {' '}                                                                               |
| DataTypeOverride              | Specifies data type used to override fixed-point data types. Set by <b>Data type override</b> on the Fixed-Point Tool. | string — {'UseLocalSettings'}   'ScaledDoubles'   'TrueDoubles'   'TrueSingles'   'ForceOff' |
| MinMaxOverflowLogging         | Setting for fixed-point logging. Set by <b>Logging mode</b> on the Fixed-Point Tool.                                   | string — {'UseLocalSettings'}   'MinMaxAndOverflow'   'OverflowOnly'   'ForceOff'            |
| IsSubsystemVirtual            |                                                                                                                        | boolean — {'off'}   'on'<br>Read-only                                                        |
| Enabled Subsystem (SubSystem) |                                                                                                                        |                                                                                              |

## Ports &amp; Subsystems Library Block Parameters (Continued)

| Block (Type)/Parameter          | Dialog Box Prompt                                                                                                                                                        | Values                                                                                 |
|---------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------|
| ShowPortLabels                  | Show port labels<br><br><b>Note</b> The values 'off' and 'on' are for backward compatibility only and should not be used in new models or when updating existing models. | string — 'none'   {'FromPortIcon'}   'FromPortBlockName'   'SignalName'   'off'   'on' |
| BlockChoice                     | Block choice                                                                                                                                                             | string — {''}                                                                          |
| TemplateBlock                   | Template block                                                                                                                                                           | string — {''}                                                                          |
| MemberBlocks                    | Member blocks                                                                                                                                                            | string — {''}                                                                          |
| Permissions                     | Read/Write permissions                                                                                                                                                   | string — {'ReadWrite'}   'ReadOnly'   'NoReadOrWrite'                                  |
| ErrorFcn                        | Name of error callback function                                                                                                                                          | string — {''}                                                                          |
| PermitHierarchicalResolution    | Permit hierarchical resolution                                                                                                                                           | string — {'All'}   'ExplicitOnly'   'None'                                             |
| TreatAsAtomicUnit               | Treat as atomic unit                                                                                                                                                     | string — 'off'   {'on'}                                                                |
| MinAlgLoopOccurrences           | Minimize algebraic loop occurrences                                                                                                                                      | string — {'off'}   'on'                                                                |
| PropExecContextOutsideSubsystem | Propagate execution context across subsystem boundary                                                                                                                    | string — {'off'}   'on'                                                                |
| CheckFcnCallInpInsideContextMsg | Warn if function-call inputs are context-specific                                                                                                                        | string — {'off'}   'on'                                                                |
| SystemSampleTime                | Sample time (-1 for inherited)                                                                                                                                           | string — {'-1'}                                                                        |

**Ports & Subsystems Library Block Parameters (Continued)**

| <b>Block (Type)/Parameter</b> | <b>Dialog Box Prompt</b>                                                                                               | <b>Values</b>                                                                                |
|-------------------------------|------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------|
| RTWSystemCode                 | Real-Time Workshop system code                                                                                         | string — {'Auto'}   'Inline'   'Function'   'Reusable function'                              |
| RTWFcnNameOpts                | Real-Time Workshop function name options                                                                               | string — {'Auto'}   'Use subsystem name'   'User specified'                                  |
| RTWFcnName                    | Real-Time Workshop function name                                                                                       | string — {' '}                                                                               |
| RTWFileNameOpts               | Real-Time Workshop filename options                                                                                    | string — {'Auto'}   'Use subsystem name'   'Use function name'   'User specified'            |
| RTWFileName                   | Real-Time Workshop filename (no extension)                                                                             | string — {' '}                                                                               |
| DataTypeOverride              | Specifies data type used to override fixed-point data types. Set by <b>Data type override</b> on the Fixed-Point Tool. | string — {'UseLocalSettings'}   'ScaledDoubles'   'TrueDoubles'   'TrueSingles'   'ForceOff' |
| MinMaxOverflowLogging         | Setting for fixed-point logging. Set by <b>Logging mode</b> on the Fixed-Point Tool.                                   | string — {'UseLocalSettings'}   'MinMaxAndOverflow'   'OverflowOnly'   'ForceOff'            |
| IsSubsystemVirtual            |                                                                                                                        | boolean — {'off'}   'on'<br>Read-only                                                        |
| For Iterator (ForIterator)    |                                                                                                                        |                                                                                              |
| ResetStates                   | States when starting                                                                                                   | string — {'held'}   'reset'                                                                  |
| IterationSource               | Iteration limit source                                                                                                 | string — {'internal'}   'external'                                                           |

## Ports &amp; Subsystems Library Block Parameters (Continued)

| Block (Type)/Parameter             | Dialog Box Prompt                                                                                                                                                        | Values                                                                                 |
|------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------|
| IterationLimit                     | Iteration limit                                                                                                                                                          | string — {'5'}                                                                         |
| ExternalIncrement                  | Set next i (iteration variable) externally                                                                                                                               | string — {'off'}   'on'                                                                |
| ShowIterationPort                  | Show iteration variable                                                                                                                                                  | string — 'off'   {'on'}                                                                |
| IndexMode                          | Index mode                                                                                                                                                               | string — 'Zero-based'   {'One-based'}                                                  |
| IterationVariable<br>DataType      | Iteration variable data type                                                                                                                                             | string — {'int32'}   'int16'   'int8'   'double'                                       |
| For Iterator Subsystem (SubSystem) |                                                                                                                                                                          |                                                                                        |
| ShowPortLabels                     | Show port labels<br><br><b>Note</b> The values 'off' and 'on' are for backward compatibility only and should not be used in new models or when updating existing models. | string — 'none'   {'FromPortIcon'}   'FromPortBlockName'   'SignalName'   'off'   'on' |
| BlockChoice                        | Block choice                                                                                                                                                             | string — {''}                                                                          |
| TemplateBlock                      | Template block                                                                                                                                                           | string — {''}                                                                          |
| MemberBlocks                       | Member blocks                                                                                                                                                            | string — {''}                                                                          |
| Permissions                        | Read/Write permissions                                                                                                                                                   | string — {'ReadWrite'}   'ReadOnly'   'NoReadOrWrite'                                  |
| ErrorFcn                           | Name of error callback function                                                                                                                                          | string — {''}                                                                          |
| PermitHierarchical<br>Resolution   | Permit hierarchical resolution                                                                                                                                           | string — {'All'}   'ExplicitOnly'   'None'                                             |



**Ports & Subsystems Library Block Parameters (Continued)**

| <b>Block (Type)/Parameter</b>       | <b>Dialog Box Prompt</b>                                                                                               | <b>Values</b>                                                                                |
|-------------------------------------|------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------|
| TreatAsAtomicUnit                   | Treat as atomic unit                                                                                                   | string — 'off'   {'on'}                                                                      |
| MinAlgLoopOccurrences               | Minimize algebraic loop occurrences                                                                                    | string — {'off'}   'on'                                                                      |
| PropExecContext<br>OutsideSubsystem | Propagate execution context across subsystem boundary                                                                  | string — {'off'}   'on'                                                                      |
| CheckFcnCallInp<br>InsideContextMsg | Warn if function-call inputs are context-specific                                                                      | string — {'off'}   'on'                                                                      |
| SystemSampleTime                    | Sample time (-1 for inherited)                                                                                         | string — {'-1'}                                                                              |
| RTWSystemCode                       | Real-Time Workshop system code                                                                                         | string — {'Auto'}   'Inline'   'Function'   'Reusable function'                              |
| RTWFcnNameOpts                      | Real-Time Workshop function name options                                                                               | string — {'Auto'}   'Use subsystem name'   'User specified'                                  |
| RTWFcnName                          | Real-Time Workshop function name                                                                                       | string — {''}                                                                                |
| RTWFileNameOpts                     | Real-Time Workshop filename options                                                                                    | string — {'Auto'}   'Use subsystem name'   'Use function name'   'User specified'            |
| RTWFileName                         | Real-Time Workshop filename (no extension)                                                                             | string — {''}                                                                                |
| DataTypeOverride                    | Specifies data type used to override fixed-point data types. Set by <b>Data type override</b> on the Fixed-Point Tool. | string — {'UseLocalSettings'}   'ScaledDoubles'   'TrueDoubles'   'TrueSingles'   'ForceOff' |

**Ports & Subsystems Library Block Parameters (Continued)**

| Block (Type)/Parameter                                               | Dialog Box Prompt                                                                                                                                                        | Values                                                                                               |
|----------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------|
| MinMaxOverflowLogging                                                | Setting for fixed-point logging. Set by <b>Logging mode</b> on the Fixed-Point Tool.                                                                                     | string —<br>{ 'UseLocalSettings' }<br>  'MinMaxAndOverflow'<br>  'OverflowOnly'  <br>'ForceOff'      |
| IsSubsystemVirtual                                                   |                                                                                                                                                                          | boolean — { 'off' }   'on'<br><br>Read-only                                                          |
| Function-Call Generator (Function-Call Generator) (masked subsystem) |                                                                                                                                                                          |                                                                                                      |
| sample_time                                                          | Sample time                                                                                                                                                              | string — { '1' }                                                                                     |
| numberOfIterations                                                   | Number of iterations                                                                                                                                                     | string — { '1' }                                                                                     |
| Function-Call Subsystem (SubSystem)                                  |                                                                                                                                                                          |                                                                                                      |
| ShowPortLabels                                                       | Show port labels<br><br><b>Note</b> The values 'off' and 'on' are for backward compatibility only and should not be used in new models or when updating existing models. | string — 'none'  <br>{ 'FromPortIcon' }  <br>'FromPortBlockName'  <br>'SignalName'   'off'  <br>'on' |
| BlockChoice                                                          | Block choice                                                                                                                                                             | string — { '' }                                                                                      |
| TemplateBlock                                                        | Template block                                                                                                                                                           | string — { '' }                                                                                      |
| MemberBlocks                                                         | Member blocks                                                                                                                                                            | string — { '' }                                                                                      |
| Permissions                                                          | Read/Write permissions                                                                                                                                                   | string — { 'ReadWrite' }<br>  'ReadOnly'  <br>'NoReadOrWrite'                                        |
| ErrorFcn                                                             | Name of error callback function                                                                                                                                          | string — { '' }                                                                                      |

**Ports & Subsystems Library Block Parameters (Continued)**

| <b>Block (Type)/Parameter</b>   | <b>Dialog Box Prompt</b>                                                                                               | <b>Values</b>                                                                                |
|---------------------------------|------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------|
| PermitHierarchicalResolution    | Permit hierarchical resolution                                                                                         | string — {'All'}   'ExplicitOnly'   'None'                                                   |
| TreatAsAtomicUnit               | Treat as atomic unit                                                                                                   | string — 'off'   {'on'}                                                                      |
| MinAlgLoopOccurrences           | Minimize algebraic loop occurrences                                                                                    | string — {'off'}   'on'                                                                      |
| PropExecContextOutsideSubsystem | Propagate execution context across subsystem boundary                                                                  | string — {'off'}   'on'                                                                      |
| CheckFcnCallInpInsideContextMsg | Warn if function-call inputs are context-specific                                                                      | string — {'off'}   'on'                                                                      |
| SystemSampleTime                | Sample time (-1 for inherited)                                                                                         | string — {'-1'}                                                                              |
| RTWSystemCode                   | Real-Time Workshop system code                                                                                         | string — {'Auto'}   'Inline'   'Function'   'Reusable function'                              |
| RTWFcnNameOpts                  | Real-Time Workshop function name options                                                                               | string — {'Auto'}   'Use subsystem name'   'User specified'                                  |
| RTWFcnName                      | Real-Time Workshop function name                                                                                       | string — {''}                                                                                |
| RTWFileNameOpts                 | Real-Time Workshop filename options                                                                                    | string — {'Auto'}   'Use subsystem name'   'Use function name'   'User specified'            |
| RTWFileName                     | Real-Time Workshop filename (no extension)                                                                             | string — {''}                                                                                |
| DataTypeOverride                | Specifies data type used to override fixed-point data types. Set by <b>Data type override</b> on the Fixed-Point Tool. | string — {'UseLocalSettings'}   'ScaledDoubles'   'TrueDoubles'   'TrueSingles'   'ForceOff' |

**Ports & Subsystems Library Block Parameters (Continued)**

| Block (Type)/Parameter          | Dialog Box Prompt                                                                                                                                                        | Values                                                                                 |
|---------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------|
| MinMaxOverflowLogging           | Setting for fixed-point logging. Set by <b>Logging mode</b> on the Fixed-Point Tool.                                                                                     | string — {'UseLocalSettings'}   'MinMaxAndOverflow'   'OverflowOnly'   'ForceOff'      |
| IsSubsystemVirtual              |                                                                                                                                                                          | boolean — {'off'}   'on'<br>Read-only                                                  |
| 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                                                                                                                                                      | string — 'off'   {'on'}                                                                |
| ZeroCross                       | Enable zero-crossing detection                                                                                                                                           | string — 'off'   {'on'}                                                                |
| SampleTime                      | Sample time (-1 for inherited)                                                                                                                                           | string — {'-1'}                                                                        |
| If Action Subsystem (SubSystem) |                                                                                                                                                                          |                                                                                        |
| ShowPortLabels                  | Show port labels<br><br><b>Note</b> The values 'off' and 'on' are for backward compatibility only and should not be used in new models or when updating existing models. | string — 'none'   {'FromPortIcon'}   'FromPortBlockName'   'SignalName'   'off'   'on' |
| BlockChoice                     | Block choice                                                                                                                                                             | string — {''}                                                                          |
| TemplateBlock                   | Template block                                                                                                                                                           | string — {''}                                                                          |

**Ports & Subsystems Library Block Parameters (Continued)**

| <b>Block (Type)/Parameter</b>   | <b>Dialog Box Prompt</b>                              | <b>Values</b>                                                                     |
|---------------------------------|-------------------------------------------------------|-----------------------------------------------------------------------------------|
| MemberBlocks                    | Member blocks                                         | string — {''}                                                                     |
| Permissions                     | Read/Write permissions                                | string — {'ReadWrite'}<br>  'ReadOnly'  <br>'NoReadOrWrite'                       |
| ErrorFcn                        | Name of error callback function                       | string — {''}                                                                     |
| PermitHierarchicalResolution    | Permit hierarchical resolution                        | string — {'All'}  <br>'ExplicitOnly'   'None'                                     |
| TreatAsAtomicUnit               | Treat as atomic unit                                  | string — 'off'   {'on'}                                                           |
| MinAlgLoopOccurrences           | Minimize algebraic loop occurrences                   | string — {'off'}   'on'                                                           |
| PropExecContextOutsideSubsystem | Propagate execution context across subsystem boundary | string — {'off'}   'on'                                                           |
| CheckFcnCallInpInsideContextMsg | Warn if function-call inputs are context-specific     | string — {'off'}   'on'                                                           |
| SystemSampleTime                | Sample time (-1 for inherited)                        | string — {'-1'}                                                                   |
| RTWSystemCode                   | Real-Time Workshop system code                        | string — {'Auto'}  <br>'Inline'   'Function'<br>  'Reusable function'             |
| RTWFcnNameOpts                  | Real-Time Workshop function name options              | string — {'Auto'}   'Use subsystem name'   'User specified'                       |
| RTWFcnName                      | Real-Time Workshop function name                      | string — {''}                                                                     |
| RTWFileNameOpts                 | Real-Time Workshop filename options                   | string — {'Auto'}   'Use subsystem name'   'Use function name'   'User specified' |
| RTWFileName                     | Real-Time Workshop filename (no extension)            | string — {''}                                                                     |

## Ports &amp; Subsystems Library Block Parameters (Continued)

| Block (Type)/Parameter           | Dialog Box Prompt                                                                                                      | Values                                                                                                        |
|----------------------------------|------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------|
| DataTypeOverride                 | Specifies data type used to override fixed-point data types. Set by <b>Data type override</b> on the Fixed-Point Tool. | string —<br>{ 'UseLocalSettings' }<br>  'ScaledDoubles'<br>  'TrueDoubles'<br>  'TrueSingles'  <br>'ForceOff' |
| MinMaxOverflowLogging            | Setting for fixed-point logging. Set by <b>Logging mode</b> on the Fixed-Point Tool.                                   | string —<br>{ 'UseLocalSettings' }<br>  'MinMaxAndOverflow'<br>  'OverflowOnly'  <br>'ForceOff'               |
| IsSubsystemVirtual               |                                                                                                                        | boolean — { 'off' }   'on'<br>Read-only                                                                       |
| In1 (Inport)                     |                                                                                                                        |                                                                                                               |
| Port                             | Port number                                                                                                            | string — { '1' }                                                                                              |
| IconDisplay                      | Icon display                                                                                                           | string — 'Signal name'  <br>{ 'Port number' }   'Port<br>number and signal name'                              |
| LatchByDelaying<br>OutsideSignal | Latch input by delaying<br>outside signal                                                                              | string — { 'off' }   'on'                                                                                     |
| LatchByCopying<br>InsideSignal   | Latch input by copying inside<br>signal                                                                                | string — { 'off' }   'on'                                                                                     |
| Interpolate                      | Interpolate data                                                                                                       | string — 'off'   { 'on' }                                                                                     |
| UseBusObject                     | Specify properties via bus<br>object                                                                                   | string — { 'off' }   'on'                                                                                     |
| BusObject                        | Bus object for specifying bus<br>properties                                                                            | string — { 'BusObject' }                                                                                      |
| BusOutputAsStruct                | Output as nonvirtual bus                                                                                               | string — { 'off' }   'on'                                                                                     |
| PortDimensions                   | Port dimensions (-1 for<br>inherited)                                                                                  | string — { '-1' }                                                                                             |

**Ports & Subsystems Library Block Parameters (Continued)**

| <b>Block (Type)/Parameter</b> | <b>Dialog Box Prompt</b>                                    | <b>Values</b>                                                                                                                                                                                                    |
|-------------------------------|-------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| SampleTime                    | Sample time (-1 for inherited)                              | string — {'-1'}                                                                                                                                                                                                  |
| OutMin                        | Minimum                                                     | string — {'[]'}                                                                                                                                                                                                  |
| OutMax                        | Maximum                                                     | string — {'[]'}                                                                                                                                                                                                  |
| OutDataTypeStr                | Data type                                                   | string — {'Inherit:<br>auto'}   'double'  <br>'single'   'int8'  <br>'uint8'   'int16'  <br>'uint16'   'int32'  <br>'uint32'   'boolean'<br>  'fixdt(1,16,0)'  <br>'fixdt(1,16,2^0,0)'  <br>'Enum: <class name>' |
| LockScale                     | Lock output scaling against changes by the autoscaling tool | string — {'off'}   'on'                                                                                                                                                                                          |
| SignalType                    | Signal type                                                 | string — {'auto'}   'real'<br>  'complex'                                                                                                                                                                        |
| SamplingMode                  | Sampling mode                                               | string — {'auto'}   'Sample based'   'Frame based'                                                                                                                                                               |
| <b>Model (ModelReference)</b> |                                                             |                                                                                                                                                                                                                  |
| ModelName                     | Model name (without the .mdl extension)                     | string — {'<Enter Model Name>'}                                                                                                                                                                                  |
| ParameterArgumentNames        | Model arguments                                             | string — {''}                                                                                                                                                                                                    |
| ParameterArgumentValues       | Model argument values (for this instance)                   | string — {''}                                                                                                                                                                                                    |

**Ports & Subsystems Library Block Parameters (Continued)**

| Block (Type)/Parameter | Dialog Box Prompt                                                                                                                                              | Values                                                                      |
|------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------|
| SimulationMode         | Simulation mode<br><br><b>Note</b> Specifies whether to simulate the model by generating and executing code or by interpreting the model in Simulink software. | string — {'Accelerator'   'Normal'   'Processor-in-the-loop (PIL)'}<br><br> |
| AvailSigsInstanceProps |                                                                                                                                                                | handle vector — {' '}                                                       |
| AvailSigsDefaultProps  |                                                                                                                                                                | handle vector — {' '}                                                       |
| DefaultDataLogging     |                                                                                                                                                                | string — {'off'}   'on'                                                     |
| Out1 (Outputport)      |                                                                                                                                                                |                                                                             |
| Port                   | Port number                                                                                                                                                    | string — {'1'}                                                              |
| IconDisplay            | Icon display                                                                                                                                                   | string — 'Signal name'   {'Port number'}   'Port number and signal name'    |
| UseBusObject           | Specify properties via bus object                                                                                                                              | string — {'off'}   'on'                                                     |
| BusObject              | Bus object for specifying bus properties                                                                                                                       | string — {'BusObject'}                                                      |
| BusOutputAsStruct      | Output as nonvirtual bus in parent model                                                                                                                       | string — {'off'}   'on'                                                     |
| PortDimensions         | Port dimensions (-1 for inherited)                                                                                                                             | string — {'-1'}                                                             |
| SampleTime             | Sample time (-1 for inherited)                                                                                                                                 | string — {'-1'}                                                             |
| OutMin                 | Minimum                                                                                                                                                        | string — {'[]'}                                                             |
| OutMax                 | Maximum                                                                                                                                                        | string — {'[]'}                                                             |



## Ports &amp; Subsystems Library Block Parameters (Continued)

| Block (Type)/Parameter | Dialog Box Prompt                                                                                                                                                        | Values                                                                                                                                                                                   |
|------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| OutDataTypeStr         | Data type                                                                                                                                                                | string — {'Inherit: auto'}   'double'   'single'   'int8'   'uint8'   'int16'   'uint16'   'int32'   'uint32'   'boolean'   'fixdt(1,16,0)'   'fixdt(1,16,2^0,0)'   'Enum: <class name>' |
| LockScale              | Lock output scaling against changes by the autoscaling tool                                                                                                              | string — {'off'}   'on'                                                                                                                                                                  |
| SignalType             | Signal type                                                                                                                                                              | string — {'auto'}   'real'   'complex'                                                                                                                                                   |
| SamplingMode           | Sampling mode                                                                                                                                                            | string — {'auto'}   'Sample based'   'Frame based'                                                                                                                                       |
| OutputWhenDisabled     | Output when disabled                                                                                                                                                     | string — {'held'}   'reset'                                                                                                                                                              |
| InitialOutput          | Initial output                                                                                                                                                           | string — {'[]'}                                                                                                                                                                          |
| Subsystem (SubSystem)  |                                                                                                                                                                          |                                                                                                                                                                                          |
| ShowPortLabels         | Show port labels<br><br><b>Note</b> The values 'off' and 'on' are for backward compatibility only and should not be used in new models or when updating existing models. | string — 'none'   {'FromPortIcon'}   'FromPortBlockName'   'SignalName'   'off'   'on'                                                                                                   |
| BlockChoice            | Block choice                                                                                                                                                             | string — {''}                                                                                                                                                                            |
| TemplateBlock          | Template block                                                                                                                                                           | string — {''}                                                                                                                                                                            |

**Ports & Subsystems Library Block Parameters (Continued)**

| <b>Block (Type)/Parameter</b>    | <b>Dialog Box Prompt</b>                              | <b>Values</b>                                                                     |
|----------------------------------|-------------------------------------------------------|-----------------------------------------------------------------------------------|
| MemberBlocks                     | Member blocks                                         | string — {''}                                                                     |
| Permissions                      | Read/Write permissions                                | string — {'ReadWrite'}<br>  'ReadOnly'  <br>'NoReadOrWrite'                       |
| ErrorFcn                         | Name of error callback function                       | string — {''}                                                                     |
| PermitHierarchical Resolution    | Permit hierarchical resolution                        | string — {'All'}  <br>'ExplicitOnly'   'None'                                     |
| TreatAsAtomicUnit                | Treat as atomic unit                                  | string — {'off'}   'on'                                                           |
| MinAlgLoopOccurrences            | Minimize algebraic loop occurrences                   | string — {'off'}   'on'                                                           |
| PropExecContext OutsideSubsystem | Propagate execution context across subsystem boundary | string — {'off'}   'on'                                                           |
| CheckFcnCallInp InsideContextMsg | Warn if function-call inputs are context-specific     | string — {'off'}   'on'                                                           |
| SystemSampleTime                 | Sample time (-1 for inherited)                        | string — {'-1'}                                                                   |
| RTWSystemCode                    | Real-Time Workshop system code                        | string — {'Auto'}  <br>'Inline'   'Function'<br>  'Reusable function'             |
| RTWFcnNameOpts                   | Real-Time Workshop function name options              | string — {'Auto'}   'Use subsystem name'   'User specified'                       |
| RTWFcnName                       | Real-Time Workshop function name                      | string {''}                                                                       |
| RTWFileNameOpts                  | Real-Time Workshop filename options                   | string — {'Auto'}   'Use subsystem name'   'Use function name'   'User specified' |
| RTWFileName                      | Real-Time Workshop filename (no extension)            | string — {''}                                                                     |

## Ports &amp; Subsystems Library Block Parameters (Continued)

| Block (Type)/Parameter                   | Dialog Box Prompt                                                                                                                                                        | Values                                                                                                        |
|------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------|
| DataTypeOverride                         | Specifies data type used to override fixed-point data types. Set by <b>Data type override</b> on the Fixed-Point Tool.                                                   | string —<br>{ 'UseLocalSettings' }<br>  'ScaledDoubles'<br>  'TrueDoubles'<br>  'TrueSingles'  <br>'ForceOff' |
| MinMaxOverflowLogging                    | Setting for fixed-point logging. Set by <b>Logging mode</b> on the Fixed-Point Tool.                                                                                     | string —<br>{ 'UseLocalSettings' }<br>  'MinMaxAndOverflow'<br>  'OverflowOnly'  <br>'ForceOff'               |
| IsSubsystemVirtual                       |                                                                                                                                                                          | boolean — { 'on' }   'off'<br>Read-only                                                                       |
| Virtual                                  | For internal use                                                                                                                                                         |                                                                                                               |
| Switch Case (SwitchCase)                 |                                                                                                                                                                          |                                                                                                               |
| CaseConditions                           | Case conditions (e.g., {1,[2,3]})                                                                                                                                        | string — { '{1}' }                                                                                            |
| CaseShowDefault                          | Show default case                                                                                                                                                        | string — 'off'   { 'on' }                                                                                     |
| ZeroCross                                | Enable zero-crossing detection                                                                                                                                           | string — 'off'   { 'on' }                                                                                     |
| SampleTime                               | Sample time (-1 for inherited)                                                                                                                                           | string — { '-1' }                                                                                             |
| Switch Case Action Subsystem (SubSystem) |                                                                                                                                                                          |                                                                                                               |
| ShowPortLabels                           | Show port labels<br><br><b>Note</b> The values 'off' and 'on' are for backward compatibility only and should not be used in new models or when updating existing models. | string — 'none'  <br>{ 'FromPortIcon' }  <br>'FromPortBlockName'  <br>'SignalName'   'off'  <br>'on'          |

**Ports & Subsystems Library Block Parameters (Continued)**

| <b>Block (Type)/Parameter</b>    | <b>Dialog Box Prompt</b>                              | <b>Values</b>                                                                     |
|----------------------------------|-------------------------------------------------------|-----------------------------------------------------------------------------------|
| BlockChoice                      | Block choice                                          | string — {''}                                                                     |
| TemplateBlock                    | Template block                                        | string — {''}                                                                     |
| MemberBlocks                     | Member blocks                                         | string — {''}                                                                     |
| Permissions                      | Read/Write permissions                                | string — {'ReadWrite'}<br>  'ReadOnly'  <br>'NoReadOrWrite'                       |
| ErrorFcn                         | Name of error callback function                       | string — {''}                                                                     |
| PermitHierarchical Resolution    | Permit hierarchical resolution                        | string — {'All'}  <br>'ExplicitOnly'   'None'                                     |
| TreatAsAtomicUnit                | Treat as atomic unit                                  | string — 'off'   {'on'}                                                           |
| MinAlgLoopOccurrences            | Minimize algebraic loop occurrences                   | string — {'off'}   'on'                                                           |
| PropExecContext OutsideSubsystem | Propagate execution context across subsystem boundary | string — {'off'}   'on'                                                           |
| CheckFcnCallInp InsideContextMsg | Warn if function-call inputs are context-specific     | string — {'off'}   'on'                                                           |
| SystemSampleTime                 | Sample time (-1 for inherited)                        | string — {'-1'}                                                                   |
| RTWSystemCode                    | Real-Time Workshop system code                        | string — {'Auto'}  <br>'Inline'   'Function'<br>  'Reusable function'             |
| RTWFcnNameOpts                   | Real-Time Workshop function name options              | string — {'Auto'}   'Use subsystem name'   'User specified'                       |
| RTWFcnName                       | Real-Time Workshop function name                      | string — {''}                                                                     |
| RTWFileNameOpts                  | Real-Time Workshop filename options                   | string — {'Auto'}   'Use subsystem name'   'Use function name'   'User specified' |

**Ports & Subsystems Library Block Parameters (Continued)**

| <b>Block (Type)/Parameter</b>          | <b>Dialog Box Prompt</b>                                                                                               | <b>Values</b>                                                                                               |
|----------------------------------------|------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------|
| RTWFileName                            | Real-Time Workshop filename (no extension)                                                                             | string — {''}                                                                                               |
| DataTypeOverride                       | Specifies data type used to override fixed-point data types. Set by <b>Data type override</b> on the Fixed-Point Tool. | string —<br>{ 'UseLocalSettings'  <br>'ScaledDoubles'  <br>'TrueDoubles'  <br>'TrueSingles'  <br>'ForceOff' |
| MinMaxOverflowLogging                  | Setting for fixed-point logging. Set by <b>Logging mode</b> on the Fixed-Point Tool.                                   | string —<br>{ 'UseLocalSettings'  <br>'MinMaxAndOverflow'  <br>'OverflowOnly'  <br>'ForceOff'               |
| IsSubsystemVirtual                     |                                                                                                                        | boolean — {'off'}   'on'<br><br>Read-only                                                                   |
| <b>Trigger (TriggerPort)</b>           |                                                                                                                        |                                                                                                             |
| TriggerType                            | Trigger type                                                                                                           | string — {'rising'}  <br>'falling'   'either'  <br>'function-call'                                          |
| StatesWhenEnabling                     | States when enabling                                                                                                   | string — {'held'}   'reset'  <br>'inherit'                                                                  |
| ShowOutputPort                         | Show output port                                                                                                       | string — {'off'}   'on'                                                                                     |
| OutputDataType                         | Output data type                                                                                                       | string — {'auto'}  <br>'double'   'int8'                                                                    |
| SampleTimeType                         | Sample time type                                                                                                       | string — {'triggered'}  <br>'periodic'                                                                      |
| SampleTime                             | Sample time                                                                                                            | string — {'1'}                                                                                              |
| ZeroCross                              | Enable zero-crossing detection                                                                                         | string — 'off'   {'on'}                                                                                     |
| <b>Triggered Subsystem (SubSystem)</b> |                                                                                                                        |                                                                                                             |

## Ports &amp; Subsystems Library Block Parameters (Continued)

| Block (Type)/Parameter           | Dialog Box Prompt                                                                                                                                                        | Values                                                                                 |
|----------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------|
| ShowPortLabels                   | Show port labels<br><br><b>Note</b> The values 'off' and 'on' are for backward compatibility only and should not be used in new models or when updating existing models. | string — 'none'   {'FromPortIcon'}   'FromPortBlockName'   'SignalName'   'off'   'on' |
| BlockChoice                      | Block choice                                                                                                                                                             | string — {''}                                                                          |
| TemplateBlock                    | Template block                                                                                                                                                           | string — {''}                                                                          |
| MemberBlocks                     | Member blocks                                                                                                                                                            | string — {''}                                                                          |
| Permissions                      | Read/Write permissions                                                                                                                                                   | string — {'ReadWrite'}   'ReadOnly'   'NoReadOrWrite'                                  |
| ErrorFcn                         | Name of error callback function                                                                                                                                          | string — {''}                                                                          |
| PermitHierarchical Resolution    | Permit hierarchical resolution                                                                                                                                           | string — {'All'}   'ExplicitOnly'   'None'                                             |
| TreatAsAtomicUnit                | Treat as atomic unit                                                                                                                                                     | string — 'off'   {'on'}                                                                |
| MinAlgLoopOccurrences            | Minimize algebraic loop occurrences                                                                                                                                      | string — {'off'}   'on'                                                                |
| PropExecContext OutsideSubsystem | Propagate execution context across subsystem boundary                                                                                                                    | string — {'off'}   'on'                                                                |
| CheckFcnCallInp InsideContextMsg | Warn if function-call inputs are context-specific                                                                                                                        | string — {'off'}   'on'                                                                |
| SystemSampleTime                 | Sample time (-1 for inherited)                                                                                                                                           | string — {'-1'}                                                                        |

**Ports & Subsystems Library Block Parameters (Continued)**

| <b>Block (Type)/Parameter</b>  | <b>Dialog Box Prompt</b>                                                                                               | <b>Values</b>                                                                                |
|--------------------------------|------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------|
| RTWSystemCode                  | Real-Time Workshop system code                                                                                         | string — {'Auto'}   'Inline'   'Function'   'Reusable function'                              |
| RTWFcnNameOpts                 | Real-Time Workshop function name options                                                                               | string — {'Auto'}   'Use subsystem name'   'User specified'                                  |
| RTWFcnName                     | Real-Time Workshop function name                                                                                       | string — {' '}                                                                               |
| RTWFileNameOpts                | Real-Time Workshop filename options                                                                                    | string — {'Auto'}   'Use subsystem name'   'Use function name'   'User specified'            |
| RTWFileName                    | Real-Time Workshop filename (no extension)                                                                             | string — {' '}                                                                               |
| DataTypeOverride               | Specifies data type used to override fixed-point data types. Set by <b>Data type override</b> on the Fixed-Point Tool. | string — {'UseLocalSettings'}   'ScaledDoubles'   'TrueDoubles'   'TrueSingles'   'ForceOff' |
| MinMaxOverflowLogging          | Setting for fixed-point logging. Set by <b>Logging mode</b> on the Fixed-Point Tool.                                   | string — {'UseLocalSettings'}   'MinMaxAndOverflow'   'OverflowOnly'   'ForceOff'            |
| IsSubsystemVirtual             |                                                                                                                        | boolean — {'off'}   'on'<br>Read-only                                                        |
| While Iterator (WhileIterator) |                                                                                                                        |                                                                                              |
| MaxIters                       | Maximum number of iterations (-1 for unlimited)                                                                        | string — {'5'}                                                                               |

**Ports & Subsystems Library Block Parameters (Continued)**

| Block (Type)/Parameter               | Dialog Box Prompt                                                                                                                                                        | Values                                                                                 |
|--------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------|
| WhileBlockType                       | While loop type                                                                                                                                                          | string — {'while'}   'do-while'                                                        |
| ResetStates                          | States when starting                                                                                                                                                     | string — {'held'}   'reset'                                                            |
| ShowIterationPort                    | Show iteration number port                                                                                                                                               | string — {'off'}   'on'                                                                |
| OutputDataType                       | Output data type                                                                                                                                                         | string — {'int32'}   'int16'   'int8'   'double'                                       |
| While Iterator Subsystem (SubSystem) |                                                                                                                                                                          |                                                                                        |
| ShowPortLabels                       | Show port labels<br><br><b>Note</b> The values 'off' and 'on' are for backward compatibility only and should not be used in new models or when updating existing models. | string — 'none'   {'FromPortIcon'}   'FromPortBlockName'   'SignalName'   'off'   'on' |
| BlockChoice                          | Block choice                                                                                                                                                             | string — {''}                                                                          |
| TemplateBlock                        | Template block                                                                                                                                                           | string — {''}                                                                          |
| MemberBlocks                         | Member blocks                                                                                                                                                            | string — {''}                                                                          |
| Permissions                          | Read/Write permissions                                                                                                                                                   | string — {'ReadWrite'}   'ReadOnly'   'NoReadOrWrite'                                  |
| ErrorFcn                             | Name of error callback function                                                                                                                                          | string — {''}                                                                          |
| PermitHierarchicalResolution         | Permit hierarchical resolution                                                                                                                                           | string — {'All'}   'ExplicitOnly'   'None'                                             |
| TreatAsAtomicUnit                    | Treat as atomic unit                                                                                                                                                     | string — 'off'   {'on'}                                                                |



**Ports & Subsystems Library Block Parameters (Continued)**

| <b>Block (Type)/Parameter</b>       | <b>Dialog Box Prompt</b>                                                                                               | <b>Values</b>                                                                                |
|-------------------------------------|------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------|
| MinAlgLoopOccurrences               | Minimize algebraic loop occurrences                                                                                    | string — {'off'}   'on'                                                                      |
| PropExecContext<br>OutsideSubsystem | Propagate execution context across subsystem boundary                                                                  | string — {'off'}   'on'                                                                      |
| CheckFcnCallInp<br>InsideContextMsg | Warn if function-call inputs are context-specific                                                                      | string — {'off'}   'on'                                                                      |
| SystemSampleTime                    | Sample time (-1 for inherited)                                                                                         | string — {'-1'}                                                                              |
| RTWSystemCode                       | Real-Time Workshop system code                                                                                         | string — {'Auto'}   'Inline'   'Function'   'Reusable function'                              |
| RTWFcnNameOpts                      | Real-Time Workshop function name options                                                                               | string — {'Auto'}   'Use subsystem name'   'User specified'                                  |
| RTWFcnName                          | Real-Time Workshop function name                                                                                       | string — {' '}                                                                               |
| RTWFileNameOpts                     | Real-Time Workshop filename options                                                                                    | string — {'Auto'}   'Use subsystem name'   'Use function name'   'User specified'            |
| RTWFileName                         | Real-Time Workshop filename (no extension)                                                                             | string — {' '}                                                                               |
| DataTypeOverride                    | Specifies data type used to override fixed-point data types. Set by <b>Data type override</b> on the Fixed-Point Tool. | string — {'UseLocalSettings'}   'ScaledDoubles'   'TrueDoubles'   'TrueSingles'   'ForceOff' |

**Ports & Subsystems Library Block Parameters (Continued)**

| Block (Type)/Parameter | Dialog Box Prompt                                                                    | Values                                                                            |
|------------------------|--------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|
| MinMaxOverflowLogging  | Setting for fixed-point logging. Set by <b>Logging mode</b> on the Fixed-Point Tool. | string — {'UseLocalSettings'}   'MinMaxAndOverflow'   'OverflowOnly'   'ForceOff' |
| IsSubsystemVirtual     |                                                                                      | boolean — {'off'}   'on'<br>Read-only                                             |

**Signal Attributes Library Block Parameters**

| Block (Type)/Parameter                    | Dialog Box Prompt                                           | Values                                                                                                                                                                                                           |
|-------------------------------------------|-------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Bus to Vector (BusToVector)               |                                                             |                                                                                                                                                                                                                  |
| Data Type Conversion (DataTypeConversion) |                                                             |                                                                                                                                                                                                                  |
| OutMin                                    | Output minimum                                              | string — {'[]'}                                                                                                                                                                                                  |
| OutMax                                    | Output maximum                                              | string — {'[]'}                                                                                                                                                                                                  |
| OutDataTypeStr                            | Output data type                                            | string — {'Inherit: Inherit via back propagation'}   'double'   'single'   'int8'   'uint8'   'int16'   'uint16'   'int32'   'uint32'   'boolean'   'fixdt(1,16,0)'   'fixdt(1,16,2^0,0)'   'Enum: <class name>' |
| LockScale                                 | Lock output scaling against changes by the autoscaling tool | string — {'off'}   'on'                                                                                                                                                                                          |
| ConvertRealWorld                          | Input and output to have equal                              | string — {'Real World Value (RWV)'}   'Stored Integer (SI)'                                                                                                                                                      |

**Signal Attributes Library Block Parameters (Continued)**

| <b>Block (Type)/Parameter</b>                                            | <b>Dialog Box Prompt</b>                                       | <b>Values</b>                                                                             |
|--------------------------------------------------------------------------|----------------------------------------------------------------|-------------------------------------------------------------------------------------------|
| RndMeth                                                                  | Integer rounding mode                                          | string — 'Ceiling'   'Convergent'   {'Floor'}   'Nearest'   'Round'   'Simplest'   'Zero' |
| SaturateOnInteger Overflow                                               | Saturate on integer overflow                                   | string — {'off'}   'on'                                                                   |
| SampleTime                                                               | Sample time (-1 for inherited)                                 | string — {'-1'}                                                                           |
| Data Type Conversion Inherited (Conversion Inherited) (masked subsystem) |                                                                |                                                                                           |
| ConvertRealWorld                                                         | Input and Output to have equal                                 | string — {'Real World Value'}   'Stored Integer'                                          |
| RndMeth                                                                  | Integer rounding mode                                          | string — 'Ceiling'   'Convergent'   {'Floor'}   'Nearest'   'Round'   'Simplest'   'Zero' |
| DoSatur                                                                  | Saturate to max or min when overflows occur                    | string — {'off'}   'on'                                                                   |
| 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                                        | string — 'Specify via dialog'   {'Inherit via propagation rule'}                          |
| PropDataType                                                             | 1.1. Propagated data type (e.g., fixdt(1,16), fixdt('single')) | string — {'fixdt(1,16)'}   {'single'}                                                     |
| IfRefDouble                                                              | 1.1. If any reference input is double, output is               | string — {'double'}   'single'                                                            |
| IfRefSingle                                                              | 1.2. If any reference input is single, output is               | string — 'double'   {'single'}                                                            |

**Signal Attributes Library Block Parameters (Continued)**

| <b>Block (Type)/Parameter</b> | <b>Dialog Box Prompt</b>                                           | <b>Values</b>                                                                                                      |
|-------------------------------|--------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------|
| IsSigned                      | 1.3. Is-Signed                                                     | string — 'IsSigned1'   'IsSigned2'   {'IsSigned1 or IsSigned2'}   'TRUE'   'FALSE'                                 |
| NumBitsBase                   | 1.4.1. Number-of-Bits: Base                                        | string — '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                                              | string — 'Specify via dialog'   {'Inherit via propagation rule'}   'Obtain via best precision'                     |
| PropScaling                   | 2.1. Propagated scaling: Slope or [Slope Bias] ex. 2 <sup>-9</sup> | string — {'2 <sup>-10</sup> '}                                                                                     |
| ValuesUsedBestPrec            | 2.1. Values used to determine best precision scaling               | string — {'[5 -7]'}                                                                                                |

**Signal Attributes Library Block Parameters (Continued)**

| <b>Block (Type)/Parameter</b>                              | <b>Dialog Box Prompt</b>                | <b>Values</b>                                                                                                                                                                                                                                                  |
|------------------------------------------------------------|-----------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| SlopeBase                                                  | 2.1.1. Slope: Base                      | string — '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                       | string — {'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)**

| <b>Block (Type)/Parameter</b> | <b>Dialog Box Prompt</b>        | <b>Values</b>                                                                                                             |
|-------------------------------|---------------------------------|---------------------------------------------------------------------------------------------------------------------------|
| Probe (Probe)                 |                                 |                                                                                                                           |
| ProbeWidth                    | Probe width                     | string — 'off'   {'on'}                                                                                                   |
| ProbeSampleTime               | Probe sample time               | string — 'off'   {'on'}                                                                                                   |
| ProbeComplexSignal            | Detect complex signal           | string — 'off'   {'on'}                                                                                                   |
| ProbeSignalDimensions         | Probe signal dimensions         | string — 'off'   {'on'}                                                                                                   |
| ProbeFramedSignal             | Detect framed signal            | string — 'off'   {'on'}                                                                                                   |
| ProbeWidthDataType            | Data type for width             | string — {'double'}   'single'   'int8'   'uint8'   'int16'   'uint16'   'int32'   'uint32'   'boolean'   'Same as input' |
| ProbeSampleTimeDataType       | Data type for sample time       | string — {'double'}   'single'   'int8'   'uint8'   'int16'   'uint16'   'int32'   'uint32'   'boolean'   'Same as input' |
| ProbeComplexityDataType       | Data type for signal complexity | string — {'double'}   'single'   'int8'   'uint8'   'int16'   'uint16'   'int32'   'uint32'   'boolean'   'Same as input' |
| ProbeDimensionsDataType       | Data type for signal dimensions | string — {'double'}   'single'   'int8'   'uint8'   'int16'   'uint16'   'int32'   'uint32'   'boolean'   'Same as input' |

**Signal Attributes Library Block Parameters (Continued)**

| <b>Block (Type)/Parameter</b>              | <b>Dialog Box Prompt</b>                           | <b>Values</b>                                                                                                             |
|--------------------------------------------|----------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------|
| ProbeFrameDataType                         | Data type for signal frames                        | string — {'double'}   'single'   'int8'   'uint8'   'int16'   'uint16'   'int32'   'uint32'   'boolean'   'Same as input' |
| Rate Transition (RateTransition)           |                                                    |                                                                                                                           |
| Integrity                                  | Ensure data integrity during data transfer         | string — 'off'   {'on'}                                                                                                   |
| Deterministic                              | Ensure deterministic data transfer (maximum delay) | string — 'off'   {'on'}                                                                                                   |
| X0                                         | Initial conditions                                 | string — {'0'}                                                                                                            |
| OutPortSampleTimeOpt                       | Output port sample time options                    | string — {'Specify'}   'Inherit'   'Multiple of input port sample time'                                                   |
| OutPortSampleTimeMultiple                  | Sample time multiple (>0)                          | string — {'1'}                                                                                                            |
| OutPortSampleTime                          | Output port sample time                            | string — {'-1'}                                                                                                           |
| Signal Conversion (SignalConversion)       |                                                    |                                                                                                                           |
| ConversionOutput                           | Output                                             | string — {'Contiguous copy'}   'Bus copy'   'Virtual bus'   'Nonvirtual bus'                                              |
| OverrideOpt                                | Override optimizations and always copy signal      | string — {'off'}   'on'                                                                                                   |
| Signal Specification (SignalSpecification) |                                                    |                                                                                                                           |
| Dimensions                                 | Dimensions (-1 for inherited)                      | string — {'-1'}                                                                                                           |
| SampleTime                                 | Sample time (-1 for inherited)                     | string — {'-1'}                                                                                                           |
| OutMin                                     | Minimum                                            | string — {'[]'}                                                                                                           |
| OutMax                                     | Maximum                                            | string — {'[]'}                                                                                                           |

**Signal Attributes Library Block Parameters (Continued)**

| <b>Block (Type)/Parameter</b>                              | <b>Dialog Box Prompt</b>                                    | <b>Values</b>                                                                                                                                                                            |
|------------------------------------------------------------|-------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| OutDataTypeStr                                             | Data type                                                   | string — {'Inherit: auto'}   'double'   'single'   'int8'   'uint8'   'int16'   'uint16'   'int32'   'uint32'   'boolean'   'fixdt(1,16,0)'   'fixdt(1,16,2^0,0)'   'Enum: <class name>' |
| LockScale                                                  | Lock output scaling against changes by the autoscaling tool | string — {'off'}   'on'                                                                                                                                                                  |
| SignalType                                                 | Signal type                                                 | string — {'auto'}   'real'   'complex'                                                                                                                                                   |
| SamplingMode                                               | Sampling mode                                               | string — {'auto'}   'Sample based'   'Frame based'                                                                                                                                       |
| Weighted Sample Time (Sample Time Math) (masked subsystem) |                                                             |                                                                                                                                                                                          |
| TsampMathOp                                                | Operation                                                   | string — '+'   '-'   '*'   '/'   {'Ts Only'}   '1/Ts Only'                                                                                                                               |
| weightValue                                                | Weight value                                                | string — {'1.0'}                                                                                                                                                                         |
| TsampMathImp                                               | Implement using                                             | string — {'Online Calculations'}   'Offline Scaling Adjustment'                                                                                                                          |
| OutputDataTypeScaling Mode                                 | Output data type mode                                       | string — {'Inherit via internal rule'}   'Inherit via back propagation'                                                                                                                  |
| RndMeth                                                    | Integer rounding mode                                       | string — 'Ceiling'   'Convergent'   {'Floor'}   'Nearest'   'Round'   'Simplest'   'Zero'                                                                                                |



**Signal Attributes Library Block Parameters (Continued)**

| <b>Block (Type)/Parameter</b> | <b>Dialog Box Prompt</b>                    | <b>Values</b>                                                                                        |
|-------------------------------|---------------------------------------------|------------------------------------------------------------------------------------------------------|
| DoSatur                       | Saturate to max or min when overflows occur | string — {'off'}   'on'                                                                              |
| Width (Width)                 |                                             |                                                                                                      |
| OutputDataTypeScaling Mode    | Output data type mode                       | string — {'Choose intrinsic data type'}   'Inherit via back propagation'   'All ports same datatype' |
| DataType                      | Output data type                            | string — {'double'}   'single'   'int8'   'uint8'   'int16'   'uint16'   'int32'   'uint32'          |

**Signal Routing Library Block Parameters**

| <b>Block (Type)/Parameter</b>  | <b>Dialog Box Prompt</b>                                                                                                                                                                                                | <b>Values</b>   |
|--------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|
| 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, <code>set_param(gcb, ''a'', 'b'')</code> ; sets the currently selected Bus Creator block two have two inputs named a and b. | string — {'2'}  |

**Signal Routing Library Block Parameters (Continued)**

| <b>Block (Type)/Parameter</b>              | <b>Dialog Box Prompt</b>                                                                                                                               | <b>Values</b>                           |
|--------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------|
| DisplayOption                              |                                                                                                                                                        | string — 'none'   'signals'   {'bar'}   |
| UseBusObject                               | Specify properties via bus object                                                                                                                      | string — {'off'}   'on'                 |
| BusObject                                  | Bus object for specifying bus properties                                                                                                               | string — {'BusObject'}                  |
| NonVirtualBus                              | Output as nonvirtual bus                                                                                                                               | string — {'off'}   'on'                 |
| <b>Bus Selector (BusSelector)</b>          |                                                                                                                                                        |                                         |
| OutputSignals                              | Specifies the names of the input bus signals selected for output. Corresponds to the <b>Selected signals</b> list on the block's parameter dialog box. | string — {'signal1,signal2'}            |
| OutputAsBus                                | Output as bus                                                                                                                                          | string — {'off'}   'on'                 |
| InputSignals                               | Specifies the names of the signal elements of the bus connected to the Bus Selector's input port.                                                      | matrix — {'{'}}                         |
| <b>Data Store Memory (DataStoreMemory)</b> |                                                                                                                                                        |                                         |
| DataStoreName                              | Data store name                                                                                                                                        | string — {'A'}                          |
| ReadBeforeWriteMsg                         | Detect read before write                                                                                                                               | string — 'none'   {'warning'}   'error' |
| WriteAfterWriteMsg                         | Detect write after write                                                                                                                               | string — 'none'   {'warning'}   'error' |
| WriteAfterReadMsg                          | Detect write after read                                                                                                                                | string — 'none'   {'warning'}   'error' |
| InitialValue                               | Initial value                                                                                                                                          | string — {'0'}                          |

**Signal Routing Library Block Parameters (Continued)**

| <b>Block (Type)/Parameter</b>          | <b>Dialog Box Prompt</b>                                    | <b>Values</b>                                                                                                                                                                            |
|----------------------------------------|-------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| StateMustResolveToSignalObject         | Data store name must resolve to Simulink signal object      | string — {'off'}   'on'                                                                                                                                                                  |
| RTWStateStorageClass                   | Real-Time Workshop storage class                            | string — {'Auto'}   'ExportedGlobal'   'ImportedExtern'   'ImportedExternPointer'                                                                                                        |
| RTWStateStorageTypeQualifier           | Real-Time Workshop type qualifier                           | string — {''}                                                                                                                                                                            |
| VectorParams1D                         | Interpret vector parameters as 1-D                          | string — 'off'   {'on'}                                                                                                                                                                  |
| ShowAdditionalParam                    | Show additional parameters                                  | string — {'off'}   'on'                                                                                                                                                                  |
| OutMin                                 | Minimum                                                     | string — {'[]'}                                                                                                                                                                          |
| OutMax                                 | Maximum                                                     | string — {'[]'}                                                                                                                                                                          |
| OutDataTypeStr                         | Data type                                                   | string — {'Inherit: auto'}   'double'   'single'   'int8'   'uint8'   'int16'   'uint16'   'int32'   'uint32'   'boolean'   'fixdt(1,16,0)'   'fixdt(1,16,2^0,0)'   'Enum: <class name>' |
| LockScale                              | Lock output scaling against changes by the autoscaling tool | string — {'off'}   'on'                                                                                                                                                                  |
| SignalType                             | Signal type                                                 | string — {'auto'}   'real'   'complex'                                                                                                                                                   |
| <b>Data Store Read (DataStoreRead)</b> |                                                             |                                                                                                                                                                                          |
| DataStoreName                          | Data store name                                             | string — {'A'}                                                                                                                                                                           |
| SampleTime                             | Sample time                                                 | string — {'0'}                                                                                                                                                                           |

**Signal Routing Library Block Parameters (Continued)**

| <b>Block (Type)/Parameter</b>                                      | <b>Dialog Box Prompt</b>       | <b>Values</b>                                            |
|--------------------------------------------------------------------|--------------------------------|----------------------------------------------------------|
| 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                 | string — 'none'   {'bar'}                                |
| BusSelectionMode                                                   | Bus selection mode             | string — {'off'}   'on'                                  |
| Environment Controller (Environment Controller) (masked subsystem) |                                |                                                          |
| From (From)                                                        |                                |                                                          |
| GotoTag                                                            | Goto tag                       | string — {'A'}                                           |
| IconDisplay                                                        | Icon display                   | string — 'Signal name'   {'Tag'}   'Tag and signal name' |
| Goto (Goto)                                                        |                                |                                                          |
| GotoTag                                                            | Tag                            | string — {'A'}                                           |
| IconDisplay                                                        | Icon display                   | string — 'Signal name'   {'Tag'}   'Tag and signal name' |
| TagVisibility                                                      | Tag visibility                 | string — {'local'}   'scoped'   'global'                 |
| Goto Tag Visibility (GotoTagVisibility)                            |                                |                                                          |
| GotoTag                                                            | Goto tag                       | string — {'A'}                                           |
| Index Vector (Multi-Port Switch)                                   |                                |                                                          |
| Inputs                                                             | Number of inputs               | string — {'1'}                                           |
| zeroidx                                                            | Use zero-based indexing        | string — 'off'   {'on'}                                  |

**Signal Routing Library Block Parameters (Continued)**

| <b>Block (Type)/Parameter</b>                    | <b>Dialog Box Prompt</b>                                | <b>Values</b>                                                                                                                                                                                                        |
|--------------------------------------------------|---------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| SampleTime                                       | Sample time (-1 for inherited)                          | string — {'-1'}                                                                                                                                                                                                      |
| InputSameDT                                      | Require all data port inputs to have the same data type | string — {'off'}   'on'                                                                                                                                                                                              |
| OutDataTypeStr                                   | Output data type                                        | string — {'Inherit: Inherit via internal rule'}   'Inherit: Inherit via back propagation'   'double'   'single'   'int8'   'uint8'   'int16'   'uint16'   'int32'   'uint32'   'fixdt(1,16,0)'   'fixdt(1,16,2^0,0)' |
| RndMeth                                          | Integer rounding mode                                   | string — 'Ceiling'   'Convergent'   {'Floor'}   'Nearest'   'Round'   'Simplest'   'Zero'                                                                                                                            |
| SaturateOnInteger Overflow                       | Saturate on integer overflow                            | string — {'off'}   'on'                                                                                                                                                                                              |
| 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                               | string — {'off'}   'on'                                                                                                                                                                                              |
| InputPortOffsets                                 | Input port offsets                                      | string — {'[]'}                                                                                                                                                                                                      |
| Multiport Switch (Multi-Port Switch)             |                                                         |                                                                                                                                                                                                                      |
| Inputs                                           | Number of inputs                                        | string — {'3'}                                                                                                                                                                                                       |

**Signal Routing Library Block Parameters (Continued)**

| <b>Block (Type)/Parameter</b> | <b>Dialog Box Prompt</b>                                    | <b>Values</b>                                                                                                                                                                                                        |
|-------------------------------|-------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| zeroidx                       | Use zero-based indexing                                     | string — {'off'}   'on'                                                                                                                                                                                              |
| SampleTime                    | Sample time (-1 for inherited)                              | string — {'-1'}                                                                                                                                                                                                      |
| InputSameDT                   | Require all data port inputs to have the same data type     | string — {'off'}   'on'                                                                                                                                                                                              |
| OutMin                        | Output minimum                                              | string — {'[]'}                                                                                                                                                                                                      |
| OutMax                        | Output maximum                                              | string — {'[]'}                                                                                                                                                                                                      |
| OutDataTypeStr                | Output data type                                            | string — {'Inherit: Inherit via internal rule'}   'Inherit: Inherit via back propagation'   'double'   'single'   'int8'   'uint8'   'int16'   'uint16'   'int32'   'uint32'   'fixdt(1,16,0)'   'fixdt(1,16,2^0,0)' |
| LockScale                     | Lock output scaling against changes by the autoscaling tool | string — {'off'}   'on'                                                                                                                                                                                              |
| RndMeth                       | Integer rounding mode                                       | string — 'Ceiling'   'Convergent'   {'Floor'}   'Nearest'   'Round'   'Simplest'   'Zero'                                                                                                                            |
| SaturateOnInteger Overflow    | Saturate on integer overflow                                | string — {'off'}   'on'                                                                                                                                                                                              |
| Mux (Mux)                     |                                                             |                                                                                                                                                                                                                      |
| Inputs                        | Number of inputs                                            | string — {'2'}                                                                                                                                                                                                       |
| DisplayOption                 | Display option                                              | string — 'none'   'signals'   {'bar'}                                                                                                                                                                                |
| UseBusObject                  | For internal use                                            |                                                                                                                                                                                                                      |

**Signal Routing Library Block Parameters (Continued)**

| <b>Block (Type)/Parameter</b> | <b>Dialog Box Prompt</b>                             | <b>Values</b>                                                                                                                           |
|-------------------------------|------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------|
| BusObject                     | For internal use                                     |                                                                                                                                         |
| NonVirtualBus                 | For internal use                                     |                                                                                                                                         |
| Selector (Selector)           |                                                      |                                                                                                                                         |
| NumberOfDimensions            | Number of input dimensions                           | string — {'1'}                                                                                                                          |
| IndexMode                     | Index mode                                           | string — 'Zero-based'  <br>'One-based'                                                                                                  |
| IndexOptionArray              | Index Option                                         | string — 'Select all'  <br>'Index vector (dialog)'<br>'Index vector (port)'  <br>'Starting index (dialog)'  <br>'Starting index (port)' |
| IndexParamArray               | Index                                                | cell array                                                                                                                              |
| OutputSizeArray               | Output Size                                          | cell array                                                                                                                              |
| InputPortWidth                | Input port size                                      | string — {'1'}                                                                                                                          |
| SampleTime                    | Sample time (-1 for inherited)                       | string — {'-1'}                                                                                                                         |
| IndexOptions                  | See IndexOptionArray parameter for more information. |                                                                                                                                         |
| Indices                       | See IndexParamArray parameter for more information.  |                                                                                                                                         |
| OutputSizes                   | See OutputSizeArray parameter for more information.  |                                                                                                                                         |
| Switch (Switch)               |                                                      |                                                                                                                                         |
| Criteria                      | Criteria for passing first input                     | string — {'u2 >= Threshold'  <br>'u2 > Threshold'   'u2 ~= 0'}                                                                          |
| Threshold                     | Threshold                                            | string — {'0'}                                                                                                                          |

### Signal Routing Library Block Parameters (Continued)

| Block (Type)/Parameter     | Dialog Box Prompt                                           | Values                                                                                                                                                                                                               |
|----------------------------|-------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| ZeroCross                  | Enable zero-crossing detection                              | string — 'off'   {'on'}                                                                                                                                                                                              |
| SampleTime                 | Sample time (-1 for inherited)                              | string — {'-1'}                                                                                                                                                                                                      |
| InputSameDT                | Require all data port inputs to have the same data type     | string — {'off'}   'on'                                                                                                                                                                                              |
| OutMin                     | Output minimum                                              | string — {'[]'}                                                                                                                                                                                                      |
| OutMax                     | Output maximum                                              | string — {'[]'}                                                                                                                                                                                                      |
| OutDataTypeStr             | Output data type                                            | string — {'Inherit: Inherit via internal rule'}   'Inherit: Inherit via back propagation'   'double'   'single'   'int8'   'uint8'   'int16'   'uint16'   'int32'   'uint32'   'fixdt(1,16,0)'   'fixdt(1,16,2^0,0)' |
| LockScale                  | Lock output scaling against changes by the autoscaling tool | string — {'off'}   'on'                                                                                                                                                                                              |
| RndMeth                    | Integer rounding mode                                       | string — 'Ceiling'   'Convergent'   {'Floor'}   'Nearest'   'Round'   'Simplest'   'Zero'                                                                                                                            |
| SaturateOnInteger Overflow | Saturate on integer overflow                                | string — {'off'}   'on'                                                                                                                                                                                              |

### Sinks Library Block Parameters

| Block (Type)/Parameter | Dialog Box Prompt | Values |
|------------------------|-------------------|--------|
| Display (Display)      |                   |        |



**Sinks Library Block Parameters (Continued)**

| <b>Block (Type)/Parameter</b> | <b>Dialog Box Prompt</b>       | <b>Values</b>                                                                                                                                                            |
|-------------------------------|--------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Format                        | Format                         | string — {'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               | string — {'off'}   'on'                                                                                                                                                  |
| SampleTime                    | Sample time (-1 for inherited) | string — {'-1'}                                                                                                                                                          |
| Floating Scope (Scope)        |                                |                                                                                                                                                                          |
| Floating                      |                                | string — 'off'   {'on'}                                                                                                                                                  |
| Location                      |                                | vector — {'[376 294 700 533]'}                                                                                                                                           |
| Open                          |                                | string — {'off'}   'on'                                                                                                                                                  |
| NumInputPorts                 |                                | string {'1'}                                                                                                                                                             |
| TickLabels                    |                                | string — 'on'   'off'   {'OneTimeTick'}                                                                                                                                  |
| ZoomMode                      |                                | string — {'on'}   'xonly'   'yonly'                                                                                                                                      |
| AxesTitles                    |                                | string                                                                                                                                                                   |
| Grid                          |                                | string — 'off'   {'on'}   'xonly'   'yonly'                                                                                                                              |
| TimeRange                     |                                | string — {'auto'}                                                                                                                                                        |
| YMin                          |                                | string — {'-5'}                                                                                                                                                          |
| YMax                          |                                | string — {'5'}                                                                                                                                                           |
| SaveToWorkspace               |                                | string — {'off'}   'on'                                                                                                                                                  |

**Sinks Library Block Parameters (Continued)**

| <b>Block (Type)/Parameter</b> | <b>Dialog Box Prompt</b>                    | <b>Values</b>                                                                  |
|-------------------------------|---------------------------------------------|--------------------------------------------------------------------------------|
| SaveName                      |                                             | string — {'ScopeData'}                                                         |
| DataFormat                    |                                             | string —<br>{'StructureWithTime'}  <br>'Structure'   'Array'                   |
| LimitDataPoints               |                                             | string — 'off'   {'on'}                                                        |
| MaxDataPoints                 |                                             | string — {'5000'}                                                              |
| Decimation                    |                                             | string — {'1'}                                                                 |
| SampleInput                   |                                             | string — {'off'}   'on'                                                        |
| SampleTime                    |                                             | string — {'0'}                                                                 |
| Out1 (Outport)                |                                             |                                                                                |
| Port                          | Port number                                 | string — {'1'}                                                                 |
| IconDisplay                   | Icon display                                | string — 'Signal name'  <br>{'Port number'}   'Port<br>number and signal name' |
| UseBusObject                  | Specify properties via bus<br>object        | string — {'off'}   'on'                                                        |
| BusObject                     | Bus object for specifying bus<br>properties | string — {'BusObject'}                                                         |
| BusOutputAsStruct             | Output as nonvirtual bus in<br>parent model | string — {'off'}   'on'                                                        |
| PortDimensions                | Port dimensions (-1 for<br>inherited)       | string — {'-1'}                                                                |
| SampleTime                    | Sample time (-1 for inherited)              | string — {'-1'}                                                                |
| OutMin                        | Minimum                                     | string — {'[]'}                                                                |
| OutMax                        | Maximum                                     | string — {'[]'}                                                                |

**Sinks Library Block Parameters (Continued)**

| <b>Block (Type)/Parameter</b> | <b>Dialog Box Prompt</b>                                    | <b>Values</b>                                                                                                                                                                            |
|-------------------------------|-------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| OutDataTypeStr                | Data type                                                   | string — {'Inherit: auto'}   'double'   'single'   'int8'   'uint8'   'int16'   'uint16'   'int32'   'uint32'   'boolean'   'fixdt(1,16,0)'   'fixdt(1,16,2^0,0)'   'Enum: <class name>' |
| LockScale                     | Lock output scaling against changes by the autoscaling tool | string — {'off'}   'on'                                                                                                                                                                  |
| SignalType                    | Signal type                                                 | string — {'auto'}   'real'   'complex'                                                                                                                                                   |
| SamplingMode                  | Sampling mode                                               | string — {'auto'}   'Sample based'   'Frame based'                                                                                                                                       |
| OutputWhenDisabled            | Output when disabled                                        | string — {'held'}   'reset'                                                                                                                                                              |
| InitialOutput                 | Initial output                                              | string — {'[]'}                                                                                                                                                                          |
| Scope (Scope)                 |                                                             |                                                                                                                                                                                          |
| Floating                      |                                                             | string — {'off'}   'on'                                                                                                                                                                  |
| Location                      |                                                             | vector — {'[188 390 512 629]'}                                                                                                                                                           |
| Open                          |                                                             | string — {'off'}   'on'                                                                                                                                                                  |
| NumInputPorts                 |                                                             | string — {'1'}                                                                                                                                                                           |
| TickLabels                    |                                                             | string — 'on'   'off'   {'OneTimeTick'}                                                                                                                                                  |
| ZoomMode                      |                                                             | string — {'on'}   'xonly'   'yonly'                                                                                                                                                      |
| AxesTitles                    |                                                             | string                                                                                                                                                                                   |

**Sinks Library Block Parameters (Continued)**

| <b>Block (Type)/Parameter</b> | <b>Dialog Box Prompt</b>       | <b>Values</b>                                                |
|-------------------------------|--------------------------------|--------------------------------------------------------------|
| Grid                          |                                | string — 'off'   {'on'}   'xonly'   'yonly'                  |
| TimeRange                     |                                | string — {'auto'}                                            |
| YMin                          |                                | string — {'-5'}                                              |
| YMax                          |                                | string — {'5'}                                               |
| SaveToWorkspace               |                                | string — {'off'}   'on'                                      |
| SaveName                      |                                | string — {'ScopeData1'}                                      |
| DataFormat                    |                                | string —<br>{'StructureWithTime'}  <br>'Structure'   'Array' |
| LimitDataPoints               |                                | string — 'off'   {'on'}                                      |
| MaxDataPoints                 |                                | string — {'5000'}                                            |
| Decimation                    |                                | string — {'1'}                                               |
| SampleInput                   |                                | string — {'off'}   'on'                                      |
| 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'}                                               |

**Sinks Library Block Parameters (Continued)**

| <b>Block (Type)/Parameter</b>          | <b>Dialog Box Prompt</b>             | <b>Values</b>                                            |
|----------------------------------------|--------------------------------------|----------------------------------------------------------|
| SampleTime                             | Sample time (-1 for inherited)       | string — {'-1'}                                          |
| SaveFormat                             | Save format                          | string — 'Structure With Time'   {'Structure'}   'Array' |
| FixptAsFi                              | Log fixed-point data as an fi object | string — {'off'}   'on'                                  |
| 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**

| <b>Block (Type)/Parameter</b>                                          | <b>Dialog Box Prompt</b>            | <b>Values</b>           |
|------------------------------------------------------------------------|-------------------------------------|-------------------------|
| 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  | string — 'off'   {'on'} |
| 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 | string — 'off'   {'on'} |

**Sources Library Block Parameters (Continued)**

| <b>Block (Type)/Parameter</b>                                  | <b>Dialog Box Prompt</b>                                    | <b>Values</b>                                                                                                                                                                                                                                                                |
|----------------------------------------------------------------|-------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Clock (Clock)                                                  |                                                             |                                                                                                                                                                                                                                                                              |
| DisplayTime                                                    | Display time                                                | string — {'off'}   'on'                                                                                                                                                                                                                                                      |
| Decimation                                                     | Decimation                                                  | string — {'10'}                                                                                                                                                                                                                                                              |
| Constant (Constant)                                            |                                                             |                                                                                                                                                                                                                                                                              |
| Value                                                          | Constant value                                              | string — {'1'}                                                                                                                                                                                                                                                               |
| VectorParams1D                                                 | Interpret vector parameters as 1-D                          | string — 'off'   {'on'}                                                                                                                                                                                                                                                      |
| SamplingMode                                                   | Sampling mode                                               | string — {'Sample based'}   'Frame based'                                                                                                                                                                                                                                    |
| OutMin                                                         | Output minimum                                              | string — {'[]'}                                                                                                                                                                                                                                                              |
| OutMax                                                         | Output maximum                                              | string — {'[]'}                                                                                                                                                                                                                                                              |
| OutDataTypeStr                                                 | Output data type                                            | string — {'Inherit: Inherit from 'Constant value''}   'Inherit: Inherit via back propagation'   'double'   'single'   'int8'   'uint8'   'int16'   'uint16'   'int32'   'uint32'   'boolean'   'fixdt(1,16)'   'fixdt(1,16,0)'   'fixdt(1,16,2^0,0)'   'Enum: <class name>'} |
| LockScale                                                      | Lock output scaling against changes by the autoscaling tool | string — {'off'}   'on'                                                                                                                                                                                                                                                      |
| SampleTime                                                     | Sample time                                                 | string — {'inf'}                                                                                                                                                                                                                                                             |
| FramePeriod                                                    | Frame period                                                | string — {'inf'}                                                                                                                                                                                                                                                             |
| Counter Free-Running (Counter Free-Running) (masked subsystem) |                                                             |                                                                                                                                                                                                                                                                              |

**Sources Library Block Parameters (Continued)**

| <b>Block (Type)/Parameter</b>                        | <b>Dialog Box Prompt</b>              | <b>Values</b>                                                                                |
|------------------------------------------------------|---------------------------------------|----------------------------------------------------------------------------------------------|
| NumBits                                              | Number of Bits                        | string — {'16'}                                                                              |
| tsamp                                                | Sample time                           | string — {'-1'}                                                                              |
| Counter Limited (Counter Limited) (masked subsystem) |                                       |                                                                                              |
| uplimit                                              | Upper limit                           | string — {'7'}                                                                               |
| tsamp                                                | Sample time                           | string — {'-1'}                                                                              |
| Digital Clock (DigitalClock)                         |                                       |                                                                                              |
| SampleTime                                           | Sample time                           | string — {'1'}                                                                               |
| From File (FromFile)                                 |                                       |                                                                                              |
| FileName                                             | File name                             | string — {'untitled.mat'}                                                                    |
| SampleTime                                           | Sample time                           | string — {'0'}                                                                               |
| From Workspace (FromWorkspace)                       |                                       |                                                                                              |
| VariableName                                         | Data                                  | string — {'simin'}                                                                           |
| SampleTime                                           | Sample time                           | string — {'0'}                                                                               |
| Interpolate                                          | Interpolate data                      | string — 'off'   {'on'}                                                                      |
| ZeroCross                                            | Enable zero-crossing detection        | string — 'off'   {'on'}                                                                      |
| OutputAfterFinalValue                                | Form output after final data value by | string — {'Extrapolation'}   'Setting to zero'   'Holding final value'   'Cyclic repetition' |
| Ground                                               |                                       |                                                                                              |
| In1 (Inport)                                         |                                       |                                                                                              |
| Port                                                 | Port number                           | string — {'1'}                                                                               |
| IconDisplay                                          | Icon display                          | string — 'Signal name'   {'Port number'}   'Port number and signal name'                     |
| UseBusObject                                         | Specify properties via bus object     | string — {'off'}   'on'                                                                      |

## Sources Library Block Parameters (Continued)

| Block (Type)/Parameter                   | Dialog Box Prompt                                           | Values                                                                                                                                                                                                           |
|------------------------------------------|-------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| BusObject                                | Bus object for specifying bus properties                    | string — {'BusObject'}                                                                                                                                                                                           |
| BusOutputAsStruct                        | Output as nonvirtual bus                                    | string — {'off'}   'on'                                                                                                                                                                                          |
| PortDimensions                           | Port dimensions (-1 for inherited)                          | string — {'-1'}                                                                                                                                                                                                  |
| SampleTime                               | Sample time (-1 for inherited)                              | string — {'-1'}                                                                                                                                                                                                  |
| OutMin                                   | Minimum                                                     | string — {'[]'}                                                                                                                                                                                                  |
| OutMax                                   | Maximum                                                     | string — {'[]'}                                                                                                                                                                                                  |
| OutDataTypeStr                           | Data type                                                   | string — {'Inherit:<br>auto'}   'double'  <br>'single'   'int8'  <br>'uint8'   'int16'  <br>'uint16'   'int32'  <br>'uint32'   'boolean'<br>  'fixdt(1,16,0)'  <br>'fixdt(1,16,2^0,0)'  <br>'Enum: <class name>' |
| LockScale                                | Lock output scaling against changes by the autoscaling tool | string — {'off'}   'on'                                                                                                                                                                                          |
| SignalType                               | Signal type                                                 | string — {'auto'}   'real'<br>  'complex'                                                                                                                                                                        |
| SamplingMode                             | Sampling mode                                               | string — {'auto'}   'Sample<br>based'   'Frame based'                                                                                                                                                            |
| LatchByDelaying<br>OutsideSignal         | Latch input by delaying outside signal                      | string — {'off'}   'on'                                                                                                                                                                                          |
| LatchByCopying<br>InsideSignal           | Latch input by copying inside signal                        | string — {'off'}   'on'                                                                                                                                                                                          |
| Interpolate                              | Interpolate data                                            | string — 'off'   {'on'}                                                                                                                                                                                          |
| Pulse Generator (DiscretePulseGenerator) |                                                             |                                                                                                                                                                                                                  |



**Sources Library Block Parameters (Continued)**

| <b>Block (Type)/Parameter</b>                                  | <b>Dialog Box Prompt</b>           | <b>Values</b>                                            |
|----------------------------------------------------------------|------------------------------------|----------------------------------------------------------|
| PulseType                                                      | Pulse type                         | string — {'Time based'}   'Sample based'                 |
| TimeSource                                                     | Time (t)                           | string — {'Use simulation time'}   'Use external signal' |
| Amplitude                                                      | Amplitude                          | string — {'1'}                                           |
| Period                                                         | Period                             | string — {'10'}                                          |
| PulseWidth                                                     | Pulse width                        | string — {'5'}                                           |
| PhaseDelay                                                     | Phase delay                        | string — {'0'}                                           |
| SampleTime                                                     | Sample time                        | string — {'1'}                                           |
| VectorParams1D                                                 | Interpret vector parameters as 1-D | string — 'off'   {'on'}                                  |
| <b>Ramp (Ramp) (masked subsystem)</b>                          |                                    |                                                          |
| slope                                                          | Slope                              | string — {'1'}                                           |
| start                                                          | Start time                         | string — {'0'}                                           |
| X0                                                             | Initial output                     | string — {'0'}                                           |
| VectorParams1D                                                 | Interpret vector parameters as 1-D | string — 'off'   {'on'}                                  |
| <b>Random Number (RandomNumber)</b>                            |                                    |                                                          |
| Mean                                                           | Mean                               | string — {'0'}                                           |
| Variance                                                       | Variance                           | string — {'1'}                                           |
| Seed                                                           | Seed                               | string — {'0'}                                           |
| SampleTime                                                     | Sample time                        | string — {'0.1'}                                         |
| VectorParams1D                                                 | Interpret vector parameters as 1-D | string — 'off'   {'on'}                                  |
| <b>Repeating Sequence (Repeating table) (masked subsystem)</b> |                                    |                                                          |
| rep_seq_t                                                      | Time values                        | string — {'[0 2]'}                                       |

**Sources Library Block Parameters (Continued)**

| <b>Block (Type)/Parameter</b>                                          | <b>Dialog Box Prompt</b>                                    | <b>Values</b>                                                                                                                                                                 |
|------------------------------------------------------------------------|-------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| rep_seq_y                                                              | Output values                                               | string — {'[0 2]'}<br>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                                               | string —<br>{'Interpolation-Use End Values'}   'Use Input Nearest'   'Use Input Below'   'Use Input Above'                                                                    |
| tsamp                                                                  | Sample time                                                 | string — {'0.01'}                                                                                                                                                             |
| OutMin                                                                 | Output minimum                                              | string — {'[]'}                                                                                                                                                               |
| OutMax                                                                 | Output maximum                                              | string — {'[]'}                                                                                                                                                               |
| OutDataTypeStr                                                         | Output data type                                            | string — 'Inherit: Inherit via back propagation'   {'double'}   'single'   'int8'   'uint8'   'int16'   'uint16'   'int32'   'uint32'   'fixdt(1,16,0)'   'fixdt(1,16,2^0,0)' |
| OutputDataTypeScaling Mode                                             | Deprecated                                                  |                                                                                                                                                                               |
| OutDataType                                                            | Deprecated                                                  |                                                                                                                                                                               |
| OutScaling                                                             | Deprecated                                                  |                                                                                                                                                                               |
| LockScale                                                              | Lock output scaling against changes by the autoscaling tool | string — {'off'}   'on'                                                                                                                                                       |
| Repeating Sequence Stair (Repeating Sequence Stair) (masked subsystem) |                                                             |                                                                                                                                                                               |

**Sources Library Block Parameters (Continued)**

| <b>Block (Type)/Parameter</b>                        | <b>Dialog Box Prompt</b>                                    | <b>Values</b>                                                                                                                                                                                 |
|------------------------------------------------------|-------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| OutValues                                            | Vector of output values                                     | string — {'[3 1 4 2 1].'} }                                                                                                                                                                   |
| tsamp                                                | Sample time                                                 | string — {'-1'}                                                                                                                                                                               |
| OutMin                                               | Output minimum                                              | string — {'[]'}                                                                                                                                                                               |
| OutMax                                               | Output maximum                                              | string — {'[]'}                                                                                                                                                                               |
| OutDataTypeStr                                       | Output data type                                            | string — 'Inherit: Inherit via back propagation'   {'double'}   'single'   'int8'   'uint8'   'int16'   'uint16'   'int32'   'uint32'   'fixdt(1,16)'   'fixdt(1,16,0)'   'fixdt(1,16,2^0,0)' |
| OutputDataTypeScaling Mode                           | Deprecated                                                  |                                                                                                                                                                                               |
| OutDataType                                          | Deprecated                                                  |                                                                                                                                                                                               |
| ConRadixGroup                                        | Deprecated                                                  |                                                                                                                                                                                               |
| OutScaling                                           | Deprecated                                                  |                                                                                                                                                                                               |
| LockScale                                            | Lock output scaling against changes by the autoscaling tool | string — {'off'}   'on'                                                                                                                                                                       |
| Signal Builder (Sigbuilder block) (masked subsystem) |                                                             |                                                                                                                                                                                               |
| Signal Generator (SignalGenerator)                   |                                                             |                                                                                                                                                                                               |
| WaveForm                                             | Wave form                                                   | string — {'sine'}   'square'   'sawtooth'   'random'                                                                                                                                          |
| TimeSource                                           | Time (t)                                                    | string — {'Use simulation time'}   'Use external signal'                                                                                                                                      |
| Amplitude                                            | Amplitude                                                   | string — {'1'}                                                                                                                                                                                |

**Sources Library Block Parameters (Continued)**

| <b>Block (Type)/Parameter</b> | <b>Dialog Box Prompt</b>           | <b>Values</b>                                            |
|-------------------------------|------------------------------------|----------------------------------------------------------|
| Frequency                     | Frequency                          | string — {'1'}                                           |
| Units                         | Units                              | string — 'rad/sec'   {'Hertz'}                           |
| VectorParams1D                | Interpret vector parameters as 1-D | string — 'off'   {'on'}                                  |
| <b>Sine Wave (Sin)</b>        |                                    |                                                          |
| SineType                      | Sine type                          | string — {'Time based'}   'Sample based'                 |
| TimeSource                    | Time (t)                           | string — {'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 | string — 'off'   {'on'}                                  |
| <b>Step (Step)</b>            |                                    |                                                          |
| Time                          | Step time                          | string — {'1'}                                           |
| Before                        | Initial value                      | string — {'0'}                                           |
| After                         | Final value                        | string — {'1'}                                           |
| SampleTime                    | Sample time                        | string — {'0'}                                           |
| VectorParams1D                | Interpret vector parameters as 1-D | string — 'off'   {'on'}                                  |

**Sources Library Block Parameters (Continued)**

| <b>Block (Type)/Parameter</b>               | <b>Dialog Box Prompt</b>           | <b>Values</b>           |
|---------------------------------------------|------------------------------------|-------------------------|
| ZeroCross                                   | Enable zero-crossing detection     | string — 'off'   {'on'} |
| Uniform Random Number (UniformRandomNumber) |                                    |                         |
| Minimum                                     | Minimum                            | string — {'-1'}         |
| Maximum                                     | Maximum                            | string — {'1'}          |
| Seed                                        | Seed                               | string — {'0'}          |
| SampleTime                                  | Sample time                        | string — {'0'}          |
| VectorParams1D                              | Interpret vector parameters as 1-D | string — 'off'   {'on'} |

**User-Defined Functions Library Block Parameters**

| <b>Block (Type)/Parameter</b>                      | <b>Dialog Box Prompt</b>       | <b>Values</b>                                |
|----------------------------------------------------|--------------------------------|----------------------------------------------|
| Embedded MATLAB Fcn (Stateflow) (masked subsystem) |                                |                                              |
| Fcn (Fcn)                                          |                                |                                              |
| Expr                                               | Expression                     | string —<br>{ '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             | string — {'auto'}   'real'   'complex'       |

**User-Defined Functions Library Block Parameters (Continued)**

| <b>Block (Type)/Parameter</b>                              | <b>Dialog Box Prompt</b>       | <b>Values</b>           |
|------------------------------------------------------------|--------------------------------|-------------------------|
| Output1D                                                   | Collapse 2-D results to 1-D    | string — 'off'   {'on'} |
| 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**

| <b>Block (Type)/Parameter</b>                                        | <b>Dialog Box Prompt</b>            | <b>Values</b>                                      |
|----------------------------------------------------------------------|-------------------------------------|----------------------------------------------------|
| 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'}                                   |
| InternalDataType                                                     | Data type for internal calculations | string — {'fixdt('double')'}                       |
| StateEqScaling                                                       | Scaling for State Equation AX+BU    | string — {'2^0'}                                   |

**Additional Discrete Block Library Parameters (Continued)**

| <b>Block (Type)/Parameter</b>                                                                          | <b>Dialog Box Prompt</b>                                    | <b>Values</b>                                                                             |
|--------------------------------------------------------------------------------------------------------|-------------------------------------------------------------|-------------------------------------------------------------------------------------------|
| OutputEqScaling                                                                                        | Scaling for Output Equation CX+DU                           | string — {'2^0'}                                                                          |
| LockScale                                                                                              | Lock output scaling against changes by the autoscaling tool | string — {'off'}   'on'                                                                   |
| RndMeth                                                                                                | Integer rounding mode                                       | string — 'Ceiling'   'Convergent'   {'Floor'}   'Nearest'   'Round'   'Simplest'   'Zero' |
| DoSatur                                                                                                | Saturate to max or min when overflows occur                 | string — {'off'}   'on'                                                                   |
| 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                                                                                                | Integer rounding mode                                       | string — 'Ceiling'   'Convergent'   {'Floor'}   'Nearest'   'Round'   'Simplest'   'Zero' |
| DoSatur                                                                                                | Saturate to max or min when overflows occur                 | string — {'off'}   'on'                                                                   |
| Transfer Fcn Direct Form II Time Varying (Transfer Fcn Direct Form II Time Varying) (masked subsystem) |                                                             |                                                                                           |
| vinit                                                                                                  | Initial condition                                           | string — {'0.0'}                                                                          |
| RndMeth                                                                                                | Integer rounding mode                                       | string — 'Ceiling'   'Convergent'   {'Floor'}   'Nearest'   'Round'   'Simplest'   'Zero' |

**Additional Discrete Block Library Parameters (Continued)**

| <b>Block (Type)/Parameter</b>                                                                                           | <b>Dialog Box Prompt</b>                    | <b>Values</b>             |
|-------------------------------------------------------------------------------------------------------------------------|---------------------------------------------|---------------------------|
| DoSatur                                                                                                                 | Saturate to max or min when overflows occur | string — { 'off' }   'on' |
| 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)                                    |                                             |                           |
| vinit                                                                                                                   | Initial condition                           | string — { '0.0' }        |
| tsamp                                                                                                                   | Sample time                                 | string — { '-1' }         |



**Additional Discrete Block Library Parameters (Continued)**

| <b>Block (Type)/Parameter</b>                                                                                                      | <b>Dialog Box Prompt</b> | <b>Values</b>    |
|------------------------------------------------------------------------------------------------------------------------------------|--------------------------|------------------|
| 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**

| <b>Block (Type)/Parameter</b>                                                | <b>Dialog Box Prompt</b> | <b>Values</b> |
|------------------------------------------------------------------------------|--------------------------|---------------|
| Decrement Real World (Real World Value Decrement) (masked subsystem)         |                          |               |
| Decrement Stored Integer (Stored Integer Value Decrement) (masked subsystem) |                          |               |
| 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

### In this section...

“About Mask Parameters” on page 8-218

“Notes on Mask Parameter Storage” on page 8-223

### About Mask Parameters

This section lists parameters that describe masked blocks. You can use these descriptive parameters with `get_param` and `set_param` to obtain and specify the properties of a block mask.

The descriptive mask parameters listed in this section apply to all masks, and provide access to all mask properties. Be careful not to confuse these descriptive mask parameters with the mask-specific parameters defined for an individual mask in the Mask Editor **Parameters** pane.

See “Working with Block Masks” for information about block masks and the Mask Editor.

### 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 <b>Dialog callback</b> field on the <b>Parameters</b> pane of the Mask Editor dialog box. | pipe-delimited string { ' ' } |
| MaskCallbacks      | Cell array version of MaskCallbackString.                                                                                                                                                               | cell array { ' [] ' }         |

**Mask Parameters (Continued)**

| <b>Parameter</b> | <b>Description/Prompt</b>                                                                                                                                                         | <b>Values</b>                                              |
|------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------|
| MaskDescription  | Block description. Set by the <b>Mask description</b> field on the <b>Documentation</b> pane of the Mask Editor dialog box.                                                       | string { '' }                                              |
| MaskDisplay      | Drawing commands for the block icon. Set by the <b>Drawing commands</b> field on the <b>Icon &amp; Ports</b> pane of the Mask Editor dialog box.                                  | string { '' }                                              |
| MaskEditorHandle | For internal use only.                                                                                                                                                            |                                                            |
| MaskEnableString | Option that determines whether a parameter is greyed out in the dialog. Set by the <b>Enable parameter</b> check box on the <b>Parameters</b> pane of the Mask Editor dialog box. | pipe-delimited string { '' }                               |
| MaskEnables      | Cell array version of MaskEnableString.                                                                                                                                           | cell array of strings, each either 'on' or 'off' { '[ ]' } |
| MaskHelp         | Block help. Set by the <b>Mask help</b> field on the <b>Documentation</b> 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 <b>Block Frame</b> option on the <b>Icon &amp; Ports</b> pane of the Mask Editor dialog box.   | { 'on' }   'off'                                           |

**Mask Parameters (Continued)**

| <b>Parameter</b>   | <b>Description/Prompt</b>                                                                                                                                                          | <b>Values</b>                          |
|--------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------|
| MaskIconOpaque     | Set the transparency of the icon (Opaque is on, Transparent is off). Set by the <b>Icon Transparency</b> option on the <b>Icon &amp; Ports</b> 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 <b>Icon Rotation</b> option on the <b>Icon &amp; Ports</b> pane of the Mask Editor dialog box.              | 'on'   {'off'}                         |
| MaskIconUnits      | Set the units for the drawing commands. Set by the <b>Icon Units</b> option on the <b>Icon &amp; Ports</b> pane of the Mask Editor dialog box.                                     | 'pixel'   {'autoscale'}   'normalized' |
| MaskInitialization | Initialization commands. Set by the <b>Initialization commands</b> field on the <b>Initialization</b> pane of the Mask Editor dialog box.                                          | MATLAB command {''}                    |
| MaskNames          | Cell array of mask dialog parameter names. Set inside the <b>Variable</b> column in the <b>Parameters</b> pane of the Mask Editor dialog box.                                      | matrix {'[[']}                         |
| MaskPortRotate     | Specify the port rotation policy for the masked block. Set in the <b>Port Rotation</b> area on the <b>Icon &amp; Ports</b> pane of the Mask Editor dialog box.                     | {'default'}   'physical'               |

**Mask Parameters (Continued)**

| <b>Parameter</b>         | <b>Description/Prompt</b>                                                                                                                                                           | <b>Values</b>                 |
|--------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------|
| MaskPrompts              | List of dialog parameter prompts (see below). Set inside the <b>Dialog parameters</b> area on the <b>Parameters</b> pane of the Mask Editor dialog box.                             | cell array of strings {' []'} |
| MaskPromptString         | List of dialog parameter prompts (see below). Set inside the <b>Dialog parameters</b> area on the <b>Parameters</b> pane of the Mask Editor dialog box.                             | string {' '}<br>See Note 1.   |
| MaskPropertyNameString   | Pipe-delimited version of <b>MaskNames</b> .                                                                                                                                        | string {' '}                  |
| MaskRunInitForIconRedraw | For internal use only.                                                                                                                                                              |                               |
| MaskSelfModifiable       | Indicates that the block can modify itself. Set by the <b>Allow library block to modify its contents</b> check box on the <b>Initialization</b> 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 <b>Type</b> column in the <b>Parameters</b> pane of the Mask Editor dialog box.      | cell array {' []'}            |
| MaskStyleString          | Comma-separated version of <b>MaskStyles</b> .                                                                                                                                      | string {' '}<br>See Note 2.   |
| MaskTabNameString        | For internal use only.                                                                                                                                                              |                               |
| MaskTabNames             | For internal use only.                                                                                                                                                              |                               |

**Mask Parameters (Continued)**

| <b>Parameter</b>       | <b>Description/Prompt</b>                                                                                                                                                                                                                                                                                                              | <b>Values</b>                        |
|------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------|
| MaskToolTipsDisplay    | Determines which mask dialog parameters to display in the data tip for this masked block (see "Block Data Tips" in the Simulink documentation). Specify as a cell array of 'on' or 'off' values, each of which indicates whether to display the parameter named at the corresponding position in the cell array returned by MaskNames. | 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 <b>Tunable</b> column in the <b>Parameters</b> 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 <b>Mask type</b> field on the <b>Documentation</b> pane of the Mask Editor dialog box.                                                                                                                                                                                                                           | string {'Stateflow'}                 |
| MaskValues             | Dialog parameter values.                                                                                                                                                                                                                                                                                                               | cell array {'[]'}                    |
| MaskValueString        | Delimited string version of MaskValues.                                                                                                                                                                                                                                                                                                | delimited string {''}<br>See Note 3. |

## Mask Parameters (Continued)

| Parameter            | Description/Prompt                                                                                                                                                                              | Values                        |
|----------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------|
| 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 only.                                                                                                                                                                          |                               |
| MaskVariables        | List of the dialog parameters' variables (see below). Set inside the <b>Dialog parameters</b> area on the <b>Parameters</b> pane of the Mask Editor dialog box.                                 | string { ' ' }<br>See Note 4. |
| MaskVisibilities     | Specifies visibility of parameters. Set with the <b>Show parameter</b> check box in the <b>Options for selected parameter</b> area on the <b>Parameters</b> pane of the Mask Editor dialog box. | matrix { ' []' }              |
| MaskVisibilityString | Delimited string version of MaskVisibilities.                                                                                                                                                   | string { ' ' }                |
| MaskWSVariables      | List of the variables defined in the mask workspace (read only).                                                                                                                                | matrix { ' []' }              |

## Notes on Mask Parameter Storage

- The MaskPromptString parameter stores the **Prompt** field values for all mask dialog box parameters as a string, with individual values separated by vertical bars (|), for example:

"Slope: |Intercept:"

- 2** The `MaskStyleString` parameter stores the **Type** field values for all mask dialog box parameters as a string, with individual values separated by commas. The **Popup strings** values appear after the popup type, as shown in this example:

```
"edit,checkbox,popup(red|blue|green)"
```

- 3** The `MaskValueString` parameter stores the values of all mask dialog box parameters 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:

```
"2|5"
```

- 4** The `MaskVariables` parameter stores the **Variable** field values for all mask dialog box parameters as a string, with individual assignments separated by semicolons. A sequence number indicates the prompt that is associated with a variable. A special character preceding the sequence number indicates whether the parameter value is evaluated or used literally. An at-sign (`@`) indicates evaluation; an ampersand (`&`) indicates literal usage. For example:

```
"a=@1;b=&2;"
```

This string defines two **Variable** field values:

- The value entered in the first parameter field is evaluated in the MATLAB workspace, and the result is assigned to variable `a` in the mask workspace.
- The value entered in the second parameter field is not evaluated, but is assigned literally to variable `b` in the mask workspace.



# Model File Format

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## Model File Contents

| In this section...                           |
|----------------------------------------------|
| “About Model File Formats” on page 9-2       |
| “Model Section” on page 9-4                  |
| “Simulink.ConfigSet Section” on page 9-5     |
| “BlockDefaults Section” on page 9-6          |
| “BlockParameterDefaults Section” on page 9-6 |
| “AnnotationDefaults Section” on page 9-7     |
| “LineDefaults Section” on page 9-7           |
| “System Section” on page 9-8                 |

---

**Note** Model file formatting is a topic for advanced users. The MathWorks does not recommend editing the model file. In the next release, The MathWorks will deprecate this chapter.

---

### About Model File Formats

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>
  ...
  Array {
    Simulink.ConfigSet {
      $ObjectID <Object ID>
      <ConfigSet Parameter Name> <ConfigSet Parameter Value>
      ...
    }
  }
}
```

```
Simulink.ConfigSet {
  $PropName "ActiveConfigurationSet"
  $ObjectID <Object ID>
}
BlockDefaults {
  <Block Parameter Name> <Block Parameter Value>
  ...
}
BlockParameterDefaults {
  Block {
    <Block Parameter Name> <Block Parameter Value>
    ...
  }
}
AnnotationDefaults {
  <Annotation Parameter Name> <Annotation Parameter Value>
  ...
}
LineDefaults {
  <Line Parameter Name> <Line 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>
  ...
}
```

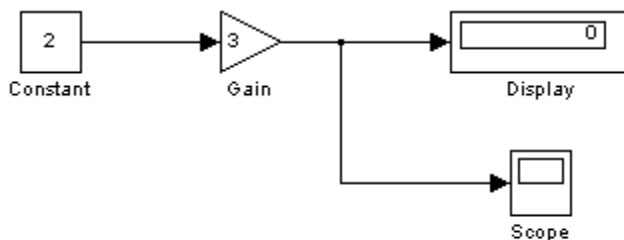
```

    }
  }
}

```

See Chapter 8, “Model and Block Parameters” for descriptions of model and block parameters.

This reference contains examples of each section, extracted from the model file of the following model:



This model generates...

## Model Section

The Model section, located at the top of the model file, contains all other sections of the model file and defines the values for model-level parameters. These parameters include the model name, the version of Simulink software last used to modify the model, and configuration set parameters (see “Configuration Sets” in the online Simulink documentation) among others.

The following example shows parts of the Model section for a model.

```

Model {
  Name           "my_model"
  Version        6.4
  MdlSubVersion  0
  GraphicalInterface {
    NumRootInports      0
    NumRootOutports     0
    ParameterArgumentNames ""
    ComputedModelVersion "1.10"
    NumModelReferences  0
  }
}

```

```

        NumTestPointedSignals    0
    }
    SavedCharacterEncoding    "windows-1252"
    SaveDefaultBlockParams    on
    ...
    Array {
        Type                    "Handle"
        Dimension                2
        Simulink.ConfigSet {
            $ObjectID            1
            Version              "1.2.0"
            Array {
                Type              "Handle"
                Dimension          7
                Simulink.SolverCC {
                    ...
                }
            }
            ...
        }
        ...
    }
    ...
}

```

## Simulink.ConfigSet Section

The `Simulink.ConfigSet` section appears after the configuration set parameters. This section identifies the active configuration set for the model (see “The Active Set” in the online Simulink documentation).

The following example shows the `Simulink.ConfigSet` section for a model.

```

Simulink.ConfigSet {
    $PropName    "ActiveConfigurationSet"
    $ObjectID    1
}

```

## BlockDefaults Section

The `BlockDefaults` section appears after the `Simulink.ConfigSet` section. This section defines the default values for common block parameters in the model. These values can be overridden by individual block parameters, defined in `Block` subsections of `System` sections.

The following example shows the `BlockDefaults` section for a model.

```
BlockDefaults {
  Orientation      "right"
  ForegroundColor "black"
  BackgroundColor "white"
  DropShadow      off
  NamePlacement   "normal"
  FontName        "Arial"
  FontSize        10
  FontWeight      "normal"
  FontAngle       "normal"
  ShowName        on
}
```

## BlockParameterDefaults Section

The `BlockParameterDefaults` section appears after the `BlockDefaults` section. This section defines the default values for block-specific parameters using `Block` subsections. Each `Block` subsection defines the default parameter-value pairs for a particular type of block in the model. These values can be overridden by individual block parameters, defined in `Block` subsections of `System` sections.

The following example shows part of the `BlockParameterDefaults` section for a model.

```
BlockParameterDefaults {
  Block {
    BlockType      Constant
  }
  Block {
    BlockType      Display
    Format          "short"
    Decimation     "10"
  }
}
```

```
        Floating            off
        SampleTime         "-1"
    }
    ...
}
```

## AnnotationDefaults Section

The `AnnotationDefaults` section appears after the `BlockParameterDefaults` section. This section defines the default parameters for all annotations in the model (see `Simulink.Annotation`).

The following example shows the `AnnotationDefaults` section for a model.

```
AnnotationDefaults {
    HorizontalAlignment    "center"
    VerticalAlignment      "middle"
    ForegroundColor        "black"
    BackgroundColor        "white"
    DropShadow             off
    FontName                "Courier New"
    FontSize                10
    FontWeight              "normal"
    FontAngle               "normal"
}
```

## LineDefaults Section

The `LineDefaults` section appears after the `AnnotationDefaults` section. This section defines the default parameters for all lines in the model.

The following example shows the `LineDefaults` section for a model.

```
LineDefaults {
    FontName                "Courier New"
    FontSize                9
    FontWeight              "normal"
    FontAngle               "normal"
}
```

## 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.

The following example shows parts of the `System` section for a model.

```
System {
  Name           "my_model"
  Location       [480, 85, 1206, 386]
  Open           on
  ModelBrowserVisibility off
  ModelBrowserWidth 200
  ScreenColor    "white"
  PaperOrientation "landscape"
  ...
  Block {
    BlockType      Constant
    Name           "Constant"
    Position       [65, 100, 95, 130]
    Value          "2"
    ...
  }
  ...
  Line {
    SrcBlock       "Gain"
    SrcPort        1
    Points         [25, 0]
    Branch {
      Points       [0, 70]
      DstBlock     "Scope"
      DstPort      1
    }
    Branch {
      Points       [20, 0]
      DstBlock     "Display"
      DstPort      1
    }
  }
}
```



```
}  
...  
  
Annotation {  
  Name          "This model generates..."  
  Position      [149, 234]  
  UseDisplayTextAsClickCallback off  
}  
}
```



# Model Advisor Checks

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## Simulink Checks

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### **Simulink Check Overview**

Use the Simulink Model Advisor checks to configure your model for simulation.

#### **See Also**

- Consulting Model Advisor in the Simulink documentation.
- Real-Time Workshop Model Advisor Check Reference in the Real-Time Workshop documentation.
- Simulink Verification and Validation Model Advisor Check Reference in the Simulink Verification and Validation documentation.

## Check model, local libraries, and referenced models for known upgrade issues

Uses the `supdate` command analysis mode to check for common upgrade issues.

### Description

Check blocks, settings, and references in the model for compatibility issues resulting from using a new version of Simulink software.

### Results and Recommended Actions

| Condition                                                        | Recommended Action                                                   |
|------------------------------------------------------------------|----------------------------------------------------------------------|
| Referenced models recommended for update.                        | Run Simulink update tool, <code>supdate</code> on the listed models. |
| Check library update status.                                     | Verify that indicated libraries are valid.                           |
| Check update status for the Level 2 API S-functions.             | Consider replacing Level 1 S-functions with Level 2.                 |
| Blocks have configuration sets or ports with undesired settings. | Run Simulink update tool, <code>supdate</code> , in update mode.     |

### See Also

- `supdate` in the Simulink documentation.
- *Writing S-Functions* in the Simulink documentation.

## Identify unconnected lines, input ports, and output ports

Check for unconnected lines or ports.

### Description

This check lists unconnected lines or ports. These can have difficulty propagating signal attributes such as data type, sample time, and dimensions.

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**Note** Ports connected to ground/terminator blocks will pass this test.

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### Results and Recommended Actions

| Condition                                            | Recommended Action                                                                              |
|------------------------------------------------------|-------------------------------------------------------------------------------------------------|
| Lines, input ports, or output ports are unconnected. | Ensure all signals are connected. Double-click the list of unconnected items to locate failure. |

### Tips

Use the `PortConnectivity` command to obtain an array of structures describing block input or output ports.

### See Also

“Common Block Parameters” on page 8-83 in the Simulink documentation for information on the `PortConnectivity` command.



## Check root model Inport block specifications

Check that root model Inport blocks fully define dimensions, sample time, and data type.

### Description

Using root model Inport blocks that do not fully define dimensions, sample time, or data type can lead to undesired simulation results. Simulink software back-propagates dimensions, sample times and data types from downstream blocks unless you explicitly assign them values.

### Results and Recommended Actions

| Condition                                           | Recommended Action                                           |
|-----------------------------------------------------|--------------------------------------------------------------|
| Root-level Inport blocks have undefined attributes. | Fully define the attributes of all root-level Inport blocks. |

### See Also

- “Working with Data Types” in the Simulink documentation.
- “Determining Output Signal Dimensions” in the Simulink documentation.
- “How to Specify the Sample Time” in the Simulink documentation.

## Check optimization settings

Check for optimizations that can lead to nonoptimal code generation and simulation.

### Description

This check reviews the status of optimizations that can improve code efficiency and simulation time.

### Results and Recommended Actions

| Condition                            | Recommended Action                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|--------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| The specified optimizations are off. | Select the following optimization check boxes in the Optimization pane of the Configuration Parameters dialog box: <ul style="list-style-type: none"> <li>• “Block reduction”</li> <li>• “Conditional input branch execution”</li> <li>• “Inline parameters”</li> <li>• “Implement logic signals as boolean data (vs. double)”</li> <li>• “Enable local block outputs”</li> <li>• “Reuse block outputs”</li> <li>• “Eliminate superfluous local variables (Expression folding)”</li> <li>• “Use memset to initialize floats and doubles to 0.0”</li> <li>• “Ignore integer downcasts in folded expressions”</li> <li>• “Remove code from floating-point to integer conversions that wraps out-of-range values”</li> <li>• “Inline invariant signals”</li> <li>• “Remove root level I/O zero initialization”</li> <li>• “Remove internal data zero initialization”</li> </ul> |

| Condition                                                                                                                   | Recommended Action                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|-----------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                                                                                             | <ul style="list-style-type: none"> <li>• “Use bitsets for storing state configuration”</li> <li>• “Use bitsets for storing boolean data”</li> </ul>                                                                                                                                                                                                                                                                                                |
| <p>“<b>Application lifespan (days)</b>” is set as infinite. This could lead to expensive 64-bit counter usage.</p>          | <p>Choose appropriate stop time if this is not intended.</p>                                                                                                                                                                                                                                                                                                                                                                                       |
| <p>The specified diagnostics, which can increase the time it takes to simulate your model, are set to warning or error.</p> | <p>Select none for:</p> <ul style="list-style-type: none"> <li>• <b>Diagnostics &gt; Solver &gt; Solver data inconsistency</b></li> <li>• <b>Diagnostics &gt; Data Validity &gt; Array bounds exceeded</b></li> <li>• <b>Diagnostics &gt; Data Validity &gt; Simulation range checking</b></li> </ul>                                                                                                                                              |
| <p>The specified Real-Time Workshop Embedded Coder parameters are off.</p>                                                  | <p>If you have a Real-Time Workshop Embedded Coder license, and you are using an ERT-based system target file, select the following check boxes:</p> <ul style="list-style-type: none"> <li>• <b>Real-Time Workshop &gt; Interface &gt; “Single output/update function”</b></li> <li>• <b>Real-Time Workshop &gt; General &gt; “Ignore test point signals”</b></li> <li>• <b>Optimization &gt; “Pass reusable subsystem outputs as”</b></li> </ul> |

## Tips

If the system contains Model blocks and the referenced model is in Accelerator mode, simulating the model requires generating and compiling code.

## See Also

- “Optimization Pane” in the Simulink documentation.
- “Optimizing a Model for Code Generation” in the Real-Time Workshop documentation.

- “Code Generation Options and Optimizations” in the Real-Time Workshop Embedded Coder documentation.

## Check for parameter tunability information ignored for referenced models

Checks if parameter tunability information is included in the Model Parameter Configuration dialog box.

### Description

Simulink software ignores tunability information specified in the Model Parameter Configuration dialog box. This check identifies those models containing parameter tunability information that Simulink software will ignore if the model is referenced by other models.

### Results and Recommended Actions

| Condition                                                | Recommended Action                                                                           |
|----------------------------------------------------------|----------------------------------------------------------------------------------------------|
| Model contains ignored parameter tunability information. | Click the links to convert to equivalent Simulink parameter objects in the MATLAB workspace. |

### See Also

“Parameter Storage, Interfacing, and Tuning” in the Simulink documentation.

## Check for implicit signal resolution

Identify models that attempt to resolve named signals and states to `Simulink.Signal` objects.

### Description

Requiring Simulink software to resolve all named signals and states is inefficient and slows incremental code generation and model reference. This check identifies those signals and states for which you may turn off implicit signal resolution and enforce resolution.

### Results and Recommended Actions

| Condition                                | Recommended Action                                                                                               |
|------------------------------------------|------------------------------------------------------------------------------------------------------------------|
| Not all signals and states are resolved. | Turn off implicit signal resolution and enforce resolution for each signal and state that successfully resolves. |

### See Also

“Resolving Signal Objects for Output Data” in the Simulink documentation.

## Check for optimal bus virtuality

Identify virtual buses that could be made nonvirtual. Making these buses nonvirtual improves generated code efficiency.

### Description

This check identifies blocks incorporating virtual buses that cross a model boundary. Changing these to nonvirtual improves generated code efficiency.

### Results and Recommended Actions

| Condition                                                    | Recommended Action                        |
|--------------------------------------------------------------|-------------------------------------------|
| Blocks that specify a virtual bus crossing a model boundary. | Change the highlighted bus to nonvirtual. |

### See Also

- “Working with Signals” in the Simulink documentation.
- “Virtual and Nonvirtual Buses” in the Simulink documentation.

## Check for Discrete-Time Integrator blocks with initial condition uncertainty

Identify Discrete-Time Integrator blocks with state ports and initial condition ports that are fed by neither an Initial Condition nor a Constant block.

### Description

Discrete-Time Integrator blocks with state port and initial condition ports might not be properly initialized unless they are fed from an Initial Condition or Constant block. This is more likely to happen when Discrete-Time Integrator blocks are used to model second-order or higher-order dynamic systems.

### Results and Recommended Actions

| Condition                                                                                  | Recommended Action                                                                     |
|--------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------|
| Discrete-Time Integrator blocks are not initialized during the model initialization phase. | Add a Constant or Initial Condition block to feed the external Initial Condition port. |

### See Also

- IC block
- Discrete-Time Integrator block
- Constant block



## Identify disabled library links

Search model for disabled library links.

### Description

Disabled library links can cause unexpected simulation results. All disabled links should be resolved before a model is saved.

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**Note** This check may overlap with “Check model, local libraries, and referenced models for known upgrade issues” on page 10-5.

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### Results and Recommended Actions

| Condition                   | Recommended Action                                                  |
|-----------------------------|---------------------------------------------------------------------|
| Library links are disabled. | Use Restore Link from the Link Options setting in the context menu. |

### Tips

- Use the Model Browser to find library links.
- To enable a broken link, right-click a block in your model to display the context menu. Choose Link Options and click Restore Link.

### See Also

“The Model Browser” in the Simulink documentation.

## Identify parameterized library links

Search model for parameterized library links.

### Description

Parameterized library links that are unintentional can result in unexpected parameter settings in your model. This can result in improper model operation.

### Results and Recommended Actions

| Condition                       | Recommended Action                                |
|---------------------------------|---------------------------------------------------|
| Parameterized links are listed. | Verify that all parameterized links are intended. |

### Tips

- Right-click a block in your model to display the context menu. Choose **Link Options** and click **Go To Library Block** to see the original block from the library.
- To parameterize a library link, choose **Look Under Mask**, from the context menu and select the parameter.

### See Also

“Working with Block Masks” in the Simulink documentation.

## Identify unresolved library links

Search the model for unresolved library links, where the specified library block cannot be found.

### Description

Check for unresolved library links. Models do not simulate while there are unresolved library links.

### Results and Recommended Actions

| Condition                     | Recommended Action                              |
|-------------------------------|-------------------------------------------------|
| Library links are unresolved. | Locate missing library block or an alternative. |

### See Also

“Fixing Unresolved Library Links”

## Check for proper usage of Data Store Memory blocks

Look for modeling issues related to Data Store Memory blocks.

### Description

Checks shadowing of data stores of higher scope, strong typing, multitasking data integrity, and runtime diagnostics.

### Results and Recommended Actions

| Condition                                        | Recommended Action                                          |
|--------------------------------------------------|-------------------------------------------------------------|
| Data Store blocks have duplicate names.          | Give each Data Store block in the model a unique name.      |
| Data Store blocks are not strongly typed.        | Specify a data type other than <code>Inherit: auto</code> . |
| Multiple tasks access the same data store.       | Change the model to avoid multitask data stores.            |
| Reading and writing occur out of order.          | Restructure and prioritize so enforce correct order.        |
| Multiple writes occur within a single time step. | Change the model to write data only once per step.          |

### See Also

- “Working with Data Stores”
- “Storage Classes for Data Store Memory Blocks”
- Data Store Memory
- Data Store Read
- Data Store Write
- “Duplicate data store names”
- “Multitask data store”
- “Detect read before write”

- “Detect write after read”
- “Detect write after write”

## Check for proper bus usage

Identify Mux blocks used as a bus creator and any bus signal that is treated as a vector.

### Description

Models should not contain bus signals that Simulink software implicitly converts to vectors. Instead, either insert a Bus to Vector conversion block between the bus signal and the block input port that it feeds, or use the `Simulink.BlockDiagram.addBusToVector` command.

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**Note** You should always run this check before running Check consistency of initialization parameters for Outport and Merge blocks.

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### Results and Recommended Actions

| Condition                                        | Recommended Action                                                                              |
|--------------------------------------------------|-------------------------------------------------------------------------------------------------|
| Identify signals used as vectors.                | In the Configuration Parameters dialog box, set Mux blocks used to create bus signals to error. |
| Model uses buses properly.                       | In the Configuration Parameters dialog set Bus signal treated as vector to error.               |
| Bus signals are implicitly converted to vectors. | Use <code>Simulink.BlockDiagram.addBusToVector</code> or insert a Bus to Vector block.          |

### Tips

The Bus to Vector conversion block is located in the Simulink/Signal Attributes library.

### See Also

- Bus to Vector block
- “Mux blocks used to create bus signals”

- “Bus signal treated as vector”
- “Check consistency of initialization parameters for Outport and Merge blocks” on page 10-25
- `Simulink.BlockDiagram.addBusToVector` in the Simulink documentation.

## Check for potentially delayed function-call subsystem return values

Identify function-call return values that might be delayed because Simulink software inserted an implicit Signal Conversion block.

### Description

To ensure that signals reside in contiguous memory, Simulink software can automatically insert an implicit Signal Conversion block in front of function-call initiator block input ports. This can result in a one-step delay in returning signal values from calling function-call subsystems. The delay can be avoided by ensuring the signal originates from a signal block within the function-call system. Or, if the delay is acceptable, insert a Unit Delay block in front of the affected input ports.

### Results and Recommended Actions

| Condition                                                                    | Recommended Action                                                                                                                                                                                                                                                                                                                                                            |
|------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| The listed block input ports could have an implicit Signal Conversion block. | Decide if a one-step delay in returning signal values is acceptable for the listed signals. <ul style="list-style-type: none"> <li>• If the delay is not acceptable, rework your model so that the input signal originates from within the calling subsystem.</li> <li>• If the delay is acceptable, insert a Unit Delay block in front of each listed input port.</li> </ul> |

### See Also

Signal Conversion block

Unit Delay block



## Identify block output signals with continuous sample time and non-floating point data type

Find continuous sample time, non-floating-point output signals.

### Description

Non-floating-point signals cannot properly represent continuous variables.

### Results and Recommended Actions

| Condition                                                                 | Recommended Action                                                                                      |
|---------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------|
| Signals with continuous sample times have a non-floating-point data type. | On the identified signals, either change the sample time to be discrete or fixed-in-minor-step ([0 1]). |

### See Also

“Working with Sample Times” in the Simulink documentation.

## Check for proper Merge block usage

Analyze Merge blocks in the same tree as a group, and determine the possibility for them to execute at the same time step.

### Description

Blocks that directly drive the same tree of Merge blocks should have mutually exclusive execution in each time step. This check identifies those blocks that drive the same tree of Merge blocks, and so are likely to execute at the same time step.

### Input Parameters

#### Maximum analysis time (seconds)

Provide a maximum analysis time to execute the check.

### Results and Recommended Actions

| Condition                                                    | Recommended Action                                                       |
|--------------------------------------------------------------|--------------------------------------------------------------------------|
| Merge blocks can be interconnected to form a tree structure. | Rework your model so that no blocks drive the same tree of Merge blocks. |

### See Also

- Merge block
- “Check consistency of initialization parameters for Outport and Merge blocks” on page 10-25

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## Check consistency of initialization parameters for Outport and Merge blocks

Identify Outport and Merge blocks with parameter settings that can lead to unexpected initialization behavior, and migrate your model to simplified initialization mode.

### Description

In R2008b or later, you can choose simplified initialization mode for conditionally executed subsystems, Merge blocks, subsystem elapsed time, and Discrete-Time Integrator blocks. Simplified initialization mode improves the consistency of simulation results, especially for models that do not specify initial conditions for conditionally executed subsystem output ports, and for models that have conditionally executed subsystem output ports connected to S-functions.

This Model Advisor check identifies settings in your model that can cause problems when using simplified initialization mode. There are two types of messages in this check, *errors* and *warnings*. Error messages identify issues that you need to address manually before the model can be migrated to simplified initialization mode. Warning messages identify issues or changes in behavior that may occur after migration.

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**Note** Before running this check, run the check: **Check for proper bus usage** to ensure that Merge blocks are used correctly, and enable strict Merge run-time diagnostics.

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After running this check, select the **Explore Result** button to access the blocks listed in each message, with the exception of library-linked blocks.

Once you have addressed all issues identified by the check, select **Proceed** to migrate your model to the simplified initialization mode.

---

**Note** Because it is difficult to undo these changes, save a backup copy of your model and libraries before migrating to simplified initialization mode.

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**Results and Recommended Actions**

| Condition                                                       | Recommended Action                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|-----------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>Error: Strict Bus Mode Must Be Enabled</p>                   | <ol style="list-style-type: none"> <li><b>1</b> Run <b>Check for proper bus usage</b> in the Model Advisor to ensure that Mux blocks are used correctly in the model.</li> <li><b>2</b> In the model window, select <b>Simulation &gt; Configuration Parameters &gt; Diagnostics &gt; Connectivity</b>.</li> <li><b>3</b> Set <b>Mux blocks used to create bus signals</b> to error.</li> <li><b>4</b> Set <b>Bus signal treated as vector</b> to error.</li> </ol> |
| <p>Error: Strict Merge Run-Time Diagnostics Must Be Enabled</p> | <p>In the model window:</p> <ol style="list-style-type: none"> <li><b>1</b> Select <b>Simulation &gt; Configuration Parameters &gt; Diagnostics &gt; Data Validity</b>.</li> <li><b>2</b> Set <b>Detect multiple driving blocks executing at the same time step</b> to error.</li> <li><b>3</b> Ensure that the model simulates without errors before running this check again.</li> </ol>                                                                          |
| <p>Error: Referenced Models Not Yet Migrated</p>                | <p>Migrate the model referenced by the Model block to simplified initialization mode, then migrate the top-level model.</p>                                                                                                                                                                                                                                                                                                                                         |

| Condition                                                                                       | Recommended Action                                                                                                                                                                                                                                                                                                                                                |
|-------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Error: Single-Input Merge Blocks                                                                | Replace both the Mux block used to produce the input signal and the Merge block with one multi-input Merge block. Single-input Merge blocks are not supported in simplified initialization mode.                                                                                                                                                                  |
| Error: Root Merge Blocks With Unspecified Initial Output                                        | Specify an explicit value for the <b>Initial output</b> parameter of the <i>root Merge block</i> . A root Merge block is any Merge block with an output port that does not connect to another Merge block.                                                                                                                                                        |
| Error: Merge Blocks With Non-zero Input Port Offsets                                            | <p>Deselect the <b>Allow unequal port widths</b> parameter of the Merge block.</p> <hr/> <p><b>Note</b> Consider using Merge blocks only for signal elements that require true merging. Other elements can be combined with merged elements using the Concatenate block.</p> <hr/>                                                                                |
| Error: Merge Blocks With Unconnected Inputs or Inputs from Non-Conditionally Executed Subsystem | Set the <b>Number of inputs</b> parameter of the Merge block to the correct number of inputs, so that each input is connected to a signal. Ensure that the Merge block inputs are each driven by a conditionally executed subsystem. Merge blocks cannot be driven directly by an Iterator Subsystem or any block that is not a conditionally executed subsystem. |

| <b>Condition</b>                                                                                                 | <b>Recommended Action</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Error: Merge Blocks With Inputs That Have Been Combined Or Reordered Outside of Conditionally Execute Subsystems | Ensure that any combination or reordering of Merge block input signals (using Mux, Bus Creator, or Selector blocks, for example) takes place within a conditionally executed subsystem.                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Error: Merge Blocks With Inconsistent Input Sample Times                                                         | Ensure that each input signal has the same <b>Sample time</b> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Error: Merge Blocks With Multiple Input Ports Driven By Same Source                                              | Ensure that the Merge block does not have multiple input signals that are driven by the same conditionally executed subsystem or conditionally executed Model block.                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| Error: Outport Blocks With Conflicting Buffer Requirements                                                       | The Outport block has function-call trigger or function-call data dependency signal passing through it, along with regular signals. Some of the regular data signals require an explicit signal buffer to ensure correct initialization of the corresponding subsystem's output signal. However, buffering function-call related signals will lead to a function-call data dependency violation. Consider modifying the model to pass function-call related signals through a separate Outport. For examples of function-call data dependency violations, see the demo model <code>sl_subsys_semantics</code> . |

| <b>Condition</b>                                              | <b>Recommended Action</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|---------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Error: Outports Requiring Explicit Bus Copy                   | An explicit copy of the bus signal driving the Output block is needed to ensure correct initialization of the corresponding subsystem's output signal. Insert a Signal Conversion block before the Output block, then set the <b>Output</b> parameter of the Signal Conversion block to Bus copy.                                                                                                                                                                             |
| Error: Output Blocks Being Merged But Can Reset When Disabled | Set the <b>Output when disabled</b> parameter of the Output block to held. For more information, see the Output block documentation.                                                                                                                                                                                                                                                                                                                                          |
| Error: Output Blocks With Unspecified Initial Output          | Specify the <b>Initial output</b> parameter for the Output block, unless you want the block to obtain its initial output value from its input signal. If you want the Output block to obtain its initial output value from its input signal, ensure that all of its sources are valid initial output value sources. Output blocks can inherit initial output value from Constant, Initial Condition, Merge (with initial output), or conditionally executed subsystem blocks. |

| Condition                                                       | Recommended Action                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|-----------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                                 | <hr/> <p><b>Note</b> If you are working with a conditionally executed subsystem Outputport block that is driven directly by another conditionally executed subsystem Outputport block, you should resolve this error message for the inner Outputport block first, then run this Model Advisor check again to see if the problem is resolved for the outer Outputport block.</p> <hr/>                                                                                                                                                                     |
| <p>Error: Outputport Blocks With Automatic Rate Transitions</p> | <p>Simulink has inserted Rate Transition blocks on the input signals of the Outputport block. If such rate transitions are needed, specify the <b>Initial output</b> parameter for each Outputport block.</p> <p>Otherwise, perform the following procedure:</p> <ol style="list-style-type: none"> <li><b>1</b> Select <b>Simulation &gt; Configuration Parameters &gt; Solver</b>.</li> <li><b>2</b> Deselect the option <b>Automatically handle rate transition for data transfer</b>.</li> <li><b>3</b> Run this Model Advisor check again.</li> </ol> |



| <b>Condition</b>                                                                                              | <b>Recommended Action</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|---------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Error: Outport Blocks Require Explicit Initial Output                                                         | <p>Specify the <b>Initial output</b> parameter for the Outport block.</p> <p>The Outport block cannot obtain initial output values from its input signals due to Simulink internal signal storage handling.</p>                                                                                                                                                                                                                                                                                   |
| Error: Outport Blocks Reset When Disabled With Unspecified Initial Output                                     | <p>Specify the <b>Initial output</b> parameter of the Outport block. You must specify the initial output value for blocks that are configured to reset when disabled.</p>                                                                                                                                                                                                                                                                                                                         |
| Error: Outport Blocks Passing Through Function-call Data Dependency Signal Must Not Have Initial Output Value | <p>You cannot specify an Initial output value for the Outport block because function-call data dependency signals are passing through it. To set the initial output value:</p> <ol style="list-style-type: none"><li><b>1</b> Set the <b>Initial output</b> parameter of the Outport block to [ ].</li><li><b>2</b> Provide the initial value at the source of the data dependency signal rather than at the Outport block.</li></ol> |

| <b>Condition</b>                                                                                 | <b>Recommended Action</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|--------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>Error: Blocks Requiring Elapsed Timer Will Not Be Allowed In Iterator Subsystem</p>           | <p>Within an Iterator subsystem hierarchy, do not use blocks that require a service that maintains the time that has elapsed between two consecutive executions. Since Iterator subsystem can be executed multiple times at a given time step, the concept of elapsed time is not well-defined between two such executions. Using these blocks inside an Iterator subsystem can cause unexpected behavior.</p>                                                                                                                    |
| <p>Warning: Outport Blocks Initial Output Value Can No Longer Be Specified By Signal Objects</p> | <p>Ensure that the following behavior is acceptable. The <b>Initial output</b> parameter of the Outport block cannot be specified by signal objects. You can initialize the input or output signals for an Outport block using signal objects, but the initialization results may be overwritten by that from the Outport block.</p>                                                                                                                                                                                              |
| <p>Warning: Outport Blocks Being Merged But Is Unconnected Or Connected To Ground Block</p>      | <p>Ensure that the following behavior is acceptable.</p> <p>The Outport block is driving a Merge block, but its inputs are either unconnected or connected to Ground blocks. In classic initialization mode, unconnected or grounded outputs do not update the merge signal even when their parent conditionally executed subsystems are executing. In simplified initialization mode, however, these outputs will update the merge signal with zero value when their parent conditionally executed subsystems are executing.</p> |

| Condition                                                                                | Recommended Action                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Warning: Merge Blocks Initial Output Value Can No Longer Be Specified By Signal Objects  | <p>Ensure that the following behavior is acceptable.</p> <p>The <b>Initial output</b> parameter of the Merge block cannot be specified by signal objects. You can initialize the input or output signals for a Merge block using signal objects, but the initialization results may be overwritten by that from the Merge block.</p>                                                                                                                                                                                                                                |
| Warning: Outport Blocks Will Obtain Initial Output Value from Input Signal When Migrated | <p>Ensure that the following behavior is acceptable.</p> <p>The <b>Initial output</b> parameter of the Outport block is not specified. Simplified initialization mode will assume that the initial output value for the Outport block is derived from the input signal, which may result in different initialization behavior.</p>                                                                                                                                                                                                                                  |
| Warning: Outer Outport Blocks With Explicit Initial Output                               | <p>Ensure that the following behavior is acceptable.</p> <p>The <b>Initial output</b> and <b>Output when disabled</b> parameters of the Outport block are currently required to match those of their source Outport blocks. This constraint is not required in simplified initialization mode.</p> <p>However, this flexibility means that nested Outport blocks with explicit initial output values cannot share signal storage.</p> <p>You can regain this signal storage efficiency by setting <b>Initial output</b> to [] (empty matrix), and <b>Output</b></p> |

| Condition                                                                                              | Recommended Action                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|--------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                                                                        | <p><b>when disabled</b> to held, so that the Outports derive their initial output value, and can therefore share signal storage with their input signals.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| <p>Warning: Conditionally Executed Subsystems Propagating Execution Context Across Output Boundary</p> | <p>Ensure that the following behavior is acceptable.</p> <p><b>Propagate execution context across subsystem boundary</b> is selected for the subsystem. Propagating execution context across an output boundary can cause unpredictable initialization behavior, and therefore is not supported in simplified initialization mode. Execution context will still be propagated across input boundaries.</p>                                                                                                                                                                                                                              |
| <p>Warning: Initialization Behavior Changes for Discrete-Time Integrators</p>                          | <p>Ensure that the following behavior is acceptable.</p> <p>The initialization behavior of the Discrete-Time Integrator block has been changed to be more consistent and robust in simplified initialization mode. These changes include:</p> <ul style="list-style-type: none"> <li>• Elimination of the <b>Use initial condition as initial and reset value for</b> parameter</li> <li>• Application of the <b>Initial condition</b> parameter only to the integrator output.</li> <li>• Simplified enable/disable behavior</li> </ul> <p>See the Discrete-Time Integrator block documentation for more information on simplified</p> |

| Condition                                                                                                      | Recommended Action                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|----------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                                                                                | Discrete-Time Integrator initialization.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| Warning: Blocks Will Not Be Allowed To Read Input From Conditionally Executed Subsystems During Initialization | <p>Ensure that the following behavior is acceptable.</p> <p>Some blocks, such as the Discrete-Time Integrator block, currently read their inputs from conditionally executed subsystems during initialization. This is done as an optimization.</p> <p>This optimization is not allowed in simplified initialization mode because the output of a conditionally executed subsystem at the first time step after initialization may be different than the initial value declared in the corresponding Outport block. In particular, this occurs if the subsystem is active at the first time step.</p> |
| Error: Library Blocks With Instances That Cannot Be Migrated                                                   | Examine the error messages for each block to determine a proper corrective action.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| Warning: Library Blocks With Instances That Have Warning Messages                                              | Examine the warning messages for each block before migrating.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Message: Outport Blocks Will Use Dialog Initial Output Value After Migration                                   | <p>No action required.</p> <p>The Outport block will maintain its current settings and use its specified <b>Initial output</b> value.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                             |

| Condition                                                                                      | Recommended Action                                                                                                                                                                                                                                                                                                                                                                                                                      |
|------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>Message: Outport Blocks Will Use Initial Output Value From Input Signal After Migration</p> | <p>No action required.</p> <p>The Outport block currently specifies an <b>Initial output</b> of [ ] (empty matrix), and <b>Output when disabled</b> as held. This means that each outport does not perform initialization, but implicitly relies on source blocks to initialize its input signal.</p> <p>After migration, the parameter <b>Source of initial output value</b> will be set to Input signal to reflect this behavior.</p> |
| <p>Message: Outport Blocks To Use SimEvents Initialization Semantics</p>                       | <p>No action required.</p> <p>The Outport block will continue to use an <b>Initial output</b> of [ ] (empty matrix), and <b>Output when disabled</b> as held, because their parent conditionally executed subsystems are connected to SimEvents blocks.</p>                                                                                                                                                                             |

**See Also**

- Consulting Model Advisor
- Simulink Checks
- “Check for proper bus usage” on page 10-20
- Merge block
- Discrete-Time Integrator block
- Outport block
- “Mux blocks used to create bus signals”
- “Bus signal treated as vector”

- “Detect multiple driving blocks executing at the same time step”
- “Underspecified initialization detection”

## Check sample times of Data Store blocks

Identify Data Store blocks whose sample times cause modeling errors.

### Description

Multitasking Data Store blocks often indicate a modeling problem using Data Store blocks.

### Results and Recommended Actions

| Condition                                                                        | Recommended Action                                                                                                                                |
|----------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------|
| Data Store blocks in your model have continuous or zero-order-hold sample times. | Consider making the listed blocks discrete or replacing them with Memory or Goto and From blocks.                                                 |
| The compile time diagnostic <b>Multitask data store</b> is set to none.          | Consider setting <b>Multitask data store</b> to warning or error in the <b>Configuration Parameters &gt; Diagnostics &gt; Data Validity</b> pane. |

### See Also

- “Working with Data Stores”.
- Data Store Memory
- Data Store Read
- Data Store Write



## Check for non-continuous signals driving derivative ports

Identify noncontinuous signals that drive derivative ports.

### Description

Noncontinuous signals that drive derivative ports cause the solver to reset every time the signal changes value, which slows down simulation.

### Results and Recommended Actions

| Condition                                                              | Recommended Action                                                                                                                                                                                   |
|------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| There are noncontinuous signals in the model driving derivative ports. | <ul style="list-style-type: none"><li>• Make the specified signals continuous.</li><li>• Replace the continuous blocks receiving these signals with discrete state versions of the blocks.</li></ul> |

### See Also

“How Simulink Works” in the Simulink documentation.

## Runtime diagnostics for Data Store blocks

Verify that read and write order checking is on if there are Data Store blocks in the model.

### Description

Results are unpredictable if read and write order checking is off.

### Results and Recommended Actions

| Condition                                      | Recommended Action                                                                                                                 |
|------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------|
| Detect read before write checking is disabled. | Consider enabling <b>Detect read before write</b> in the <b>Configuration Parameters &gt; Diagnostics &gt; Data Validity</b> pane. |
| Detect write after read checking is disabled.  | Consider enabling <b>Detect write after read</b> in the <b>Configuration Parameters &gt; Diagnostics &gt; Data Validity</b> pane.  |
| Detect write after write checking is disabled. | Consider enabling <b>Detect write after write</b> in the <b>Configuration Parameters &gt; Diagnostics &gt; Data Validity</b> pane. |

### Tips

The runtime diagnostics might slow down simulations considerably. Set them to **Disable** all once you have verified that Simulink does not generate any warnings or errors during simulation.

### See Also

- “Working with Data Stores”
- Data Store Memory
- Data Store Read
- Data Store Write

## Runtime diagnostics for S-functions

Check array bounds and solver consistency if S-Function blocks are in the model.

### Description

Validates whether S-Function blocks adhere to the ODE solver consistency rules that Simulink applies to its built-in blocks.

### Results and Recommended Actions

| Condition                                        | Recommended Action                                                                                                                   |
|--------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------|
| <b>Solver data inconsistency</b> is set to none. | Set <b>Solver data inconsistency</b> in the <b>Configuration Parameters &gt; Diagnostics</b> pane to warning or error.               |
| <b>Array bounds exceeded</b> is set to none.     | Set <b>Array bounds exceeded</b> in the <b>Configuration Parameters &gt; Diagnostics &gt; Data Validity</b> pane to warning or error |

### See Also

*Writing S-Functions* in the Simulink documentation



# Simulink Limits

---

The following table documents some limits on the size and complexity of Simulink models.

| <b>Model Feature</b>                                 | <b>Limit</b>                                                                              |
|------------------------------------------------------|-------------------------------------------------------------------------------------------|
| Maximum number of levels in a block diagram          | 1024                                                                                      |
| Maximum number of branches in a line                 | 1024                                                                                      |
| Maximum length of a parameter name                   | 256                                                                                       |
| Maximum length of a parameter string value           | 32768                                                                                     |
| Maximum value of a model window coordinate           | 32768                                                                                     |
| Maximum number of bytes of logged simulation data    | 2 <sup>31</sup> -1 bytes on 32-bit systems,<br>2 <sup>48</sup> -1 bytes on 64-bit systems |
| Maximum length of integer and fixed-point data types | 128 bits                                                                                  |



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