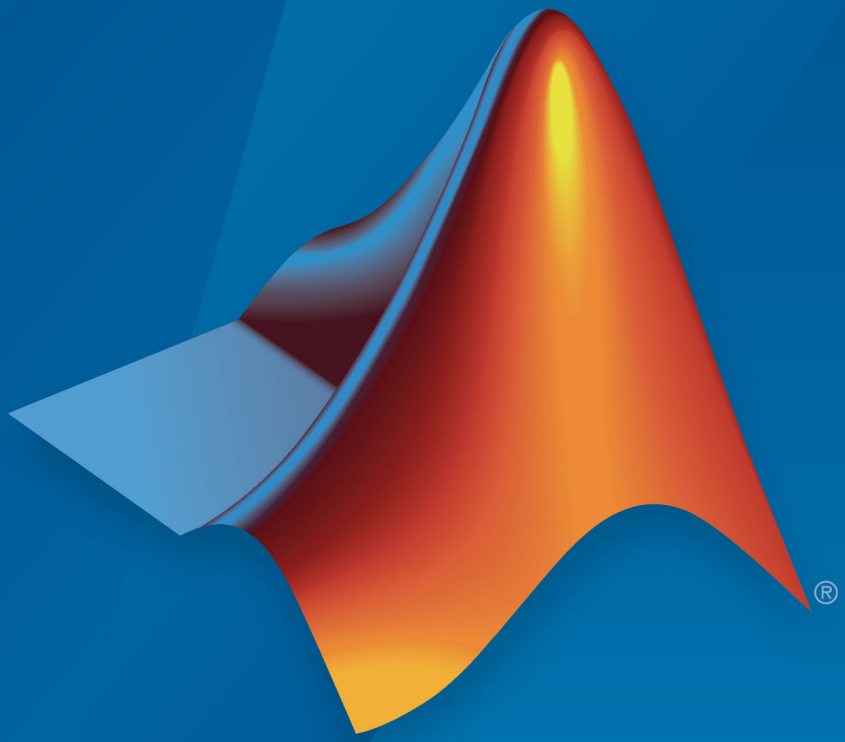
Stateflow®

Reference



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Stateflow® Reference

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Contents

Functions — Alphabetical List

sfclipboard

Stateflow clipboard object

Syntax

object = sfclipboard

Description

object = sfclipboard returns a handle to the Stateflow clipboard object, which you use to copy objects from one chart or state to another.

Examples

Copy the `init` function from the `Init` chart to the `Pool` chart in the `sf_pool` model:

```
sf_pool;
% Get handle to the root object
rt = sfroot;
% Get handle to 'init' function in Init chart
f1 = rt.find('-isa','Stateflow.EMFunction','Name','init');
% Get handle to Pool chart
chP = rt.find('-isa','Stateflow.Chart','Name','Pool');
% Get handle to the clipboard object
cb = sfclipboard;
% Copy 'init' function to the clipboard
cb.copy(f1);
% Paste 'init' function to the Pool chart
cb.pasteTo(chP);
% Get handle to newly pasted function
f2 = chP.find('-isa','Stateflow.EMFunction','Name','init');
% Reset position of new function in the Pool chart
f2.Position = [90 180 90 60];
```

See Also

`sfgco` | `sfnew` | `sfroot` | `stateflow`

Topics

“Copy and Paste Stateflow Objects”
“Create Charts by Using the Stateflow API”
“Get a Handle on Stateflow API Objects”
“Access the Chart Object”

Introduced before R2006a

sfclose

Close chart

Syntax

```
sfclose
sfclose('chart_name')
sfclose('all')
```

Description

`sfclose` closes the current chart.

`sfclose('chart_name')` closes the chart called `'chart_name'`.

`sfclose('all')` closes all open or minimized charts. `'all'` is a literal character vector.

See Also

`sfnew` | `sfopen` | `stateflow`

Introduced in R2006a

sfdebugger

Open Stateflow Debugger

Syntax

```
sfdebugger
sfdebugger('model_name')
```

Description

`sfdebugger` opens the Stateflow Debugger for the current model.

`sfdebugger('model_name')` opens the debugger for the Simulink® model called `'model_name'`. Use this input argument to specify which model to debug when you have multiple models open.

See Also

`sfexplr` | `sfhelp` | `sflib`

Topics

“Debug Run-Time Errors in a Chart”

Introduced in R2006a

sfexplr

Open Model Explorer

Syntax

```
sfexplr
```

Description

`sfexplr` opens the Model Explorer. A model does not need to be open.

See Also

`sfdebugger` | `sfhelp` | `sflib`

Topics

“Use the Model Explorer with Stateflow Objects”

Introduced in R2006a

sfgco

Recently selected objects in chart

Syntax

```
object = sfgco
```

Description

`object = sfgco` returns a handle or vector of handles to the most recently selected objects in a chart.

Output Arguments

`object`

Handle or vector of handles to the most recently selected objects in a chart

Empty matrix	No charts are open, or you have no edited charts.
Handle to the chart most recently clicked	You clicked in a chart, but did not select any objects.
Handle to the selected object	You selected one object in a chart.
Vector of handles to the selected objects	You selected multiple objects in a chart.
Vector of handles to the most recently selected objects in the most recently selected chart	You selected multiple objects in multiple charts.

Examples

Zoom in on a state after clicking it:

```
myState = sfgco;
% Zoom in on the selected state
myState.fitToView;
```

See Also

`sfnew` | `sfroot` | `stateflow`

Topics

“Create Charts by Using the Stateflow API”
“Get a Handle on Stateflow API Objects”
“View Stateflow Graphical Objects”

Introduced before R2006a

sfhelp

Open Stateflow online help

Syntax

```
sfhelp
```

Description

`sfhelp` opens the Stateflow online help in the MATLAB® Help browser.

See Also

`sfdebugger` | `sfexplr` | `sfnew` | `stateflow`

Introduced before R2006a

sflib

Open Stateflow library window

Syntax

```
sflib
```

Description

`sflib` opens the Stateflow block library. From this library, you can drag Stateflow blocks into Simulink models and access the Stateflow Examples Library.

See Also

`sfdebugger` | `sfexplr` | `sfhelp` | `sfnew`

Introduced in R2006a

sfnew

Create Simulink model that contains an empty Stateflow block

Syntax

```
sfnew
sfnew chart_type
sfnew model_name
sfnew chart_type model_name
```

Description

`sfnew` creates an untitled Simulink model that contains an empty Stateflow chart.

`sfnew chart_type` creates an untitled model that contains an empty block of type `chart_type`.

`sfnew model_name` creates a model called `model_name` that contains an empty chart.

`sfnew chart_type model_name` creates a model called `model_name` that contains an empty block of type `chart_type`.

Examples

Untitled Model with Chart

Create an untitled model that contains an empty Stateflow chart that uses MATLAB as the action language.

```
sfnew
```

Untitled Model with Truth Table

Create an untitled model called `MyModel` that contains an empty Stateflow truth table block.

```
sfnew -TT
```

Named Model with Chart

Create a model called `MyModel` that contains an empty Stateflow chart that uses MATLAB as the action language.

```
sfnew 'MyModel'
```

Named Model with Moore Chart

Create a model called `MyModel` that contains an empty Stateflow chart that uses Moore semantics.

```
sfnew -Moore 'MyModel'
```

Input Arguments

`chart_type` — Type of block
`-MATLAB` (default) | `-C` | `-Mealy` | `-Moore` | `-STT` | `-TT`

Type of Stateflow block to add to empty model, specified as one of these options.

Option	Description
`-MATLAB`	Chart that supports MATLAB expressions in actions
`-C`	Chart that supports C expressions in actions
`-Mealy`	Chart that supports Mealy machine semantics

Option	Description
`-Moore`	Chart that supports Moore machine semantics
`-STT`	State Transition Table
`-TT`	Truth Table

`model_name` — Name of model
character vector

Name of the Simulink model, specified as a character vector.

Tips

- The default action language for new charts is MATLAB. To change the default action language to C, use the command `sfpref('ActionLanguage','C')`. For more information, see “Modify the Action Language for a Chart”.
- To create a standalone chart that you can execute as a MATLAB object, open the Stateflow editor by using the `edit` function. For example, at the MATLAB Command Window, enter:

  ```
  edit chart.sfx
  ```

  For more information, see “Create Stateflow Charts for Execution as MATLAB Objects”.

See Also

`sfhelp` | `sfprint` | `sfroot` | `sfsave` | `stateflow`

Topics

“Differences Between MATLAB and C as Action Language Syntax”
“Overview of Mealy and Moore Machines”
“Reuse Combinatorial Logic by Defining Truth Tables”
“State Transition Tables in Stateflow”

Introduced before R2006a

sfopen

Open existing model

Syntax

```
sfopen
```

Description

`sfopen` prompts you for a model file and opens the model that you select from your file system.

See Also

`sfclose` | `sfdebugger` | `sfexplr` | `sflib` | `sfnew` | `stateflow`

Introduced in R2006a

sfprint

Print graphical view of charts

Syntax

```
sfprint
sfprint(objects)
sfprint(objects,format)
sfprint(objects,format,outputOption)
sfprint(objects,format,outputOption,wholeChart)
```

Description

`sfprint` prints the current chart to the default printer.

`sfprint(objects)` prints all charts specified by `objects` to the default printer.

`sfprint(objects,format)` prints all charts specified by `objects` in the specified `format` to output files. Each output file matches the name of the chart and the file extension matches the `format`.

`sfprint(objects,format,outputOption)` prints all charts specified by `objects` in the specified `format` to the file or printer specified in `outputOption`.

`sfprint(objects,format,outputOption,wholeChart)` prints all charts specified by `objects` in the specified `format` to the file or printer specified in `outputOption`. As specified in `wholeChart`, prints either a complete or current view.

Examples

Print open chart

```
sfprint
```

Prints current chart to the default printer.

Print all charts specified in path

```
sfprint('sf_car/shift_logic');
```

Prints the chart with the path ‘sf_car/shift_logic’ to the default printer.

Print chart specified in path to a JPG file format.

```
sfprint('sf_car/shift_logic','jpg')
```

Prints a copy of the chart ‘sf_car/shift_logic’ in JPG format to the file ‘sf_car_shift_logic.jpg’.

Print chart in TIFF format to the clipboard.

```
sfprint(gcs,'tiff','clipboard')
```

Prints the chart in the current system to the clipboard in TIFF format.

Print the current view of a chart.

```
sfprint('sf_car/shift_logic','png','file',0)
```

Prints the current view of ‘sf_car/shift_logic’ in a PNG format to the file ‘sf_car_shift_logic.png’.

Input Arguments

`objects` — Identifier of charts to print

`gcb` (default) | `gcs` | character vector

Identifier of charts to print. Use:

- `gcb` to specify the current block of the model.
- `gcs` to specify the current system of the model.
- a character vector to specify the path of a chart, model, subsystem, or block.

Example: `sfprint(gcs)`

Prints all the charts in the current system to the default printer.

Example: `sfprint('sf_pool/Pool')`

Prints the complete chart with the path `'sf_pool/Pool'` to the default printer.

`format` — Output format of printed charts
`'bitmap'` | `'jpg'` | `'meta'` | `'pdf'` | `'png'` | `'svg'` | `'tiff'`

Output format of the printed charts specified as one of these values:

`'bitmap'`	Save the chart image to the clipboard as a bitmap (for Windows® operating systems only)
`'jpg'`	Generate a JPEG file
`'meta'`	Save the chart image to the clipboard as an enhanced metafile (for Windows operating systems only)
`'pdf'`	Generate a PDF file
`'png'`	Generate a PNG file
`'svg'`	Generate an SVG file
`'tiff'`	Generate a TIFF file

Example: `sfprint('sf_car/shift_logic','jpg')`

Prints the complete chart `'sf_car/shift_logic'` in a JPEG format to a file in the current folder named `'sf_car_shift_logic.jpg'`.

Example: `sfprint('sf_bounce/BouncingBall','meta','myImage')`

Prints the complete chart `'sf_bounce/BouncingBall'` as an enhanced metafile in the current folder named `'myImage.emf'`.

Data Types: `char`

outputOption — Name of the printer or output file
'file' (default) | character vector | 'clipboard' | 'promptForFile' | 'printer'

Name of the output file or printer specified as one of these values:

'file'	Send output to a default file with the name *chart_name.file_extension*. The file name is the name of the chart, with an extension that matches the output format.
character vector	Specify the name of the output file with a character vector.
'clipboard'	Copy output to the clipboard
'promptForFile'	Prompts the user interactively for path and file name.
'printer'	Send output to the default printer (use only with 'ps', or 'eps' formats)

Example: sfprint('sf_car/shift_logic','png','myFile')

Prints the complete chart whose path is 'sf_car/shift_logic' in the PNG format to a file in the current folder with the name 'myFile'.png.

Example: sfprint('sf_car/shift_logic,'pdf','promptForFile')

Prints all charts in the current block of the model in PDF format. A dialog box opens for each chart to prompt you for the path and name of the output file.

Data Types: char

wholeChart — View of charts to print
1 (default) | 0

View of charts to print specified as a integer of value 0 or 1. A value of 1 prints the complete views of all the charts, whereas a value of 0 prints the current views of all the charts.

Example: sfprint(gcs,'png','file',0)

Prints the current view of all charts in the current system in PNG format using default file names.

See Also

`gcb` | `gcs` | `sfhelp` | `sfnew` | `sfsave` | `stateflow`

Introduced before R2006a

sfroot

Root object

Syntax

```
object = sfroot
```

Description

`object = sfroot` returns a handle to the top-level object in the Stateflow hierarchy of objects. Use the root object to access all other objects in your charts when using the API.

Examples

Zoom in on a state in your chart:

```
old_sf_car;
% Get handle to the root object
rt = sfroot;
% Find the state with the name 'first'
myState = rt.find('-isa','Stateflow.State','Name','first');
% Zoom in on that state in the chart
myState.fitToView;
```

See Also

`sfclipboard` | `sfgco`

Topics

“Create Charts by Using the Stateflow API”
“Get a Handle on Stateflow API Objects”
“Access the Chart Object”

Introduced before R2006a

sfsave

Save chart in current folder

Syntax

```
sfsave
sfsave('model_name')
sfsave('model_name','new_model_name')
sfsave('Defaults')
```

Description

`sfsave` saves the chart in the current model.

`sfsave('model_name')` saves the chart in the model called '*model_name*'.

`sfsave('model_name','new_model_name')` saves the chart in '*model_name*' to '*new_model_name*'.

`sfsave('Defaults')` saves the settings of the current model as defaults.

The model must be open and the current folder must be writable.

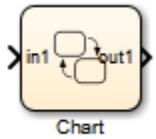
Examples

Develop a script to create a baseline chart and save it in a new model:

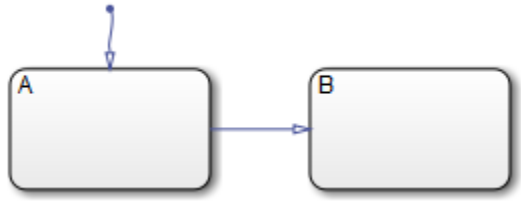
```
bdclose('all');

% Create an empty chart in a new model
sfnew;

% Get root object
rt = sfroot;
```

```
% Get model
m = rt.find('-isa','Simulink.BlockDiagram');

% Get chart
chart1 = m.find('-isa','Stateflow.Chart');

% Create two states, A and B, in the chart
sA = Stateflow.State(chart1);
sA.Name = 'A';
sA.Position = [50 50 100 60];
sB = Stateflow.State(chart1);
sB.Name = 'B';
sB.Position = [200 50 100 60];

% Add a transition from state A to state B
tAB = Stateflow.Transition(chart1);
tAB.Source = sA;
tAB.Destination = sB;
tAB.SourceOClock = 3;
tAB.DestinationOClock = 9;

% Add a default transition to state A
dtA = Stateflow.Transition(chart1);
dtA.Destination = sA;
dtA.DestinationOClock = 0;
x = sA.Position(1)+sA.Position(3)/2;
y = sA.Position(2)-30;
dtA.SourceEndPoint = [x y];

% Add an input in1
d1 = Stateflow.Data(chart1);
d1.Scope = 'Input';
d1.Name = 'in1';

% Add an output out1
d2 = Stateflow.Data(chart1);
d2.Scope = 'Output';
d2.Name = 'out1';

% Save the chart in a model called "NewModel"
% in current folder
sfsave('untitled','NewModel');
```

Here is the resulting model:



Here is the resulting chart:



See Also

`find` | `sfclose` | `sfnew` | `sfopen` | `sfroot`

Topics

“Create Charts by Using the Stateflow API”
“Create Charts by Using a MATLAB Script”

Introduced before R2006a

stateflow

Open Stateflow library window and create Simulink model that contains an empty chart

Syntax

```
stateflow
```

Description

`stateflow` creates an untitled Simulink model that contains an empty Stateflow chart. The function also opens the Stateflow block library. From this library, you can drag Stateflow blocks into models or access the Stateflow Examples Library.

Tips

- To only create a Simulink model that contains an empty Stateflow block, use the `sfnew` function.
- To only open the Stateflow block library, use the `sflib` function.
- To create a standalone chart that you can execute as a MATLAB object, open the Stateflow editor by using the `edit` function. For example, at the MATLAB Command Window, enter:

  ```
  edit chart.sfx
  ```

  For more information, see “Create Stateflow Charts for Execution as MATLAB Objects”.

Compatibility Considerations

Opening Stateflow

Behavior change in future release

The behavior of the `stateflow` function will change in a future release. Use `sfnew` and `sflib` instead.

See Also

`edit` | `sflib` | `sfnew`

Introduced before R2006a

Stateflow.exportAsClass

Export MATLAB class for standalone chart

Syntax

```
Stateflow.exportAsClass(source)
Stateflow.exportAsClass(source,destination)
```

Description

`Stateflow.exportAsClass(source)` saves a standalone Stateflow chart as a MATLAB class file in the current folder. The saved file has the same name as the chart. For example, if `source` is `chart.sfx`, the function saves the MATLAB class in the file `chart.m`.

`Stateflow.exportAsClass(source,destination)` saves the chart as a MATLAB class file in the folder `destination`.

Note The MATLAB class produced by `Stateflow.exportAsClass` is intended for debugging purposes only, and not for production use or manual modification. For more information, see “Tips” on page 1-28.

Examples

Export Chart in Current Folder

Save Stateflow chart `chart.sfx` as the MATLAB class file `chart.m` in the current folder.

```
Stateflow.exportAsClass('chart.sfx');
```

Export Chart in Folder Specified by Path

Save Stateflow chart `chart.sfx`, which is located in folder `dir1`, as the MATLAB class file `chart.m` in the current folder.

```
Stateflow.exportAsClass(fullfile('dir1','chart.sfx'));
```

Export Chart to MATLAB Class in Another Folder

Save Stateflow chart `chart.sfx`, which is located in the current folder, as the MATLAB class file `chart.m` in the folder `dir2`.

```
Stateflow.exportAsClass('chart.sfx','dir2');
```

Input Arguments

`source` — Path and file name of standalone Stateflow chart

character vector | string scalar

Path and file name of a standalone chart, specified as a string scalar or character vector. You can use the absolute path from the root folder or the relative path from the current folder. Standalone charts have the extension `.sfx`.

Data Types: `char` | `string`

`destination` — Path of destination folder for MATLAB class file

character vector | string scalar

Path of the destination folder for the MATLAB class file, specified as a string scalar or character vector. You can use the absolute path from the root folder or the relative path from the current folder. If not specified, the function saves the MATLAB script file in the current folder.

Data Types: `char` | `string`

Tips

- Use the code produced by `Stateflow.exportAsClass` to debug run-time errors that are otherwise difficult to diagnose. For example, suppose that you encounter an error

while executing a Stateflow chart that controls a MATLAB application. If you export the chart as a MATLAB class file, you can replace the chart with the class in your application and diagnose the error by using the MATLAB debugger.

Note Error messages produced by the MATLAB class point to different line numbers than the corresponding error messages produced by the Stateflow chart.

- When you execute the MATLAB class produced by `Stateflow.exportAsClass`, the Stateflow Editor does not animate the original chart.

See Also

`fullfile`

Topics

“Create Stateflow Charts for Execution as MATLAB Objects”

Introduced in R2019b

Operators — Alphabetical List

after

Control chart execution with the `after` operator

Syntax

```
after(n,E)
after(n,time_unit)
```

Description

`after(n,E)` returns `true` if the base event `E` has occurred at least `n` times since activation of the associated state. Otherwise, the operator returns `false`.

In a chart with no input events, `after(n,tick)` returns `true` if the chart has woken up `n` times or more since activation of the associated state.

The `after` operator resets the counter for `E` to 0 each time the associated state reactivates.

`after(n,time_unit)` returns `true` if `n` units of time have elapsed since activation of the associated state. Otherwise, the operator returns `false`. Specify `time_unit` as seconds (`sec`), milliseconds (`msec`), or microseconds (`usec`).

The `after` operator resets the counter for `sec`, `msec`, and `usec` to 0 each time the associated state reactivates.

Examples

Event Based State Action (`on after`)

A status message appears during each `CLK` cycle, starting 5 clock cycles after activation of the state.

```
on after(5,CLK): status('on');
```

Event Based Transition

A transition out of the associated state occurs only on broadcast of a `ROTATE` event, but no sooner than 10 `CLK` cycles after activation of the state.

```
ROTATE[after(10,CLK)]
```

Absolute-Time Based State Action (`on after`)

After 12.3 seconds since activation of the state, `temp` variable becomes `LOW` .

```
on after(12.3,sec): temp = LOW;
```

Absolute-Time Based Transition

After 8 milliseconds since activation of the state, a transition out of the associated state occurs.

```
after(8,msec)
```

Tips

- You can use quotation marks to enclose the keywords `'tick'`, `'sec'`, `'msec'`, and `'usec'`. For example, `after(5,'tick')` is equivalent to `after(5,tick)`.
- The timing for absolute-time temporal logic operators depends on the type of Stateflow chart:
  - Charts in a Simulink model define temporal logic in terms of simulation time.
  - Standalone charts in MATLAB define temporal logic in terms of wall-clock time.

  The difference in timing can affect the behavior of a chart. For example, suppose that this chart is executing the `during` action of state `A`.

- In a Simulink model, the function call to `f` executes in a single time step and does not contribute to the simulation time. The chart completes the function call to `f` before it takes the transition from state `A` to state `B` and calls function `g`.
- In a standalone chart, the function call to `f` can take several seconds of wall-clock time to complete. If the call lasts more than two seconds, the chart takes the transition to state `B` and calls function `g` before the function `f` finishes executing.

See Also

at | before | every

Topics

“Control Chart Execution by Using Temporal Logic”

Introduced in R2014b

ascii2str

Convert array of type `uint8` to string

Syntax

```
dest = ascii2str(A)
```

Description

`dest = ascii2str(A)` converts ASCII values in array `A` of type `uint8` to a string.

Examples

Array of Type `uint8` to String

Return string `"Hi!"`

```
A[0] = 72;
A[1] = 105;
A[2] = 33;
dest = ascii2str(A);
```

Tips

- Use in Stateflow charts that use C as the action language.

See Also

str2ascii | strcpy

Topics

“Manage Textual Information by Using Strings”

“Share String Data with Custom C Code”

Introduced in R2018b

at

Control chart execution with the `at` operator

Syntax

```
at(n,E)
```

Description

`at(n,E)` returns `true` only at the n^{th} occurrence of the base event `E` since activation of the associated state. Otherwise, the operator returns `false`.

In a chart with no input events, `at(n,tick)` returns `true` if the chart has woken up for the n^{th} time since activation of the associated state.

The `at` operator resets the counter for `E` to 0 each time the associated state reactivates.

Examples

Event Based State Action (`on at`)

A status message `on` appears at exactly 10 `CLK` cycles after activation of the state.

```
on at(10,CLK): status('on');
```

Event Based Transition

A transition out of the associated state occurs only on broadcast of a `ROTATE` event, at exactly 10 `CLK` cycles after activation of the state.

```
ROTATE[at(10,CLK)]
```

Tips

- You can use quotation marks to enclose the keyword `'tick'`. For example, `at(5,'tick')` is equivalent to `at(5,tick)`.
- Use of `at` as an absolute-time temporal logic operator is not supported. Use the `after` operator instead. For more information, see “Use the after Operator to Replace the at Operator”.

See Also

after | before | every

Topics

“Control Chart Execution by Using Temporal Logic”

Introduced in R2014b

before

Control chart execution with the `before` operator

Syntax

```
before(n,E)
before(n,time_unit)
```

Description

`before(n,E)` returns `true` if the base event `E` has occurred fewer than `n` times since activation of the associated state. Otherwise, the operator returns `false`.

In a chart with no input events, `before(n,tick)` returns `true` if the chart has woken up fewer than `n` times since activation of the associated state.

The `before` operator resets the counter for `E` to 0 each time the associated state reactivates.

`before(n,time_unit)` returns `true` if fewer than `n` units of simulation time have elapsed since activation of the associated state. Otherwise, the operator returns `false`. Specify `time_unit` as seconds (`sec`), milliseconds (`msec`), or microseconds (`usec`).

The `before` operator resets the counter for `sec`, `msec`, and `usec` to 0 each time the associated state reactivates.

Examples

Event Based State Action (`on before`)

The `temp` variable increments once per `CLK` cycle until the state reaches the `MAX` limit.

```
on before(MAX,CLK): temp++;
```

Event Based Transition

A transition out of the associated state occurs only on broadcast of a `ROTATE` event, but no later than 10 `CLK` cycles after activation of the state.

```
ROTATE[before(10,CLK)]
```

Absolute-Time Based Transition

If the variable `temp` exceeds 75 and fewer than 12.34 seconds have elapsed since activation of the state, a transition out of the associated state occurs.

```
[temp > 75 && before(12.34,sec)]
```

Tips

- You can use quotation marks to enclose the keywords `'tick'`, `'sec'`, `'msec'`, and `'usec'`. For example, `before(5,'tick')` is equivalent to `before(5,tick)`.

See Also

after | at | every

Topics

“Control Chart Execution by Using Temporal Logic”

Introduced in R2014b

count

Control chart execution with the `count` operator

Syntax

```
count(C)
```

Description

The `count(C)` operator returns a double value equivalent to the number of ticks after the conditional expression, `C`, becomes `true`. The `count` operator is reset if the conditional expression becomes `false`. If the `count` operator is used within a state, it is reset when the state that contains it is entered. If the `count` operator is used on a transition, it is reset when the source state for that transition is entered.

The value for `count` is dependent on the step size. Changing the solver or step size for your Simulink model affects the result of Stateflow charts that include the `count` operator.

To ensure that your Stateflow chart simulates without error, do not use count with these objects:

- Continuous time charts
- Graphical, MATLAB, or Simulink functions
- Simulink based states
- Transitions that can be reached from multiple states
- Default transitions

Use the `count` operator in charts that use C or MATLAB as the action language.

Examples

Absolute-Time Based Transition

The transition occurs when the value of `data` has been greater than or equal to 2 for longer than 5 ticks.

```
[count(data >= 2) > 5]
```

State Action

When the state is exited, `x` is set to the number of ticks that data has been greater than 5.

```
ex: x = count(data>5)
```

See Also

duration | elapsed | temporalCount

Topics

“Control Chart Execution by Using Temporal Logic”

Introduced in R2019a

discard

Discard message

Syntax

```
discard(message_name)
```

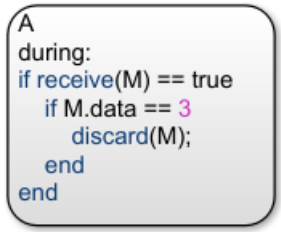
Description

`discard(message_name)` discards a valid input or local message. After a chart discards a message, it can remove another message from the queue in the same time step. A chart cannot access the data of a discarded message.

Examples

Discard Message in State Action

Check the queue for message `M`. If a message is present, remove it from the queue. If the message has a data value equal to 3, discard the message.



See Also

receive

Topics

“Control Message Activity in Stateflow Charts”

Introduced in R2018b

duration

Control chart execution with the `duration` operator

Syntax

```
duration(C)
```

Description

`duration(C)` returns the number of seconds after the conditional expression, `C`, becomes `true`. The `duration` operator is reset if the conditional expression becomes `false`. If the `duration` operator is used within a state, it is reset when the state that contains it is entered. If the `duration` operator is used on a transition, it is reset when the source state for that transition is entered.

Examples

Absolute-Time Based Transition

The transition occurs when the value of `x` has been greater than or equal to `0` for longer than `0.1` seconds.

```
[duration(x >= 0) > 0.1]
```

Tips

- The `duration` operator does not support conditions that depend on local or output structures. For more information, see “Access Bus Signals Through Stateflow Structures”.

See Also

count | elapsed | temporalCount

Topics

“Control Chart Execution by Using Temporal Logic”
“Control Oscillations by Using the duration Operator”
“Reduce Transient Signals by Using Debouncing Logic”

Introduced in R2017a

elapsed

Control chart execution with the `elapsed` operator

Syntax

```
elapsed(sec)
```

Description

`elapsed(sec)` returns the time in seconds (`sec`) that has elapsed since the activation of the associated state.

The `elapsed` operator resets the counter for `sec` to 0 each time the associated state reactivates.

Examples

Absolute-Time Based State Action

At the entry and during actions of the state, y is assigned the length of time that the state has been active.

```
en, du: y = elapsed(sec);
```

Tips

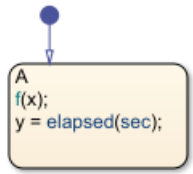
- In state and transition actions, you can use quotation marks to enclose the keyword `'sec'`. For example:

  ```
  y = elapsed('sec');
  ```

- The timing for absolute-time temporal logic operators depends on the type of Stateflow chart:

- Charts in a Simulink model define temporal logic in terms of simulation time.
- Standalone charts in MATLAB define temporal logic in terms of wall-clock time.

The difference in timing can affect the behavior of a chart. For example, suppose that this chart is executing the `entry` action of state `A`.



- In a Simulink model, the function call to `f` executes in a single time step and does not contribute to the simulation time. After calling the function `f`, the chart assigns a value of zero to `y`.
- In a standalone chart, the function call to `f` can take several seconds of wall-clock time to complete. After calling the function `f`, the chart assigns the nonzero time that has elapsed since state `A` became active to `y`.

See Also

count | duration | temporalCount

Topics

“Control Chart Execution by Using Temporal Logic”

Introduced in R2017a

every

Control chart execution with the `every` operator

Syntax

```
every(n,E)
every(n,time_unit)
```

Description

`every(n,E)` returns `true` at every n^{th} occurrence of the base event `E` since activation of the associated state. Otherwise, the operator returns `false`.

In a chart with no input events, `every(n,tick)` returns `true` if the chart has woken up an integer multiple of `n` times since activation of the associated state.

The `every` operator resets the counter for `E` to `0` each time the associated state reactivates.

`every(n,time_unit)` returns `true` every `n` units of time since activation of the associated state. Otherwise, the operator returns `false`. Specify `time_unit` as seconds (`sec`), milliseconds (`msec`), or microseconds (`usec`).

The `every` operator resets the counter for `sec`, `msec`, and `usec` to 0 each time the associated state reactivates.

Use of `every` as an absolute-time temporal logic operator is supported only in standalone charts for execution as MATLAB objects.

Examples

Event Based State Action (`on every`)

A status message `on` appears every 5 `CLK` cycles after activation of the state.

```
on every(5,CLK): status('on');
```

Absolute-Time Based State Action (`on every`)

A status message is displayed every 2 seconds after activation of the state.

```
on every(2,sec): disp('Hello!');
```

Tips

- You can use quotation marks to enclose the keywords `'tick'`, `'sec'`, `'msec'`, and `'usec'`. For example, `every(5,'tick')` is equivalent to `every(5,tick)`.
- Use of `every` as an absolute-time temporal logic operator is supported only in standalone charts for execution as MATLAB objects. In a Simulink model, use an outer self-loop transition with the `after` operator instead. For more information, see “Use an Outer Self-Loop Transition with the after Operator to Replace the every Operator”.
- The timing for absolute-time temporal logic operators depends on the type of Stateflow chart:
  - Charts in a Simulink model define temporal logic in terms of simulation time.
  - Standalone charts in MATLAB define temporal logic in terms of wall-clock time.

  The difference in timing can affect the behavior of a chart. For example, suppose that this chart is executing the `during` action of state `A` when the condition `guard` is `true`.

  - In a Simulink model, the function call to `f` executes in a single time step and does not contribute to the simulation time. The chart completes the function call to `f` before it takes the transition from state `A` to state `B` and calls function `g`.
  - In a standalone chart, the function call to `f` can take several seconds of wall-clock time to complete. If the call lasts more than two seconds, the chart takes the transition to state `B` and calls function `g` before the function `f` finishes executing.

See Also

after | at | before

Topics

“Control Chart Execution by Using Temporal Logic”

Introduced in R2014b

forward

Forward message

Syntax

```
forward(input_message_name,output_message_name)
```

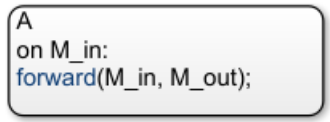
Description

`forward(input_message_name,output_message_name)` forwards a valid input or local message to a local queue or an output port. After a chart forwards a message, it can remove another message from the queue in the same time step.

Examples

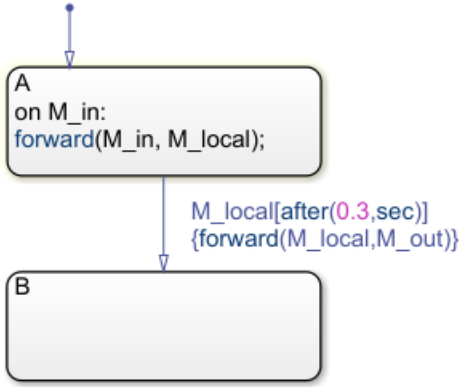
Forward an Input Message

Check the input queue for message `M_in`. If a message is present, remove the message from the queue and forward it to the output port `M_out`.



Forward a Local Message

Check the input queue for message `M_in`. If a message is present, forward the message to the local message queue `M_local`. After a delay of 0.3 seconds, transition from state `A` to state `B`, remove the message from the `M_local` message queue, and forward it to the output port `M_out`.



See Also

receive

Topics

“Control Message Activity in Stateflow Charts”

Introduced in R2018b

hasChanged

Detect change in data since last time step

Syntax

```
tf = hasChanged(u)
```

Description

`tf = hasChanged(u)` returns `true` if the value of `u` at the beginning of the current time step is different from the value of `u` at the beginning of the previous time step. If multiple input events occur in the same time step, `hasChanged` returns `true` when the value of `u` changes between input events.

The argument `u` can be:

- A scalar variable.
- A matrix or an element of a matrix. See “Supported Operations for Vectors and Matrices”.
- A structure or a field in a structure. See “Index and Assign Values to Stateflow Structures”.
- Any valid combination of structure fields or matrix indices.

Indices can be numbers or expressions that evaluate to a scalar value. If `u` is a matrix, `hasChanged` returns `true` if any element of `u` has changed value since the last time step or input event. If `u` is a structure, `hasChanged` returns `true` if any field of `u` has changed value since the last time step or input event.

The argument `u` cannot be a nontrivial expression or a custom code variable.

Examples

Detect Change in Structure

Returns `true` if any field of the structure `struct` has changed value since the last time step or input event.

```
hasChanged(struct)
```

Detect Change in Structure Field

Returns `true` if the structure field of `struct.field` has changed value since the last time step or input event.

```
hasChanged(struct.field)
```

Detect Change in Matrix

Returns `true` if any element of the matrix `M` has changed value since the last time step or input event.

```
hasChanged(M)
```

Detect Change in Matrix Element

Returns `true` if the element in row 1 and column 3 of the matrix `M` has changed value since the last time step or input event.

In charts that use MATLAB as the action language:

```
hasChanged(M(1,3))
```

In charts that use C as the action language:

```
hasChanged(M[0][2])
```

Tips

- For Stateflow charts in a Simulink model, the action language determines the scope of data that supports change detection:
  - MATLAB as the action language: `Input` only.
  - C as the action language: `Input`, `Output`, `Local`, or `Data Store Memory`.
- Standalone Stateflow charts do not support change detection on an element of a matrix or a field in a structure.
- The `hasChanged` operator returns `false` if the chart writes to the data but does not change the data value.
- If you enable the chart option **Initialize Outputs Every Time Chart Wakes Up**, do not use an output as the argument of the `hasChanged` operator. With this option enabled, the `hasChanged` operator always returns `false`. For more information, see "Initialize Outputs Every Time Chart Wakes Up".

See Also

hasChangedFrom | hasChangedTo

Topics

"Detect Changes in Data Values"
"Supported Operations for Vectors and Matrices"
"Index and Assign Values to Stateflow Structures"
"Assign Values to All Elements of a Matrix"

Introduced in R2007a

hasChangedFrom

Detect change in data from specified value

Syntax

```
tf = hasChangedFrom(u,v)
```

Description

`tf = hasChangedFrom(u,v)` returns `true` if both of these conditions are true:

- The value of `u` at the beginning of the previous time step was equal to `v`.
- The value of `u` at the beginning of the current time step is not equal to `v`.

If multiple input events occur in the same time step, `hasChangedFrom` returns `true` when the value of `u` changes from the value `v` between input events.

The first argument `u` can be:

- A scalar variable.
- A matrix or an element of a matrix. See “Supported Operations for Vectors and Matrices”.
- A structure or a field in a structure. See “Index and Assign Values to Stateflow Structures”.
- Any valid combination of structure fields or matrix indices.

Indices can be numbers or expressions that evaluate to a scalar value.

The second argument `v` can be any expression that resolves to a value that is comparable with `u`:

- If `u` is a scalar, then `v` must resolve to a scalar value.
- If `u` is a matrix, then `v` must resolve to a matrix value with the same dimensions as `u`. The `hasChangedFrom` operator returns `true` if the previous value of `u` was equal to `v` and any element of `u` has changed value since the last time step or input event.

Alternatively, in a chart that uses C as the action language, `v` can resolve to a scalar value. The chart uses scalar expansion to compare `u` to a matrix whose elements are all equal to the value specified by `v`. See “Assign Values to All Elements of a Matrix”.

- If `u` is a structure, then `v` must resolve to a structure value whose field specification matches `u` exactly. The `hasChangedFrom` operator returns `true` if the previous value of `u` was equal to `v` and any field of `u` has changed value since the last time step or input event.

The argument `u` cannot be a nontrivial expression or a custom code variable.

Examples

Detect Change in Structure

Returns `true` if the previous value of the structure `struct` was equal to `structValue` and any field of `struct` has changed value since the last time step or input event.

```
hasChangedFrom(struct,structValue)
```

Detect Change in Structure Field

Returns `true` if the structure field `struct.field` has changed from the value `5` since the last time step or input event.

```
hasChangedFrom(struct.field,5)
```

Detect Change in Matrix

Returns `true` if the previous value of the matrix `M` was equal to `matrixValue` and any element of `M` has changed value since the last time step or input event.

```
hasChangedFrom(M,matrixValue)
```

Detect Change in Matrix Element

Returns `true` if the element in row 1 and column 3 of the matrix `M` has changed from the value `7` since the last time step or input event.

In charts that use MATLAB as the action language:

```
hasChangedFrom(M(1,3),7)
```

In charts that use C as the action language:

```
hasChangedFrom(M[0][2],7)
```

Tips

- For Stateflow charts in a Simulink model, the action language determines the scope of data that supports change detection:
  - MATLAB as the action language: `Input` only.
  - C as the action language: `Input`, `Output`, `Local`, or `Data Store Memory`.
- Standalone Stateflow charts do not support change detection on an element of a matrix or a field in a structure.
- The `hasChangedFrom` operator returns `false` if the chart writes to the data but does not change the data value.
- If you enable the chart option **Initialize Outputs Every Time Chart Wakes Up**, do not use an output as the argument of the `hasChangedFrom` operator. With this option enabled, the `hasChangedFrom` operator always returns `false`. For more information, see “Initialize Outputs Every Time Chart Wakes Up”.

See Also

hasChanged | hasChangedTo

Topics

“Detect Changes in Data Values”
“Supported Operations for Vectors and Matrices”
“Index and Assign Values to Stateflow Structures”
“Assign Values to All Elements of a Matrix”

Introduced in R2007a

hasChangedTo

Detect change in data to specified value

Syntax

```
tf = hasChangedTo(u,v)
```

Description

`tf = hasChangedTo(u,v)` returns `true` if both of these conditions are true:

- The value of `u` at the beginning of the previous time step was not equal to `v`.
- The value of `u` at the beginning of the current time step is equal to `v`.

If multiple input events occur in the same time step, `hasChangedTo` returns `true` when the value of `u` changes to the value `v` between input events.

The first argument `u` can be:

- A scalar variable.
- A matrix or an element of a matrix. See “Supported Operations for Vectors and Matrices”.
- A structure or a field in a structure. See “Index and Assign Values to Stateflow Structures”.
- Any valid combination of structure fields or matrix indices.

Indices can be numbers or expressions that evaluate to a scalar value.

The second argument `v` can be any expression that resolves to a value that is comparable with `u`:

- If `u` is a scalar, then `v` must resolve to a scalar value.
- If `u` is a matrix, then `v` must resolve to a matrix value with the same dimensions as `u`. The `hasChangedTo` operator returns `true` if any element of `u` has changed value since the last time step or input event and the current value of `u` is equal to `v`.

Alternatively, in a chart that uses C as the action language, `v` can resolve to a scalar value. The chart uses scalar expansion to compare `u` to a matrix whose elements are all equal to the value specified by `v`. See “Assign Values to All Elements of a Matrix”.

- If `u` is a structure, then `v` must resolve to a structure value whose field specification matches `u` exactly. The `hasChangedTo` operator returns `true` if any field of `u` has changed value since the last time step or input event and the current value of `u` is equal to `v`.

The argument `u` cannot be a nontrivial expression or a custom code variable.

Examples

Detect Change in Structure

Returns `true` if any field of `struct` has changed value since the last time step or input event and the current value of the structure `struct` is equal to `structValue`.

```
hasChangedTo(struct,structValue)
```

Detect Change in Structure Field

Returns `true` if the structure field `struct.field` has changed to the value `5` since the last time step or input event.

```
hasChangedTo(struct.field,5)
```

Detect Change in Matrix

Returns `true` if any element of `M` has changed value since the last time step or input event and the current value of the matrix `M` is equal to `matrixValue`.

```
hasChangedTo(M,matrixValue)
```

Detect Change in Matrix Element

Returns `true` if the element in row 1 and column 3 of the matrix `M` has changed to the value `7` since the last time step or input event.

In charts that use MATLAB as the action language:

```
hasChangedTo(M(1,3),7)
```

In charts that use C as the action language:

```
hasChangedTo(M[0][2],7)
```

Tips

- For Stateflow charts in a Simulink model, the action language determines the scope of data that supports change detection:
  - MATLAB as the action language: `Input` only.
  - C as the action language: `Input`, `Output`, `Local`, or `Data Store Memory`.
- Standalone Stateflow charts do not support change detection on an element of a matrix or a field in a structure.
- The `hasChangedTo` operator returns `false` if the chart writes to the data but does not change the data value.
- If you enable the chart option **Initialize Outputs Every Time Chart Wakes Up**, do not use an output as the argument of the `hasChangedTo` operator. With this option enabled, the `hasChangedTo` operator always returns `false`. For more information, see “Initialize Outputs Every Time Chart Wakes Up”.

See Also

hasChanged | hasChangedFrom

Topics

“Detect Changes in Data Values”
“Supported Operations for Vectors and Matrices”
“Index and Assign Values to Stateflow Structures”
“Assign Values to All Elements of a Matrix”

Introduced in R2007a

isvalid

Determine if message is valid

Syntax

```
isvalid(message_name)
```

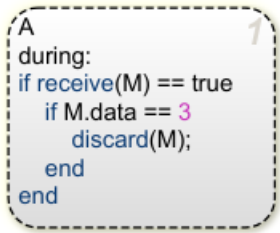
Description

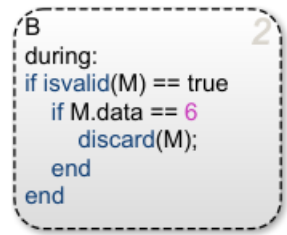
`isvalid(message_name)` checks if an input or local message is valid. A message is valid if the chart has removed it from the queue and has not forwarded or discarded it.

Examples

Check Message in State Action

When state `A` is active, receive message `M`. If the message has a data value equal to 3, discard the message. Then, when state `B` is active, check that the message `M` is still valid. If the message is valid and has a data value equal to 6, discard the message.





See Also

discard | forward | receive

Topics

“Control Message Activity in Stateflow Charts”

Introduced in R2018b

length

Determine length of message queue

Syntax

```
length(message_name)
```

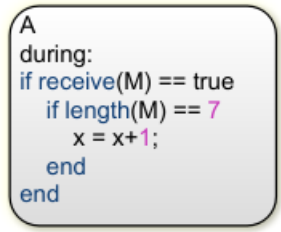
Description

`length(message_name)` checks the number of messages in the internal receiving queue of an input or local message.

Examples

Check Queue Length in State Action

Check the queue for message `M`. If a message is present, remove it from the queue. If exactly seven messages remain in the queue, increment the value of `x`.



Tips

- The `length` operator is not supported for input messages that use external receiving queues. To use the `length` operator, enable the 'Use internal message queue' property for this message.

See Also

receive

Topics

“Control Message Activity in Stateflow Charts”

Introduced in R2018b

receive

Extract message from queue

Syntax

```
receive(message_name)
```

Description

`receive(message_name)` extracts an input or local message from its receiving queue. If a valid message exists, `receive` returns `true`. If a valid message does not exist but there is a message in the queue, the chart removes the message from the queue and `receive` returns `true`. If a valid message does not exist and there are no messages in the queue, `receive` returns `false`.

Examples

Extract Message in State Action

Check the queue for message `M` and increment the value of `x` if both of these conditions are true:

- A message is present in the queue.
- The data value of the message is equal to 3.

If a message is not present or if the data value is not equal to 3, then the value of `x` does not change. If a message is present, remove it from the queue regardless of the data value.

See Also

send

Topics

“Control Message Activity in Stateflow Charts”

Introduced in R2018b

send

Broadcast message or event

Syntax

```
send(message_name)
send(output_event_name)
send(local_event_name,state_name)
send(state_name.local_event_name)
```

Description

`send(message_name)` sends a local or output message.

`send(output_event_name)` sends an output event.

`send(local_event_name,state_name)` broadcasts a local event to `state_name` and any offspring of that state in the hierarchy.

`send(state_name.local_event_name)` broadcasts a local event to its parent state `state_name` and any offspring of that state in the hierarchy.

Examples

Broadcast Message

Send a local or output message `M` with a data value of `3`.

```
M.data = 3;
send(M);
```

Broadcast Output Event

Send an output event `e`.

```
send(e);
```

Broadcast Directed Local Event

Send a local event `e` to state `A.A1` and any of its substates.

```
send(e,A.A1);
```

Broadcast by Using Qualified Event Name

Send a local event `e` to its parent state `A` and any of its substates.

```
send(A.e);
```

Tips

- If a chart sends a message that exceeds the capacity of the receiving queue, a queue overflow occurs. The result of the queue overflow depends on the type of receiving queue.
  - When an overflow occurs in an internal queue, the Stateflow chart drops the new message. You can control the level of diagnostic action by setting the **Queue Overflow Diagnostic** property for the message. See “Queue Overflow Diagnostic”.
  - When an overflow occurs in an external queue, the Queue block either drops the new message or overwrites the oldest message in the queue, depending on the configuration of the block. See “Overwrite the oldest element if queue is full” (Simulink). An overflow in an external queue always results in a warning.

See Also

receive

Topics

“Control Message Activity in Stateflow Charts”
“Activate a Simulink Block by Sending Output Events”
“Broadcast Local Events to Synchronize Parallel States”

Introduced in R2018b

str2ascii

Convert string to array of type `uint8`

Syntax

```
A = str2ascii(str,n)
```

Description

`A = str2ascii(str,n)` returns array of type `uint8` containing ASCII values for the first `n` characters in `str`, where `n` is a positive integer.

Use of variables or expressions for `n` is not supported.

Examples

String to ASCII Values

Return `uint8` array `{-72,101,108,108,111}`.

```
A = str2ascii("Hello",5);
```

Tips

- Use in Stateflow charts that use C as the action language.
- Enclose literal strings with single or double quotes.

See Also

ascii2str

Topics

“Manage Textual Information by Using Strings”
“Share String Data with Custom C Code”

Introduced in R2018a

str2double

Convert string to double precision value

Syntax

```
X = str2double(str)
```

Description

`X = str2double(str)` converts the text in string `str` to a double-precision value.

`str` contains text that represents a number. Text that represents a number can contain:

- Digits
- A decimal point
- A leading `+` or `-` sign
- An `e` preceding a power of 10 scale factor

If `str2double` cannot convert text to a number, then it returns a `NaN` value.

Examples

String Containing Decimal Notation

Return a value of `-12.345`.

```
X = srt2double("-12.345");
```

String Containing Exponential Notation

Return a value of `123400`.

```
X = srt2double("1.234e5");
```

Tips

- Use in Stateflow charts that use C as the action language.
- Enclose literal strings with single or double quotes.

See Also

tostring

Topics

“Manage Textual Information by Using Strings”

Introduced in R2018a

strcat

Concatenate strings

Syntax

```
dest = strcat(s1,...,sN)
```

Description

`dest = strcat(s1,...,sN)` concatenates strings `s1,...,sN`.

Examples

Concatenation of Strings

Concatenate strings to form `"Stateflow"`.

```
s1 = "State";
s2 = "flow";
dest = strcat(s1,s2)
```

Tips

- Use in Stateflow charts that use C as the action language.
- Enclose literal strings with single or double quotes.

See Also

strcpy | substr

Topics

“Manage Textual Information by Using Strings”

Introduced in R2018b

strcmp

Compare strings

Syntax

```
tf = strcmp(s1,s2)
s1 == s2
s1 != s2
tf = strcmp(s1,s2,n)
```

Description

`tf = strcmp(s1,s2)` compares strings `s1` and `s2`. Returns `0` if the two strings are identical. Otherwise returns a nonzero integer.

- The sign of the output value depends on the lexicographic ordering of the input strings `s1` and `s2`.
- The magnitude of the output value depends on the compiler that you use. This value can differ in simulation and generated code.

Strings are considered identical when they have the same size and content.

This operator is consistent with the C library function `strcmp` or the C++ function `string.compare`, depending on the compiler that you select for code generation. The operator behaves differently than the function `strcmp` in MATLAB.

`s1 == s2` is an alternative way to execute `strcmp(s1,s2) == 0`.

`s1 != s2` is an alternative way to execute `strcmp(s1,s2) != 0`.

`tf = strcmp(s1,s2,n)` returns `0` if the first `n` characters in `s1` and `s2` are identical.

Examples

Comparison by Using `strcmp`

Return a value of `0` (strings are equal).

```
tf = strcmp("abc","abc");
```

Return a nonzero value (strings are not equal).

```
tf = strcmp("abc","abcd");
```

Comparison by Using `==`

Return a value of `true`.

```
"abc" == "abc";
```

Comparison by Using `!=`

Return a value of `true`.

```
"abc" != "abcd";
```

Comparison of Substrings

Return a value of `0` (substrings are equal).

```
tf = strcmp("abc","abcd",3);
```

Tips

- Use in Stateflow charts that use C as the action language.
- Enclose literal strings with single or double quotes.

See Also

substr

Topics

“Manage Textual Information by Using Strings”

Introduced in R2018b

strcpy

Assign string value

Syntax

```
dest = src
strcpy(dest,src)
```

Description

`dest = src` assigns string `src` to `dest`.

`strcpy(dest,src)` is an alternative way to execute `dest = src`.

Examples

Assignment by Using =

Assign string data to `s1` and `s2`.

```
s1 = 'hello';
s2 = "good bye";
```

Assignment by Using strcpy

Assign string data to `s3` and `s4`.

```
strcpy(s3,'howdy');
strcpy(s4,"so long");
```

Tips

- Use in Stateflow charts that use C as the action language.
- Source and destination strings must refer to different symbols.
- Enclose literal strings with single or double quotes.

See Also

Topics

“Manage Textual Information by Using Strings”

Introduced in R2018b

strlen

Determine length of string

Syntax

```
L = strlen(str)
```

Description

`L = strlen(str)` returns the number of characters in the string `str`.

Examples

Number of Characters in String

Return a value of 9.

```
L = strlen("Stateflow");
```

Tips

- Use in Stateflow charts that use C as the action language.
- Enclose literal strings with single or double quotes.

See Also

Topics

“Manage Textual Information by Using Strings”

Introduced in R2018b

substr

Extract substring from string

Syntax

```
dest = substr(str,i,n)
```

Description

`dest = substr(str,i,n)` returns the substring of length `n` starting at the `i`-th character of string `str`. Use zero-based indexing.

Examples

Extract Substring

Extract substring `"Stateflow"` from a longer string.

```
str = "Stateflow rule the waves";
dest = substr(str,0,9);
```

Tips

- Use in Stateflow charts that use C as the action language.
- Use zero-based indexing.
- Enclose literal strings with single or double quotes.

See Also

strcat | strcpy | strlen

Topics

“Manage Textual Information by Using Strings”

Introduced in R2018b

temporalCount

Control chart execution with the `temporalCount` operator

Syntax

```
temporalCount(E)
temporalCount(time_unit)
```

Description

`temporalCount(E)` increments by 1 and returns a positive integer value for each occurrence of the base event `E` that takes place after activation of the associated state. Otherwise, the operator returns a value of 0.

In a chart with no input events, `temporalCount(tick)` returns the number of times that the chart has woken up since activation of the associated state.

The `temporalCount` operator resets the counter for `E` to 0 each time the associated state reactivates.

`temporalCount(time_unit)` counts and returns the number of units of time that have elapsed since activation of the associated state. Specify `time_unit` as seconds (`sec`), milliseconds (`msec`), or microseconds (`usec`).

The `temporalCount` operator resets the counter for `sec`, `msec` and `usec` to 0 each time the associated state reactivates.

Examples

State Action (`during`)

This action counts and returns the integer number of ticks that have elapsed since activation of the state. Then, the action assigns to the variable `y` the value of the `mm` array whose index is the value that the `temporalCount` operator returns.

```
du: y = mm[temporalCount(tick)];
```

State Action (`exit`)

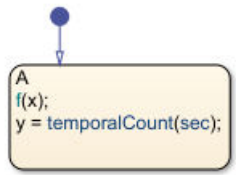
This action counts and returns the number of seconds that pass between activation and deactivation of the state.

```
ex: y = temporalCount(sec);
```

Tips

- You can use quotation marks to enclose the keywords `'tick'`, `'sec'`, `'msec'`, and `'usec'`. For example, `temporalCount('tick')` is equivalent to `temporalCount(tick)`.
- The timing for absolute-time temporal logic operators depends on the type of Stateflow chart:
  - Charts in a Simulink model define temporal logic in terms of simulation time.
  - Standalone charts in MATLAB define temporal logic in terms of wall-clock time.

  The difference in timing can affect the behavior of a chart. For example, suppose that this chart is executing the `entry` action of state `A`.



  - In a Simulink model, the function call to `f` executes in a single time step and does not contribute to the simulation time. After calling the function `f`, the chart assigns a value of zero to `y`.
  - In a standalone chart, the function call to `f` can take several seconds of wall-clock time to complete. After calling the function `f`, the chart assigns the nonzero time that has elapsed since state `A` became active to `y`.

See Also

count | duration | elapsed

Topics

“Control Chart Execution by Using Temporal Logic”

Introduced in R2008a

tostring

Convert numeric value to string

Syntax

```
dest = tostring(X)
```

Description

`dest = tostring(X)` converts numeric, Boolean, or enumerated data `X` to a string.

Examples

Numeric Value to String

Convert numeric value to string `"1.2345"`.

```
dest = tostring(1.2345);
```

Boolean Value to String

Convert Boolean value to string `"true"`.

```
dest = tostring(1==1);
```

Enumerated Value to String

Convert enumerated value to string `"RED"`.

```
dest = tostring(RED);
```

Tips

- Use in Stateflow charts that use C as the action language.

See Also

str2double | strcpy

Topics

“Manage Textual Information by Using Strings”

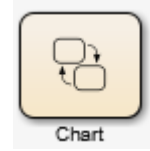
Introduced in R2018b

3

Block Reference

Chart

Implement control logic with finite state machine
Library: Stateflow



Description

A *finite state machine* is a representation of an event-driven (reactive) system. In an event-driven system, the system responds to an event by making a transition from one state (mode) to another. This transition occurs if the condition defining the change is true.

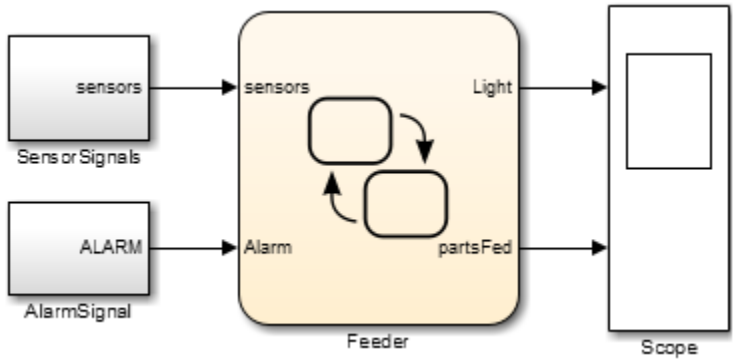
A Stateflow chart is a graphical representation of a finite state machine. *States* and *transitions* form the basic elements of the system. You can also represent stateless flow charts.

For example, you can use Stateflow charts to control a physical plant in response to events such as a temperature and pressure sensors, clocks, and user-driven events.

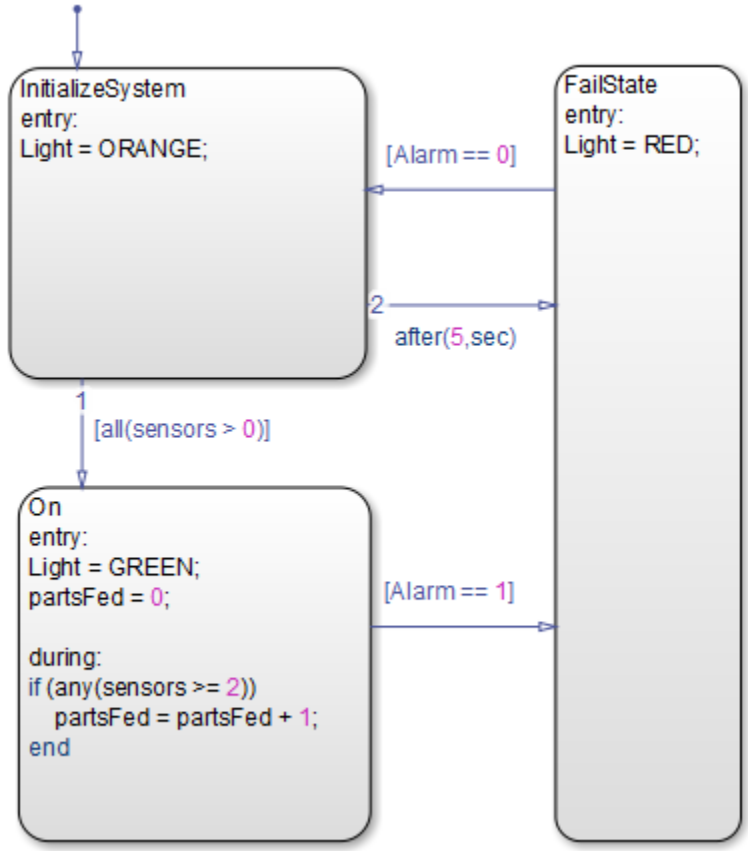
You can also use a state machine to represent the automatic transmission of a car. The transmission has these operating states: park, reverse, neutral, drive, and low. As the driver shifts from one position to another, the system makes a transition from one state to another, for example, from park to reverse.

A Stateflow chart can use MATLAB or C as the action language to implement control logic.

This block diagram represents a machine on an assembly line that feeds raw material to other parts of the line. It contains a chart, `Feeder`, with MATLAB as the action language.



To open the chart, double-click the `Feeder` block in the model.



For a tutorial on this model, see “Model an Assembly Line Feeder”.

Ports

Input

`Port_1` — Input port
scalar | vector | matrix

When you create input data in the Symbols window, Stateflow creates input ports. The input data that you create has a corresponding input port that appears once you create data.

Data Types: `single` | `double` | `int8` | `int16` | `int32` | `uint8` | `uint16` | `uint32` | `Boolean` | `fixed point` | `enumerated` | `bus`

Output

`Port_1` — Output port

scalar | vector | matrix

When you create output data in the Symbols window, Stateflow creates output ports. The output data that you create has a corresponding output port that appears once you create data.

Data Types: `single` | `double` | `int8` | `int16` | `int32` | `uint8` | `uint16` | `uint32` | `Boolean` | `fixed point` | `enumerated` | `bus`

Parameters

Parameters on the Code Generation tab require Simulink Coder™ or Embedded Coder®.

Main

`Show port labels` — Select how to display port labels

`FromPortIcon` (default) | `FromPortBlockName` | `SignalName`

Select how to display port labels on the Chart block icon.

`none`

Do not display port labels.

`FromPortIcon`

If the corresponding port icon displays a signal name, display the signal name on the Chart block. Otherwise, display the port block name.

`FromPortBlockName`

Display the name of the corresponding port block on the Chart block.

`SignalName`

If a signal name exists, display the name of the signal connected to the port on the Chart block. Otherwise, display the name of the corresponding port block.

Programmatic Use
Parameter: `ShowPortLabels`
Type: character vector
Value: `'FromPortIcon'` | `'FromPortBlockName'` | `'SignalName'`
Default: `'FromPortIcon'`

`Read/Write permissions` — Select access to contents of chart

`ReadWrite` (default) | `ReadOnly` | `NoReadOrWrite`

Control user access to the contents of the chart.

`ReadWrite`

Enable opening and modification of chart contents.

`ReadOnly`

Enable opening but not modification of the chart. If the chart resides in a block library, you can create and open links to the chart and can make and modify local copies of the chart but you cannot change the permissions or modify the contents of the original library instance.

`NoReadOrWrite`

Disable opening or modification of chart. If the chart resides in a library, you can create links to the chart in a model but you cannot open, modify, change permissions, or create local copies of the chart.

Programmatic Use
Parameter: `Permissions`
Type: character vector
Value: `'ReadWrite'` | `'ReadOnly'` | `'NoReadOrWrite'`
Default: `'ReadWrite'`

`Treat as atomic unit` — Control execution of a subsystem as one unit

off (default) | on

When determining the execution order of block methods, causes Simulink to treat the chart as a unit.

off

When determining block method execution order, treat all blocks in the chart as being at the same level in the model hierarchy as the chart. This hierarchy treatment can cause the execution of methods of blocks in the chart to be interleaved with the execution of methods of blocks outside the chart.

on

When determining the execution order of block methods, treat the chart as a unit. For example, when Simulink needs to compute the output of the chart, Simulink invokes the output methods of all the blocks in the chart before invoking the output methods of other blocks at the same level as the chart block.

Dependency

If you select this parameter, you enable the **Minimize algebraic loop occurrences**, **Sample time**, and **Function packaging** parameters. **Function packaging** requires the Simulink Coder software.

Programmatic Use

Parameter: `TreatAsAtomicUnit`
Type: character vector
Value: `'off'` | `'on'`
Default: `'off'`

See also

- “Generate Reusable Code for Atomic Subcharts”

`Minimize algebraic loop occurrences` — Control elimination of algebraic loops

off (default) | on

off

Do not try to eliminate any artificial algebraic loops that include the atomic subchart.

on

Try to eliminate any artificial algebraic loops that include the atomic subchart.

Dependency

To enable this parameter, select the **Treat as atomic unit** parameter.

Programmatic Use
Parameter: `MinAlgLoopOccurrences`
Type: character vector
Value: `'off'` | `'on'`
Default: `'off'`

`Sample time` — Specify time interval

`-1` (default) | `[Ts 0]`

Specify whether all blocks in this chart must run at the same rate or can run at different rates.

- If the blocks in the chart can run at different rates, specify the chart 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 **Sample time** parameter.
- If any of the blocks in the chart specify a different sample time (other than `-1` or `inf`), Simulink displays an error message when you update or simulate the model. For example, suppose all the blocks in the chart must run `5` times a second. To ensure this time, specify the sample time of the chart as `0.2`. In this example, if any of the blocks in the chart specify a sample time other than `0.2`, `-1`, or `inf`, Simulink displays an error when you update or simulate the model.

`-1`

Specify inherited sample time. If the blocks in the chart can run at different rates, use this sample time.

`[Ts 0]`

Specify periodic sample time.

Dependency

To enable this parameter, select the **Treat as atomic unit** parameter.

Programmatic Use
Parameter: `SystemSampleTime`
Type: character vector
Value: `'-1'` | `'[Ts 0]'`
Default: `'-1'`

`Treat as grouped when propagating variant conditions` — Control treating subsystem as unit

`on` (default) | `off`

When propagating variant conditions from Variant Source blocks or to Variant Sink blocks, causes Simulink to treat the chart as a unit.

 on

Simulink treats the chart as a unit when propagating variant conditions from Variant Source blocks or to Variant Sink blocks. For example, when Simulink computes the variant condition of the chart, it propagates that condition to all the blocks in the chart.

 off

Simulink treats all blocks in the chart as being at the same level in the model hierarchy as the chart itself when determining their variant condition.

Programmatic Use
Parameter: `TreatAsGroupedWhenPropagatingVariantConditions`
Type: character vector
Value: `'on'` | `'off'`
Default: `'on'`

Code Generation

`Function packaging` — Select code format

`Auto` (default) | `Inline` | `Nonreusable function` | `Reusable function`

Select the generated code format for an atomic (nonvirtual) subchart.

`Auto`

Simulink Coder chooses the optimal format for your system based on the type and number of instances of the chart that exist in the model.

`Inline`

Simulink Coder inlines the chart unconditionally.

`Nonreusable function`

Simulink Coder explicitly generates a separate function in a separate file. Charts with this setting generate functions that might have arguments depending on the

"Function interface" (Simulink) parameter setting. You can name the generated function and file using parameters "Function name" (Simulink) and "File name (no extension)" (Simulink). These functions are not reentrant.

`Reusable function`

Simulink Coder generates a function with arguments that allows reuse of chart code when a model includes multiple instances of the chart.

This option generates a function with arguments that allows chart code to be reused in the generated code of a model reference hierarchy that includes multiple instances of a chart across referenced models. In this case, the chart must be in a library.

Tips

- When you want multiple instances of a chart represented as one reusable function, you can designate each one of them as `Auto` or as `Reusable function`. It is best to use one because using both creates two reusable functions, one for each designation. The outcomes of these choices differ only when reuse is not possible. Selecting `Auto` does not allow for control of the function or file name for the chart code.
- The `Reusable function` and `Auto` options both determine whether multiple instances of a chart exist and the code can be reused. The options behave differently when it is impossible to reuse the code. In this case, `Auto` yields inlined code, or if circumstances prohibit inlining, separate functions for each chart instance.
- If you select the `Reusable function` while your generated code is under source control, set **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.

Dependency

- This parameter requires Simulink Coder.
- To enable this parameter, select **Treat as atomic unit**.
- Setting this parameter to `Nonreusable function` or `Reusable function` enables the following parameters:
  - **Function name options**
  - **File name options**
  - Memory section for initialize/terminate functions (requires Embedded Coder and an ERT-based system target file)

    - Memory section for execution functions (requires Embedded Coder and an ERT-based system target file)
- Setting this parameter to `Nonreusable function` enables **Function with separate data** (requires a license for Embedded Coder and an ERT-based system target file).

Programmatic Use
Parameter: `RTWSystemCode`
Type: character vector
Value: `'Auto'` | `'Inline'` | `'Nonreusable function'` | `'Reusable function'`
Default: `'Auto'`

Extended Capabilities

C/C++ Code Generation

Generate C and C++ code using Simulink® Coder™.

HDL Code Generation

Generate Verilog and VHDL code for FPGA and ASIC designs using HDL Coder™.

HDL Coder™ provides additional configuration options that affect HDL implementation and synthesized logic.

HDL Architecture

This block has a single, default HDL architecture.

Active State Output

To generate an output port in the HDL code that shows the active state, select **Create output port for monitoring** in the Properties window of the chart. The output is an enumerated data type. See “Simplify Stateflow Charts by Incorporating Active State Output”.

Registered Output

To insert an output register that delays the chart output by a simulation cycle, use the OutputPipeline (HDL Coder) block property.

HDL Block Properties

ConstMultiplierOptimization	Canonical signed digit (CSD) or factored CSD optimization. The default is `none`. See also “ConstMultiplierOptimization” (HDL Coder).
ConstrainedOutputPipeline	Number of registers to place at the outputs by moving existing delays within your design. Distributed pipelining does not redistribute these registers. The default is `0`. For more details, see “ConstrainedOutputPipeline” (HDL Coder).
DistributedPipelining	Pipeline register distribution, or register retiming. The default is `off`. See also “DistributedPipelining” (HDL Coder).
InputPipeline	Number of input pipeline stages to insert in the generated code. Distributed pipelining and constrained output pipelining can move these registers. The default is `0`. For more details, see “InputPipeline” (HDL Coder).
InstantiateFunctions	Generate a VHDL® `entity` or Verilog® `module` for each function. The default is `off`. See also “InstantiateFunctions” (HDL Coder).
LoopOptimization	Unroll, stream, or do not optimize loops. The default is `none`. See also “LoopOptimization” (HDL Coder).
MapPersistentVarsToRAM	Map persistent arrays to RAM. The default is `off`. See also “MapPersistentVarsToRAM” (HDL Coder).
OutputPipeline	Number of output pipeline stages to insert in the generated code. Distributed pipelining and constrained output pipelining can move these registers. The default is `0`. For more details, see “OutputPipeline” (HDL Coder).
ResetType	Suppress reset logic generation. The default is `default`, which generates reset logic. See also “ResetType” (HDL Coder).
SharingFactor	Number of functionally equivalent resources to map to a single shared resource. The default is 0. See also “Resource Sharing” (HDL Coder).
UseMatrixTypesInHDL	Generate 2-D matrices in HDL code. The default is `off`. See also “UseMatrixTypesInHDL” (HDL Coder).

VariablesToPipeline	**Warning** `VariablesToPipeline` is not recommended. Use `coder.hdl.pipeline` instead. Insert a pipeline register at the output of the specified MATLAB variable or variables. Specify the list of variables as a character vector, with spaces separating the variables.

Complex Data Support

This block supports code generation for complex signals.

Restrictions

To learn about restrictions of using charts, see “Introduction to Stateflow HDL Code Generation” (HDL Coder).

PLC Code Generation

Generate Structured Text code using Simulink® PLC Coder™.

Fixed-Point Conversion

Design and simulate fixed-point systems using Fixed-Point Designer™.

See Also

Introduced in R2013b

Sequence Viewer

Display messages, events, states, transitions, and functions between blocks during simulation

Library: Simulink / Messages & Events
Simulink Test
SimEvents
Stateflow

Description

The Sequence Viewer block displays messages, events, states, transitions, and functions between certain blocks during simulation. The blocks that you can display are called lifeline blocks and include:

- Subsystems
- Referenced models
- Blocks that contain messages, such as Stateflow charts
- Blocks that call functions or generate events, such as Function Caller, Function-Call Generator, and MATLAB Function blocks
- Blocks that contain functions, such as Function-Call Subsystem and Simulink Function blocks

To see states, transitions, and events for lifeline blocks in a referenced model, you must have a Sequence Viewer block in the referenced model. Without a Sequence Viewer block in the referenced model, you can see only messages and functions for lifeline blocks in the referenced model.

Parameters

`Time Precision for Variable Step` — Adjust time increment precision
3 (default)

When using a variable step solver, change this parameter to adjust the time precision for the sequence viewer.

Programmatic Use
Block Parameter: `VariableStepTimePrecision`
Type: character vector
Values: `'3'` | scalar
Default: `'3'`

`History` — Maximum number of events to keep in viewer
5000 (default)

Programmatic Use
Block Parameter: `History`
Type: character vector
Values: `'1000'` | scalar
Default: `'1000'`

Block Characteristics

Data Types	`Boolean` | `bus` | `double` | `enumerated` | `fixed point` | `integer` | `single`
Direct Feedthrough	`no`
Multidimensional Signals	`yes`
Variable-Size Signals	`no`
Zero-Crossing Detection	`no`

Extended Capabilities

C/C++ Code Generation
Generate C and C++ code using Simulink® Coder™.

This block can be used for visualizing message transitions during simulation, but is not included in the generated code.

HDL Code Generation

Generate Verilog and VHDL code for FPGA and ASIC designs using HDL Coder™.

This block displays messages during simulation when used in subsystems that generate HDL code, but it is not included in the hardware implementation.

See Also

“Use the Sequence Viewer Block to Visualize Messages, Events, and Entities” (SimEvents)

Introduced in R2015b

State Transition Table

Represent modal logic in tabular format
Library: Stateflow

Description

When you want to represent modal logic in tabular format, use this block. The State Transition Table block uses only MATLAB as the action language.

Using the State Transition Table Editor, you can:

- Add states and enter state actions.
- Add hierarchy among your states.
- Enter conditions and actions for state-to-state transitions.
- Specify default transitions, inner transitions, and self-loop transitions.
- Add input or output data and events.
- Set breakpoints for debugging.
- Run diagnostics to detect parser errors.
- View automatically generated content as you edit the table.

For more information about the State Transition Table Editor, see “State Transition Table Operations”.

Ports

Input

`Port_1` — Input port
scalar | vector | matrix

When you create input data in the Symbols window, Stateflow creates input ports. The input data that you create has a corresponding input port that appears once you create data.

Data Types: `single` | `double` | `int8` | `int16` | `int32` | `uint8` | `uint16` | `uint32` | `Boolean` | `fixed point` | `enumerated` | `bus`

Output

`Port_1` — Output port
scalar | vector | matrix

When you create output data in the Symbols window, Stateflow creates output ports. The output data that you create has a corresponding output port that appears once you create data.

Data Types: `single` | `double` | `int8` | `int16` | `int32` | `uint8` | `uint16` | `uint32` | `Boolean` | `fixed point` | `enumerated` | `bus`

Parameters

Parameters on the Code Generation tab require Simulink Coder or Embedded Coder.

Main

`Show port labels` — Select how to display port labels
`FromPortIcon` (default) | `FromPortBlockName` | `SignalName`

Select how to display port labels on the Chart block icon.

`none`

Do not display port labels.

`FromPortIcon`

If the corresponding port icon displays a signal name, display the signal name on the Chart block. Otherwise, display the port block name.

`FromPortBlockName`

Display the name of the corresponding port block on the Chart block.

`SignalName`

If a signal name exists, display the name of the signal connected to the port on the Chart block. Otherwise, display the name of the corresponding port block.

Programmatic Use
Parameter: `ShowPortLabels`
Type: character vector
Value: `'FromPortIcon'` | `'FromPortBlockName'` | `'SignalName'`
Default: `'FromPortIcon'`

`Read/Write permissions` — Select access to contents of chart

`ReadWrite` (default) | `ReadOnly` | `NoReadOrWrite`

Control user access to the contents of the chart.

`ReadWrite`

Enable opening and modification of chart contents.

`ReadOnly`

Enable opening but not modification of the chart. If the chart resides in a block library, you can create and open links to the chart and can make and modify local copies of the chart but you cannot change the permissions or modify the contents of the original library instance.

`NoReadOrWrite`

Disable opening or modification of chart. If the chart resides in a library, you can create links to the chart in a model but you cannot open, modify, change permissions, or create local copies of the chart.

Programmatic Use
Parameter: `Permissions`
Type: character vector
Value: `'ReadWrite'` | `'ReadOnly'` | `'NoReadOrWrite'`
Default: `'ReadWrite'`

`Treat as atomic unit` — Control execution of a subsystem as one unit

off (default) | on

When determining the execution order of block methods, causes Simulink to treat the chart as a unit.

off

When determining block method execution order, treat all blocks in the chart as being at the same level in the model hierarchy as the chart. This hierarchy treatment can cause the execution of methods of blocks in the chart to be interleaved with the execution of methods of blocks outside the chart.

on

When determining the execution order of block methods, treat the chart as a unit. For example, when Simulink needs to compute the output of the chart, Simulink invokes the output methods of all the blocks in the chart before invoking the output methods of other blocks at the same level as the chart block.

Dependency

If you select this parameter, you enable the **Minimize algebraic loop occurrences**, **Sample time**, and **Function packaging** parameters. **Function packaging** requires the Simulink Coder software.

Programmatic Use

Parameter: `TreatAsAtomicUnit`
Type: character vector
Value: `'off'` | `'on'`
Default: `'off'`

See also

- “Generate Reusable Code for Atomic Subcharts”

`Minimize algebraic loop occurrences` — Control elimination of algebraic loops

off (default) | on

off

Do not try to eliminate any artificial algebraic loops that include the atomic subchart.

on

Try to eliminate any artificial algebraic loops that include the atomic subchart.

Dependency

To enable this parameter, select the **Treat as atomic unit** parameter.

Programmatic Use

Parameter: `MinAlgLoopOccurrences`
Type: character vector
Value: `'off'` | `'on'`
Default: `'off'`

`Sample time` — Specify time interval

`-1` (default) | `[Ts 0]`

Specify whether all blocks in this chart must run at the same rate or can run at different rates.

- If the blocks in the chart can run at different rates, specify the chart 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 **Sample time** parameter.
- If any of the blocks in the chart specify a different sample time (other than `-1` or `inf`), Simulink displays an error message when you update or simulate the model. For example, suppose all the blocks in the chart must run `5` times a second. To ensure this time, specify the sample time of the chart as `0.2`. In this example, if any of the blocks in the chart specify a sample time other than `0.2`, `-1`, or `inf`, Simulink displays an error when you update or simulate the model.

`-1`

Specify inherited sample time. If the blocks in the chart can run at different rates, use this sample time.

`[Ts 0]`

Specify periodic sample time.

Dependency

To enable this parameter, select the **Treat as atomic unit** parameter.

Programmatic Use

Parameter: `SystemSampleTime`
Type: character vector
Value: `'-1'` | `'[Ts 0]'`
Default: `'-1'`

`Treat as grouped when propagating variant conditions` — Control treating subsystem as unit
`on` (default) | `off`

When propagating variant conditions from Variant Source blocks or to Variant Sink blocks, causes Simulink to treat the chart as a unit.

 on

Simulink treats the chart as a unit when propagating variant conditions from Variant Source blocks or to Variant Sink blocks. For example, when Simulink computes the variant condition of the chart, it propagates that condition to all the blocks in the chart.

 off

Simulink treats all blocks in the chart as being at the same level in the model hierarchy as the chart itself when determining their variant condition.

Programmatic Use
Parameter: `TreatAsGroupedWhenPropagatingVariantConditions`
Type: character vector
Value: `'on'` | `'off'`
Default: `'on'`

Code Generation

`Function packaging` — Select code format
`Auto` (default) | `Inline` | `Nonreusable function` | `Reusable function`

Select the generated code format for an atomic (nonvirtual) subchart.

`Auto`

Simulink Coder chooses the optimal format for your system based on the type and number of instances of the chart that exist in the model.

`Inline`

Simulink Coder inlines the chart unconditionally.

`Nonreusable function`

Simulink Coder explicitly generates a separate function in a separate file. Charts with this setting generate functions that might have arguments depending on the

"Function interface" (Simulink) parameter setting. You can name the generated function and file using parameters "Function name" (Simulink) and "File name (no extension)" (Simulink). These functions are not reentrant.

`Reusable function`

Simulink Coder generates a function with arguments that allows reuse of chart code when a model includes multiple instances of the chart.

This option generates a function with arguments that allows chart code to be reused in the generated code of a model reference hierarchy that includes multiple instances of a chart across referenced models. In this case, the chart must be in a library.

Tips

- When you want multiple instances of a chart represented as one reusable function, you can designate each one of them as `Auto` or as `Reusable function`. It is best to use one because using both creates two reusable functions, one for each designation. The outcomes of these choices differ only when reuse is not possible. Selecting `Auto` does not allow for control of the function or file name for the chart code.
- The `Reusable function` and `Auto` options both try to determine if multiple instances of a chart exist and if the code can be reused. The difference between the options' behavior is that when reuse is not possible. In this case, `Auto` yields inlined code, or if circumstances prohibit inlining, separate functions for each chart instance.
- If you select the `Reusable function` while your generated code is under source control, set **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.

Dependency

- This parameter requires Simulink Coder.
- To enable this parameter, select **Treat as atomic unit**.
- Setting this parameter to `Nonreusable function` or `Reusable function` enables the following parameters:
  - **Function name options**
  - **File name options**
  - Memory section for initialize/terminate functions (requires Embedded Coder and an ERT-based system target file)

- Memory section for execution functions (requires Embedded Coder and an ERT-based system target file)

- Setting this parameter to `Nonreusable function` enables **Function with separate data** (requires a license for Embedded Coder and an ERT-based system target file).

Programmatic Use
Parameter: `RTWSystemCode`
Type: character vector
Value: `'Auto'` | `'Inline'` | `'Nonreusable function'` | `'Reusable function'`
Default: `'Auto'`

Extended Capabilities

C/C++ Code Generation

Generate C and C++ code using Simulink® Coder™.

HDL Code Generation

Generate Verilog and VHDL code for FPGA and ASIC designs using HDL Coder™.

HDL Coder provides additional configuration options that affect HDL implementation and synthesized logic.

Tunable Parameters

You can use a tunable parameter in a State Transition Table intended for HDL code generation. For details, see “Generate DUT Ports for Tunable Parameters” (HDL Coder).

HDL Architecture

This block has a single, default HDL architecture.

Active State Output

To generate an output port in the HDL code that shows the active state, select **Create output port for monitoring** in the Properties window of the chart. The output is an enumerated data type. See “Simplify Stateflow Charts by Incorporating Active State Output”.

HDL Block Properties

ConstMultiplierOptimization	Canonical signed digit (CSD) or factored CSD optimization. The default is `none`. See also “ConstMultiplierOptimization” (HDL Coder).
ConstrainedOutputPipeline	Number of registers to place at the outputs by moving existing delays within your design. Distributed pipelining does not redistribute these registers. The default is `0`. For more details, see “ConstrainedOutputPipeline” (HDL Coder).
DistributedPipelining	Pipeline register distribution, or register retiming. The default is `off`. See also “DistributedPipelining” (HDL Coder).
InputPipeline	Number of input pipeline stages to insert in the generated code. Distributed pipelining and constrained output pipelining can move these registers. The default is `0`. For more details, see “InputPipeline” (HDL Coder).
InstantiateFunctions	Generate a VHDL `entity` or Verilog `module` for each function. The default is `off`. See also “InstantiateFunctions” (HDL Coder).
LoopOptimization	Unroll, stream, or do not optimize loops. The default is `none`. See also “LoopOptimization” (HDL Coder).
MapPersistentVarsToRAM	Map persistent arrays to RAM. The default is `off`. See also “MapPersistentVarsToRAM” (HDL Coder).
OutputPipeline	Number of output pipeline stages to insert in the generated code. Distributed pipelining and constrained output pipelining can move these registers. The default is `0`. For more details, see “OutputPipeline” (HDL Coder).
ResetType	Suppress reset logic generation. The default is `default`, which generates reset logic. See also “ResetType” (HDL Coder).
SharingFactor	Number of functionally equivalent resources to map to a single shared resource. The default is 0. See also “Resource Sharing” (HDL Coder).
UseMatrixTypesInHDL	Generate 2-D matrices in HDL code. The default is `off`. See also “UseMatrixTypesInHDL” (HDL Coder).

VariablesToPipeline	**Warning** `VariablesToPipeline` is not recommended. Use `coder.hdl.pipeline` instead. Insert a pipeline register at the output of the specified MATLAB variable or variables. Specify the list of variables as a character vector, with spaces separating the variables.

PLC Code Generation

Generate Structured Text code using Simulink® PLC Coder™.

Fixed-Point Conversion

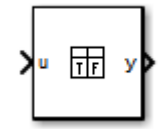
Design and simulate fixed-point systems using Fixed-Point Designer™.

See Also

Introduced in R2012b

Truth Table

Represent logical decision-making behavior with conditions, decisions, and actions
Library: Stateflow



Description

The Truth Table block is a truth table function that uses MATLAB as the action language. When you want to use truth table logic directly in a Simulink model, use this block. This block requires Stateflow.

When you add a Truth Table block directly to a model instead of calling truth table functions from a Stateflow chart, these advantages apply:

- It is a more direct approach than creating a truth table within a Stateflow chart, especially if your model requires only a single truth table.
- You can define truth table inputs and outputs with inherited types and sizes.

The Truth Table block works with a subset of the MATLAB language that is optimized for generating embeddable C code. This block generates content as MATLAB code. As a result, you can take advantage of other tools to debug your Truth Table block during simulation.

If you double-click the Truth Table block, the Truth Table Editor opens to display its conditions, actions, and decisions.

Using the Truth Table Editor, you can:

- Enter and edit conditions, actions, and decisions.
- Add or modify Stateflow data and ports by using the Ports and Data Manager.
- Run diagnostics to detect parser errors.
- View generated content after simulation.

For more information about the Truth Table Editor, see “Truth Table Operations”.

Ports

Input

u — Input port
scalar | vector | matrix

When you create input data in the Symbols window, Stateflow creates input ports. The input data that you create has a corresponding input port that appears once you create data.

Data Types: `single` | `double` | `int8` | `int16` | `int32` | `uint8` | `uint16` | `uint32` | `Boolean` | `fixed point` | `enumerated` | `bus`

Output

y — Output port
scalar | vector | matrix

When you create output data in the Symbols window, Stateflow creates output ports. The output data that you create has a corresponding output port that appears once you create data.

Data Types: `single` | `double` | `int8` | `int16` | `int32` | `uint8` | `uint16` | `uint32` | `Boolean` | `fixed point` | `enumerated` | `bus`

Parameters

Parameters on the Code Generation tab require Simulink Coder or Embedded Coder.

Main

`Show port labels` — Select how to display port labels
`FromPortIcon` (default) | `FromPortBlockName` | `SignalName`

Select how to display port labels on the Chart block icon.

`none`

Do not display port labels.

`FromPortIcon`

If the corresponding port icon displays a signal name, display the signal name on the Chart block. Otherwise, display the port block name.

`FromPortBlockName`

Display the name of the corresponding port block on the Chart block.

`SignalName`

If a signal name exists, display the name of the signal connected to the port on the Chart block. Otherwise, display the name of the corresponding port block.

Programmatic Use
Parameter: `ShowPortLabels`
Type: character vector
Value: `'FromPortIcon'` | `'FromPortBlockName'` | `'SignalName'`
Default: `'FromPortIcon'`

Read/Write permissions — Select access to contents of chart

`ReadWrite` (default) | `ReadOnly` | `NoReadOrWrite`

Control user access to the contents of the chart.

`ReadWrite`

Enable opening and modification of chart contents.

`ReadOnly`

Enable opening but not modification of the chart. If the chart resides in a block library, you can create and open links to the chart and can make and modify local copies of the chart but you cannot change the permissions or modify the contents of the original library instance.

`NoReadOrWrite`

Disable opening or modification of chart. If the chart resides in a library, you can create links to the chart in a model but you cannot open, modify, change permissions, or create local copies of the chart.

Programmatic Use
Parameter: `Permissions`
Type: character vector

Value: `'ReadWrite'` | `'ReadOnly'` | `'NoReadOrWrite'`
Default: `'ReadWrite'`

`Treat as atomic unit` — Control execution of a subsystem as one unit

off (default) | on

When determining the execution order of block methods, causes Simulink to treat the chart as a unit.

☐ off

When determining block method execution order, treat all blocks in the chart as being at the same level in the model hierarchy as the chart. This hierarchy treatment can cause the execution of methods of blocks in the chart to be interleaved with the execution of methods of blocks outside the chart.

☑ on

When determining the execution order of block methods, treat the chart as a unit. For example, when Simulink needs to compute the output of the chart, Simulink invokes the output methods of all the blocks in the chart before invoking the output methods of other blocks at the same level as the chart block.

Dependency

If you select this parameter, you enable the **Minimize algebraic loop occurrences**, **Sample time**, and **Function packaging** parameters. **Function packaging** requires the Simulink Coder software.

Programmatic Use

Parameter: `TreatAsAtomicUnit`
Type: character vector
Value: `'off'` | `'on'`
Default: `'off'`

See also

- “Generate Reusable Code for Atomic Subcharts”

`Minimize algebraic loop occurrences` — Control elimination of algebraic loops

off (default) | on

 off

Do not try to eliminate any artificial algebraic loops that include the atomic subchart.

 on

Try to eliminate any artificial algebraic loops that include the atomic subchart.

Dependency

To enable this parameter, select the **Treat as atomic unit** parameter.

Programmatic Use

Parameter: `MinAlgLoopOccurrences`
Type: character vector
Value: `'off'` | `'on'`
Default: `'off'`

`Sample time` — Specify time interval

`-1` (default) | `[Ts 0]`

Specify whether all blocks in this chart must run at the same rate or can run at different rates.

- If the blocks in the chart can run at different rates, specify the chart 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 **Sample time** parameter.
- If any of the blocks in the chart specify a different sample time (other than `-1` or `inf`), Simulink displays an error message when you update or simulate the model. For example, suppose all the blocks in the chart must run `5` times a second. To ensure this time, specify the sample time of the chart as `0.2`. In this example, if any of the blocks in the chart specify a sample time other than `0.2`, `-1`, or `inf`, Simulink displays an error when you update or simulate the model.

`-1`

Specify inherited sample time. If the blocks in the chart can run at different rates, use this sample time.

`[Ts 0]`

Specify periodic sample time.

Dependency

To enable this parameter, select the **Treat as atomic unit** parameter.

Programmatic Use

Parameter: `SystemSampleTime`
Type: character vector
Value: `'-1'` | `'[Ts 0]'`
Default: `'-1'`

`Treat as grouped when propagating variant conditions` — Control treating subsystem as unit

`on` (default) | `off`

When propagating variant conditions from Variant Source blocks or to Variant Sink blocks, causes Simulink to treat the chart as a unit.

 on

Simulink treats the chart as a unit when propagating variant conditions from Variant Source blocks or to Variant Sink blocks. For example, when Simulink computes the variant condition of the chart, it propagates that condition to all the blocks in the chart.

 off

Simulink treats all blocks in the chart as being at the same level in the model hierarchy as the chart itself when determining their variant condition.

Programmatic Use

Parameter: `TreatAsGroupedWhenPropagatingVariantConditions`
Type: character vector
Value: `'on'` | `'off'`
Default: `'on'`

Code Generation

`Function packaging` — Select code format

`Auto` (default) | `Inline` | `Nonreusable function` | `Reusable function`

Select the generated code format for an atomic (nonvirtual) subchart.

`Auto`

Simulink Coder chooses the optimal format for your system based on the type and number of instances of the chart that exist in the model.

`Inline`

Simulink Coder inlines the chart unconditionally.

`Nonreusable function`

Simulink Coder explicitly generates a separate function in a separate file. Charts with this setting generate functions that might have arguments depending on the “Function interface” (Simulink) parameter setting. You can name the generated function and file using parameters “Function name” (Simulink) and “File name (no extension)” (Simulink). These functions are not reentrant.

`Reusable function`

Simulink Coder generates a function with arguments that allows reuse of chart code when a model includes multiple instances of the chart.

This option generates a function with arguments that allows chart code to be reused in the generated code of a model reference hierarchy that includes multiple instances of a chart across referenced models. In this case, the chart must be in a library.

Tips

- When you want multiple instances of a chart represented as one reusable function, you can designate each one of them as `Auto` or as `Reusable function`. It is best to use one because using both creates two reusable functions, one for each designation. The outcomes of these choices differ only when reuse is not possible. Selecting `Auto` does not allow for control of the function or file name for the chart code.
- The `Reusable function` and `Auto` options both try to determine if multiple instances of a chart exist and if the code can be reused. The difference between the options' behavior is that when reuse is not possible. In this case, `Auto` yields inlined code, or if circumstances prohibit inlining, separate functions for each chart instance.
- If you select the `Reusable function` while your generated code is under source control, set **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.

Dependency

- This parameter requires Simulink Coder.

- To enable this parameter, select **Treat as atomic unit**.
- Setting this parameter to `Nonreusable function` or `Reusable function` enables the following parameters:
  - **Function name options**
  - **File name options**
  - Memory section for initialize/terminate functions (requires Embedded Coder and an ERT-based system target file)
  - Memory section for execution functions (requires Embedded Coder and an ERT-based system target file)
- Setting this parameter to `Nonreusable function` enables **Function with separate data** (requires a license for Embedded Coder and an ERT-based system target file).

Programmatic Use

Parameter: `RTWSystemCode`
Type: character vector
Value: `'Auto'` | `'Inline'` | `'Nonreusable function'` | `'Reusable function'`
Default: `'Auto'`

Extended Capabilities

C/C++ Code Generation

Generate C and C++ code using Simulink® Coder™.

HDL Code Generation

Generate Verilog and VHDL code for FPGA and ASIC designs using HDL Coder™.

HDL Coder provides additional configuration options that affect HDL implementation and synthesized logic.

Tunable Parameters

You can use a tunable parameter in a Truth Table intended for HDL code generation. For details, see “Generate DUT Ports for Tunable Parameters” (HDL Coder).

HDL Architecture

This block has a single, default HDL architecture.

HDL Block Properties

ConstMultiplierOptimization	Canonical signed digit (CSD) or factored CSD optimization. The default is `none`. See also “ConstMultiplierOptimization” (HDL Coder).
ConstrainedOutputPipeline	Number of registers to place at the outputs by moving existing delays within your design. Distributed pipelining does not redistribute these registers. The default is `0`. For more details, see “ConstrainedOutputPipeline” (HDL Coder).
DistributedPipelining	Pipeline register distribution, or register retiming. The default is `off`. See also “DistributedPipelining” (HDL Coder).
InputPipeline	Number of input pipeline stages to insert in the generated code. Distributed pipelining and constrained output pipelining can move these registers. The default is `0`. For more details, see “InputPipeline” (HDL Coder).
InstantiateFunctions	Generate a VHDL `entity` or Verilog `module` for each function. The default is `off`. See also “InstantiateFunctions” (HDL Coder).
LoopOptimization	Unroll, stream, or do not optimize loops. The default is `none`. See also “LoopOptimization” (HDL Coder).
MapPersistentVarsToRAM	Map persistent arrays to RAM. The default is `off`. See also “MapPersistentVarsToRAM” (HDL Coder).
OutputPipeline	Number of output pipeline stages to insert in the generated code. Distributed pipelining and constrained output pipelining can move these registers. The default is `0`. For more details, see “OutputPipeline” (HDL Coder).
ResetType	Suppress reset logic generation. The default is `default`, which generates reset logic. See also “ResetType” (HDL Coder).
SharingFactor	Number of functionally equivalent resources to map to a single shared resource. The default is 0. See also “Resource Sharing” (HDL Coder).
UseMatrixTypesInHDL	Generate 2-D matrices in HDL code. The default is `off`. See also “UseMatrixTypesInHDL” (HDL Coder).

VariablesToPipeline	**Warning** `VariablesToPipeline` is not recommended. Use `coder.hdl.pipeline` instead. Insert a pipeline register at the output of the specified MATLAB variable or variables. Specify the list of variables as a character vector, with spaces separating the variables.

PLC Code Generation

Generate Structured Text code using Simulink® PLC Coder™.

Fixed-Point Conversion

Design and simulate fixed-point systems using Fixed-Point Designer™.

See Also

Introduced before R2006a

4

Functions

Stateflow Onramp

Two-hour interactive training course included with Stateflow license

Description

To help you get started quickly with Stateflow basics, Stateflow Onramp provides a self-paced, interactive tutorial.

After completing Stateflow Onramp, you will be able to use the Stateflow environment and build Stateflow charts based on real-world examples.

To teach concepts incrementally, Stateflow Onramp uses hands-on exercises. You receive automated assessments and feedback after submitting tasks. Your progress is saved if you exit the application, so you can complete the training in multiple sessions.

Stateflow Onramp covers these topics:

- State machines
- Creating state charts
- Stateflow symbols and data
- Chart actions
- Chart execution
- Flow charts
- Functions in Stateflow
- Chart hierarchy

Stateflow Onramp helps you practice what you learn with these projects:

- Robotic Vacuum
- Robotic Vacuum Driving Modes

Open the Stateflow Onramp

- On the Simulink Start Page, click the Stateflow Onramp button 

.

- On the Simulink Toolstrip quick access toolbar, click **Help** > **Learn Stateflow**.
- At the MATLAB command prompt, enter `learning.simulink.launchOnramp('stateflow')`.

See Also

Topics

“Model Finite State Machines”
“Construct and Run a Stateflow Chart”
“Define Chart Behavior by Using Actions”
“Create a Hierarchy to Manage System Complexity”

Introduced in R2019b