CONTROL ALGORITHM MODELING GUIDELINES USING MATLAB®, Simulink®, and Stateflow®

Version 2.0

MathWorks Automotive Advisory Board (MAAB)

July 27th, 2007

1.History

Date	Change
02.04.2001	Initial document Release, Version 1.00
04.27.2007	Version 2.00 Update release

2.Introduction

2.1. Motivation

The MAAB guidelines are an important basis for project success and teamwork - both in-house and when cooperating with partners or subcontractors. Respecting the guidelines is one key prerequisite to achieving

- system integration without problems.
- well-defined interfaces.
- uniform appearance of models, code and documentation.
- reusable models.
- readable models.
- problem-free exchange of models
- a simple, effective process
- professional documentation.
- understandable presentations.
- fast software changes.
- cooperation with subcontractors.
- handing over of (research or predevelopment) projects (to product development)

2.1.1. Guideline template

Guidelines are described with the following template. Companies who wish to create additional guidelines are encouraged to use the template.

ID: Title	**XX_nnnn: Title of the guideline (unique, short)**
Priority	One of mandatory / strongly recommended / recommended
Scope	MAAB, NA-MAAB, J-MAAB, Specific Company (for optional local company usage)
MATLAB® Version	all RX, RY, RZ RX and earlier RX and later RX through RY
Prerequisites	Links to guidelines, which are prerequisite to this guideline (ID+title)
Description	Description of the guideline (text, images)
Rationale	Motivation for the guideline
Last Change	Version number of last change

Note: The elements of this template are the minimum required items that must be present for proper understanding and exchange of guidelines. The addition of project- or vendor fields to this template is possible as long as their meaning does not overlap with any of the existing fields. In fact, such additions are even encouraged if they help to integrate other guideline templates and lead to a wider acceptance of the core template itself.

2.1.2. Guideline ID:

The guideline ID is built out of two lowercase letters (representing the origin of the rule) and a four-digit number, separated by an underscore.
Once a new guideline has an ID, the ID will not be changed.
The ID is used for references to guidelines.

The two letter prefixes **na**, **jp**, **jc** and **eu** are reserved for future MAAB committee rules. Legacy prefixes, **db**, **jm**, **hd**, and **ar,** are reserved. No new rules will be written with these legacy prefixes.

2.1.3. Guideline Title:

The title should be a short, but unique description of the guidelines area of application (e.g., length of names).
The title is used for the "prerequisites"-field and for custom checker-tools.
There should be a hyperlink with the title-text. It is used for links to the guideline.
Note: The title should not be a redundant short description of the guidelines content, because while the latter may change over time, the title should remain stable.

2.1.4. Priority:

Each guideline must be rated with one of these priorities "mandatory", "strongly recommended" or "recommended." The priority not only describes the importance of the guideline but also determines the consequences of violations.

Mandatory	**Strongly Recommended**	**Recommended**
DEFINITION		
• guidelines that all companies agree to that are absolutely essential • guidelines that all companies conform to 100%	• guidelines that are agreed upon to be a good practice, but legacy models preclude a company from conforming 100% to this guideline • models should conform to these guidelines to the greatest extent possible, however 100% compliance is not required	• guidelines that are recommended to improve the appearance, but are not critical to running the model • guidelines where conformance is preferred but not required
CONSEQUENCES If the guideline is violated		
• essential things are missing • the model may not work properly	• the quality and the appearance will deteriorate • there may be an adverse effect on maintainability, portability, and reusability	• the appearance will not conform with other projects
WAIVER POLICY If the guideline is intentionally ignored		
• the reasons must be documented		

2.1.5. Scope:

The scope can be set to one of the following
MAAB (MathWorks Automotive Advisory Board)
J-MAAB (Japan MAAB)
NA-MAAB (North American MAAB)

"MAAB" is a group of automotive manufacturers and suppliers, which work closely together with The MathWorks. MAAB includes the sub-groups J-MAAB, and NA-MAAB.

“J-MAAB” is a sub group of MAAB, and is a group of automotive manufacturers and suppliers in JAPAN, which works closely with The MathWorks. Rules with J-MAAB scope are local to Japan.

“NA-MAAB” is a sub group of MAAB and is a group of automotive manufacturers and suppliers in USA and Europe, which works closely with The MathWorks. That rule is local rule in USA and Europe. Coverage is USA and Europe.

2.1.6. MATLAB® Versions

The guidelines were written to support all versions of MATLAB and Simulink. If the rule applies to a specific version, or versions, it is denoted in this field. The versions information will be one of the following three formats.

- All : all versions of MATLAB
- RX, RY, RZ : a specific version of MATLAB
- RX and earlier : all versions of MATLAB until version RX
- RX and later: all versions of MATLAB from version RX to the current version
- RX through RY: all versions of MATLAB between RX and RY

2.1.7. Prerequisites:

This field is for links to other guidelines, which are prerequisite to this guideline (logical conjunction).
The guideline ID (for consistency) and the title (for readability) have to be used for the links.
The "Prerequisites" field should contain no other text.

2.1.8. Description:

The "Description" field contains a detailed description of the guideline.
If needed, images and tables can be added.
Note: If formal notation (math, regular expression, syntax diagrams, and exact numbers/limits) is available, it should be used to unambiguously describe a guideline and specify an automated check. However, a human understandable informal description must always be provided for daily reference.

2.1.9. Rationale:

The guidelines can be recommended for one or more of the following reasons.

- Readability: Easily understood algorithms
    - Readable models
    - Uniform appearance of models, code, and documentation
    - Clean interfaces
    - Professional documentation
- Workflow: Effective Development Process/Workflow
    - Ease of maintenance
    - Rapid model changes
    - Reusable components

    - Problem-free exchange of models
    - Model portability
- Simulation: Efficient Simulation and Analysis
    - Simulation speed
    - Simulation memory
    - Model instrumentation
- Verification & Validation
    - Requirements Traceability
    - Testing
    - Problem-free system integration
    - Clean interfaces
- Code generation: Efficient/effective embedded code generation
    - Fast software changes
    - Robustness of generated code

2.1.10. Last change:

The "Last Change" field contains the document version number.

2.2. Document Usage

The following paragraphs give some directions on how to use this document for reference and for compiling a project-specific guideline document. Information on automated checking of the guidelines can be found in Appendix A.

2.2.1. Guideline Interaction Semantics

The initial sections of the document, naming conventions and model architecture are basic guidelines that apply to all types of models. The later sections, Simulink and Stateflow deal with specific rules for those environments. Some guidelines are dependent on other guidelines, these; are explicitly listed throughout the template.

3.Naming Conventions

3.1. General Guidelines

3.1.1. ar_0001: Filenames

<table>
<tr><td><b>ID: Title</b></td><td><b>ar_0001: Filenames</b></td></tr>
<tr><td>Priority</td><td>Mandatory</td></tr>
<tr><td>Scope</td><td>MAAB</td></tr>
<tr><td>MATLAB Version</td><td>All</td></tr>
<tr><td>Prerequisites</td><td></td></tr>
<tr><td>Description</td><td>A filename conforms to the following constraints:
<table>
<tr><td>FORM</td><td>filename = name.extension
<b>name</b>: no leading digits, no blanks
<b>extension</b>: no blanks</td></tr>
<tr><td>UNIQUENESS</td><td>all filenames within the parent project directory</td></tr>
<tr><td>ALLOWED CHARACTERS</td><td><b>name</b>
a b c d e f g h i j k l m n o p q r s t u v w x y z A B C D E F G H I J K L M N O P Q R S T U V W X Y Z 0 1 2 3 4 5 6 7 8 9 _
<b>extension</b>:
a b c d e f g h i j k l m n o p q r s t u v w x y z A B C D E F G H I J K L M N O P Q R S T U V W X Y Z 0 1 2 3 4 5 6 7 8 9</td></tr>
<tr><td>UNDERSCORES</td><td><b>name</b>:
• can use underscores to separate parts
• cannot have more than one consecutive underscore
• cannot start with an underscore
• cannot end with an underscore

<b>extension</b>:
• should not use underscores</td></tr>
</table></td></tr>
<tr><td>Rationale</td><td>☑ Readability
☑ Workflow
□ Simulation
□ Verification and Validation
□ Code Generation</td></tr>
<tr><td>Last Change</td><td>V1.00</td></tr>
</table>

3.1.2. ar_0002: Directory names

ID: Title	**ar_0002: Directory names**
Priority	mandatory
Scope	MAAB
MATLAB Version	All
Prerequisites	
Description	A directory name conforms to the following constraints:

<table>
<tr><td></td><td><table>
<tr><td>FORM</td><td>directory name = name
<b>name</b>: no leading digits, no blanks</td></tr>
<tr><td>UNIQUENESS</td><td>all directory names within the parent project directory</td></tr>
<tr><td>ALLOWED CHARACTERS</td><td><b>name</b>:
a b c d e f g h i j k l m n o p q r s t u v w x y z A B C D E F G H I J K L M N O P Q R S T U V W X Y Z 0 1 2 3 4 5 6 7 8 9 _</td></tr>
<tr><td>UNDERSCORES</td><td><b>name</b>:
• underscores can be used to separate parts
• cannot have more than one consecutive underscore
• cannot start with an underscore
• cannot end with an underscore</td></tr>
</table></td></tr>
<tr><td>Rationale</td><td>☑ Readability
☑ Workflow
□ Simulation
□ Verification and Validation
□ Code Generation</td></tr>
<tr><td>Last Change</td><td>V1.00</td></tr>
</table>

3.2. Model Content Guidelines

3.2.1. jc_0201: Usable characters for Subsystem name

<table>
<tr><td><b>ID: Title</b></td><td><b>jc_0201: Usable characters for Subsystem names</b></td></tr>
<tr><td>Priority</td><td>strongly recommended</td></tr>
<tr><td>Scope</td><td>MAAB</td></tr>
<tr><td>MATLAB Version</td><td>All</td></tr>
<tr><td>Prerequisites</td><td></td></tr>
<tr><td>Description</td><td>The names of all Subsystem blocks should conform to the following constraints:<table>
<tr><td>FORM</td><td><b>name</b>:
• should not start with a number
• should not have blank spaces</td></tr>
<tr><td>ALLOWED CHARACTERS</td><td><b>name</b>:
a b c d e f g h i j k l m n o p q r s t u v w x y z
A B C D E F G H I J K L M N O P Q R S T U V W X Y Z
0 1 2 3 4 5 6 7 8 9 _</td></tr>
<tr><td>UNDERSCORES</td><td><b>name</b>:
• underscores can be used to separate parts
• cannot have more than one consecutive underscore
• cannot start with an underscore
• cannot end with an underscore</td></tr>
</table></td></tr>
<tr><td>Rationale</td><td>☑ Readability
☑ Workflow
□ Simulation
□ Verification and Validation
☑ Code Generation</td></tr>
<tr><td>Last Change</td><td>V2.0</td></tr>
</table>

3.2.2. jc_0211: Usable characters for Inport block and Outport block

<table>
<tr><td><b>ID: Title</b></td><td><b>jc_0211: Usable characters for Inport block and Outport block</b></td></tr>
<tr><td>Priority</td><td>strongly recommended</td></tr>
<tr><td>Scope</td><td>MAAB</td></tr>
<tr><td>MATLAB Version</td><td>All</td></tr>
<tr><td>Prerequisites</td><td></td></tr>
<tr><td>Description</td><td>The names of all Inport blocks and Outport blocks should conform to the following constraints:
<table>
<tr><td>FORM</td><td><b>name</b>:
• should not start with a number
• should not have blank spaces</td></tr>
<tr><td>ALLOWED CHARACTERS</td><td><b>name</b>:
a b c d e f g h i j k l m n o p q r s t u v w x y z
A B C D E F G H I J K L M N O P Q R S T U V W X Y Z
0 1 2 3 4 5 6 7 8 9 _</td></tr>
<tr><td>UNDERSCORES</td><td><b>name</b>:
• underscores can be used to separate parts
• cannot have more than one consecutive underscore
• cannot start with an underscore
• cannot end with an underscore</td></tr>
</table></td></tr>
<tr><td>Rationale</td><td>☑ Readability
☑ Workflow
☐ Simulation
☐ Verification and Validation
☑ Code Generation</td></tr>
<tr><td>Last Change</td><td>V2.0</td></tr>
</table>

3.2.3. jc_0221: Usable characters for signal line name

<table>
<tr><td><b>ID: Title</b></td><td><b>jc_0221: Usable characters for signal line names</b></td></tr>
<tr><td>Priority</td><td>strongly recommended</td></tr>
<tr><td>Scope</td><td>MAAB</td></tr>
<tr><td>MATLAB Version</td><td>All</td></tr>
<tr><td>Prerequisites</td><td></td></tr>
<tr><td>Description</td><td>All named signals should conform to the following constraints:
<table>
<tr><td>FORM</td><td><b>name</b>:
• should not start with a number
• should not have blank spaces
• should not have any control characters</td></tr>
<tr><td>ALLOWED CHARACTERS</td><td><b>name</b>:
a b c d e f g h i j k l m n o p q r s t u v w x y z
A B C D E F G H I J K L M N O P Q R S T U V W X Y Z
0 1 2 3 4 5 6 7 8 9 _</td></tr>
<tr><td>UNDERSCORES</td><td><b>name</b>:
• underscores can be used to separate parts</td></tr>
</table></td></tr>
</table>

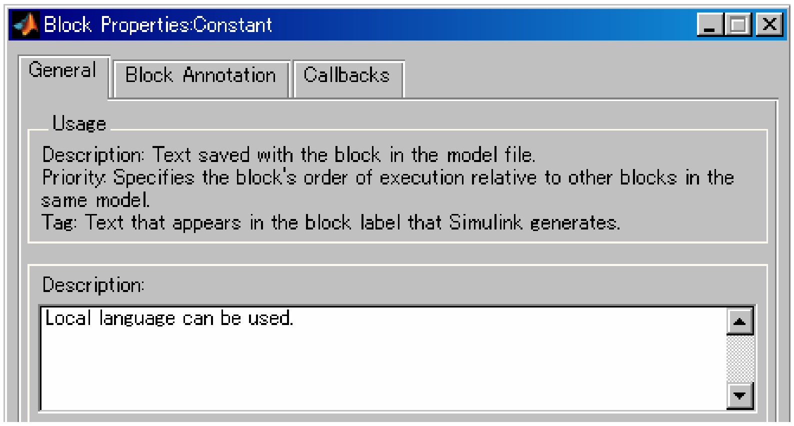
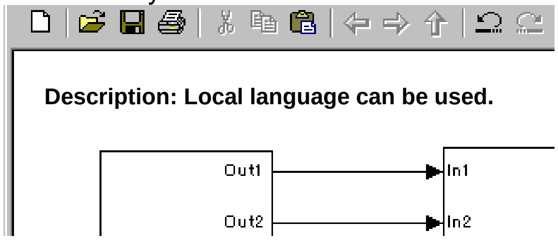
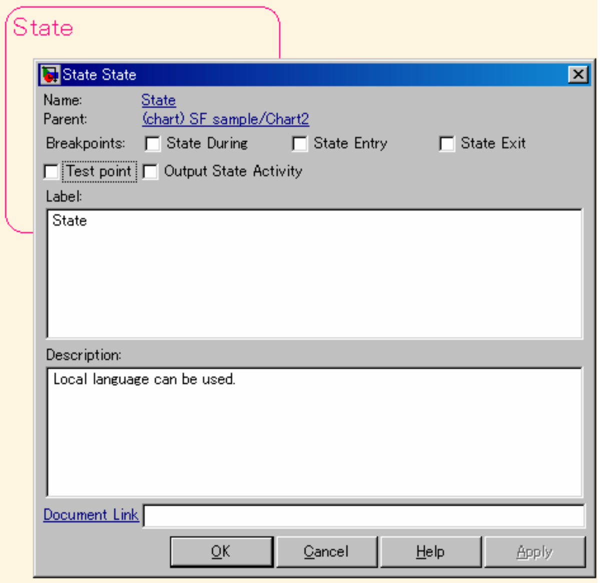
<table>
<tr><td></td><td><table><tr><td></td><td>• cannot have more than one consecutive underscore
• cannot start with an underscore
• cannot end with an underscore</td></tr></table></td></tr>
<tr><td>Rationale</td><td>☑ Readability ☐ Verification and Validation
☑ Workflow ☑ Code Generation
☐ Simulation</td></tr>
<tr><td>Last Change</td><td>V2.0</td></tr>
</table>

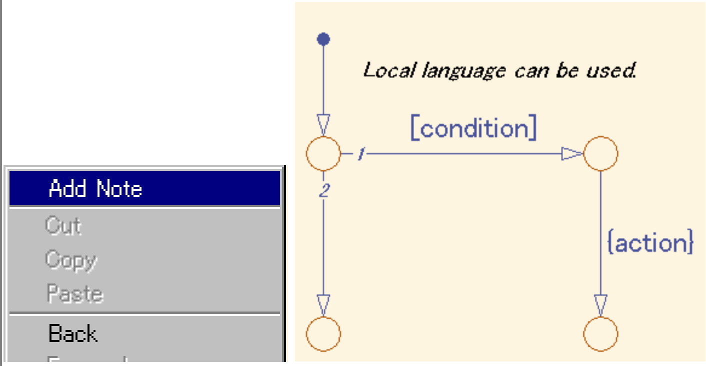
3.2.4. jc_0231: Usable characters for block names

<table>
<tr><td><b>ID: Title</b></td><td><b>jc_0231: Usable characters for block names</b></td></tr>
<tr><td>Priority</td><td>strongly recommended</td></tr>
<tr><td>Scope</td><td>MAAB</td></tr>
<tr><td>MATLAB Version</td><td>All</td></tr>
<tr><td>Prerequisites</td><td>jc_0201: Usable characters for Subsystem names</td></tr>
<tr><td>Description</td><td>All named blocks should conform to the following constraints:<table>
<tr><td>FORM</td><td><b>name</b>:
• should not start with a number
• should not start with a blank space
• may not use double byte characters
• carriage returns are allowed</td></tr>
<tr><td>ALLOWED CHARACTERS</td><td><b>name</b>:
a b c d e f g h i j k l m n o p q r s t u v w x y z
A B C D E F G H I J K L M N O P Q R S T U V W X Y Z
0 1 2 3 4 5 6 7 8 9 _</td></tr>
</table>Note: this rule does not apply to Subsystem blocks.</td></tr>
<tr><td>Rationale</td><td>☑ Readability ☐ Verification and Validation
☑ Workflow ☑ Code Generation
☐ Simulation</td></tr>
<tr><td>Last Change</td><td>V2.0</td></tr>
</table>

3.2.5. na_0014: Use of local language in Simulink and Stateflow

ID: Title	**na_0014: Use of local language in Simulink and Stateflow**
Priority	strongly recommended
Scope	J-MAAB
MATLAB Version	All
Prerequisites	

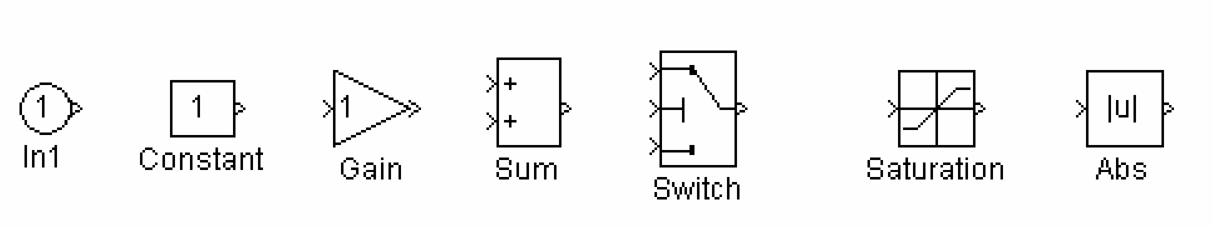
Description	The local language should be used only in descriptive fields. Descriptive fields are text entry points that do not affect code generation or simulation. Examples of descriptive fields include Simulink Example • The Description field in the Block Properties  Block Properties:Constant Usage Description: Text saved with the block in the model file. Priority: Specifies the block's order of execution relative to other blocks in the same model. Tag: Text that appears in the block label that Simulink generates. Description: Local language can be used. • Text annotation directly entered in the model  **Description: Local language can be used.** Stateflow Example • The Description field of the chart or state Properties  State State Name: State Parent: (chart) SF sample/Chart2 Breakpoints: □ State During □ State Entry □ State Exit □ Test point □ Output State Activity Label: State Description: Local language can be used. Document Link

	- Annotation description added using Add Note  Add Note Cut Copy Paste Back Local language can be used. [condition] 1 2 {action} Note: It is possible that Simulink can’t open a model that includes local language on the different character encoding systems; thus, it is important to pay attention when using local characters in case of exchanging models between overseas.
Rationale	☑ Readability ☑ Workflow ☐ Simulation ☐ Verification and Validation ☐ Code Generation
Last Change	V2.0

4.Model Architecture

Basic Blocks

This document uses the term “Basic Blocks” to refer to blocks from the base Simulink library; examples of basic blocks are shown below.



4.1. Simulink® and Stateflow® Partitioning

4.1.1. na_0006: Guidelines for mixed use of Simulink and Stateflow

ID: Title	**na_0006: Guidelines for mixed use of Simulink and Stateflow**
Priority	strongly recommended
Scope	MAAB
MATLAB Version	All
Prerequisites	

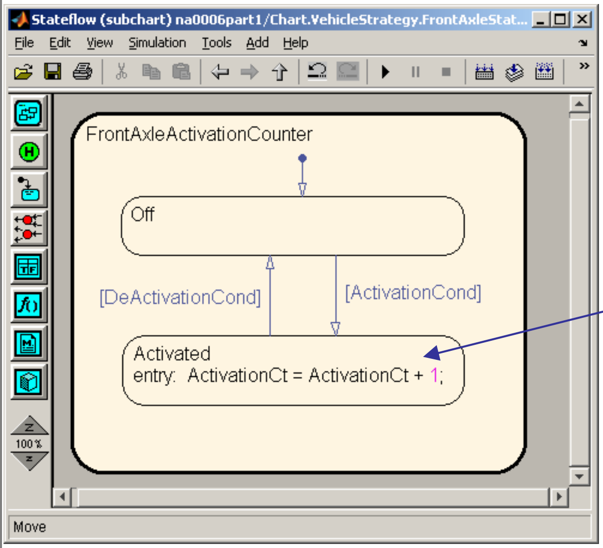
Description

The choice of whether to use Simulink or Stateflow to model a given portion of the control algorithm functionality should be driven by the nature of the behavior being modeled.

- If the function primarily involves complicated logical operations, Stateflow should be used.
    - Stateflow should be used to implement modal logic – where the control function to be performed at the current time depends on a combination of *past and present logical conditions.*
- If the function primarily involves numerical operations, Simulink should be used.

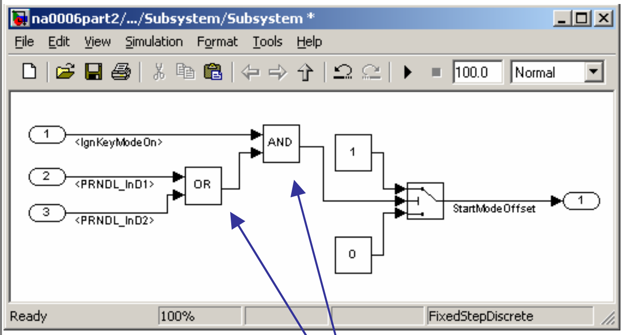
Specifics:

- If the primary nature of the function is logical, but some simple numerical calculations are done to support the logic, it is preferable to implement the simple numerical functions using the Stateflow action language.


Stateflow (subchart) na0006part1/Chart.VehicleStrategy.FrontAxleStat...
File Edit View Simulation Tools Add Help
FrontAxleActivationCounter
Off
[DeActivationCond]
[ActivationCond]
Activated
entry: ActivationCt = ActivationCt + 1;
100%
Move

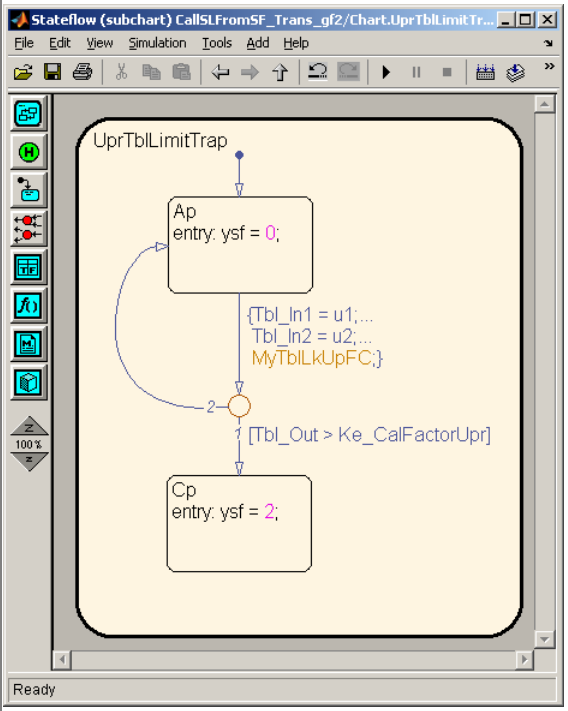
Embedded simple math operation

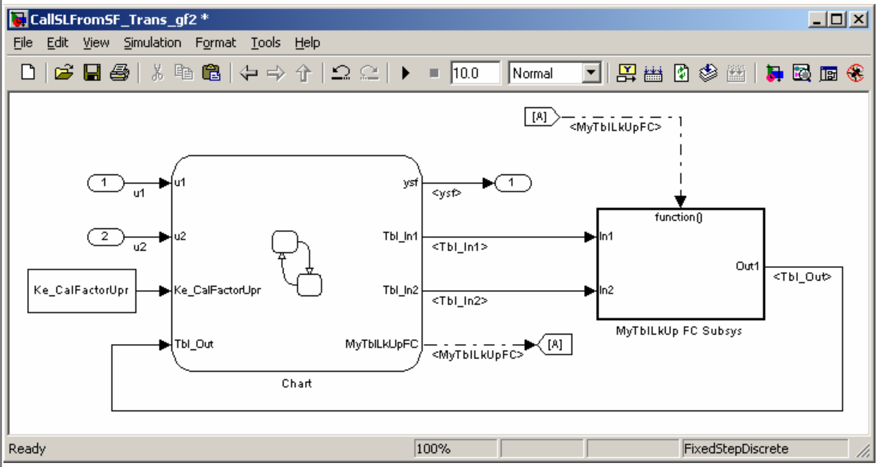
- If the primary nature of the function is numerical, but some simple logical operations are done to support the arithmetic, it is preferable to implement the simple logical functions within Simulink.

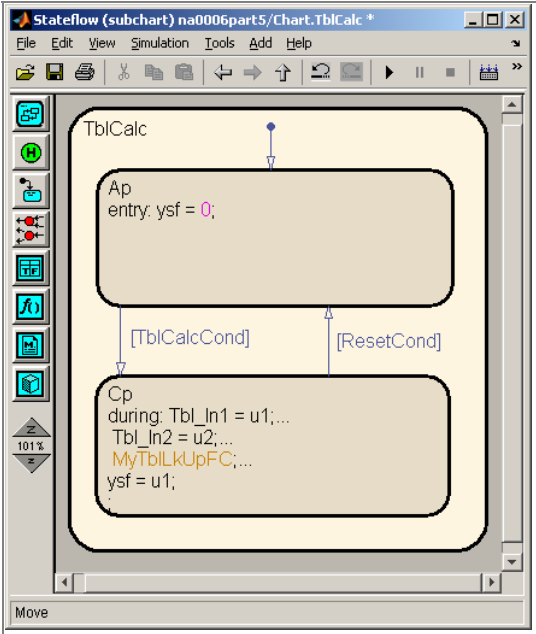


Embedded simple logic operations

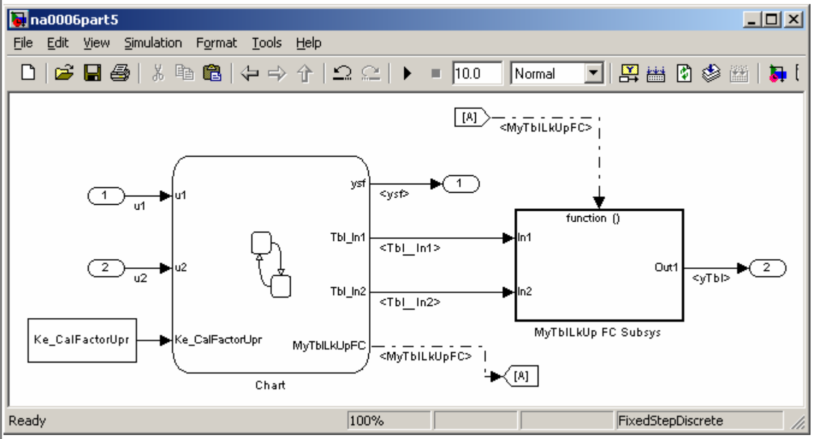
- If the primary nature of the function is logical, and some complicated numerical calculations must be done to support the logic, a Simulink subsystem should be used to implement the numerical calculations. Stateflow should invoke the execution of this subsystem using a function-call.


Stateflow (subchart) CallSLFromSF_Trans_gf2/Chart.UprTblLimitTr...
File Edit View Simulation Tools Add Help
100%
UprTblLimitTrap
Ap
entry: ysf = 0;
{Tbl_In1 = u1;...
Tbl_In2 = u2;...
MyTblLkUpFC;}
2
1
[Tbl_Out > Ke_CalFactorUpr]
Cp
entry: ysf = 2;
Ready



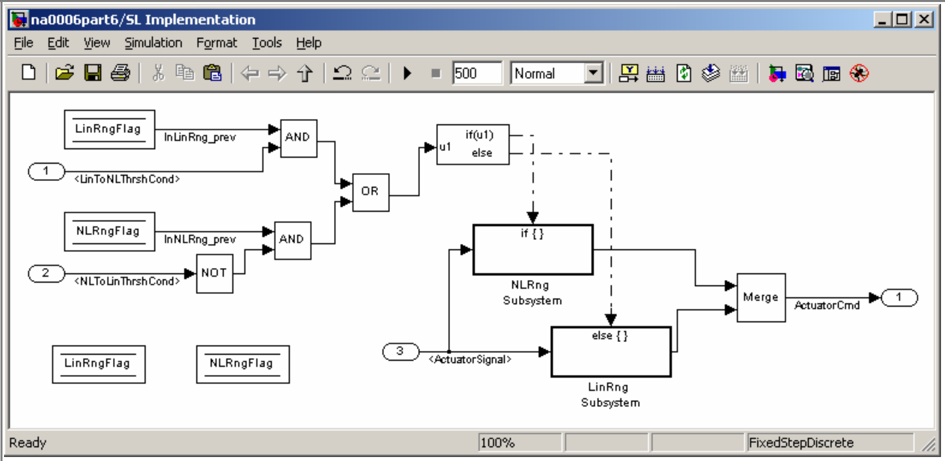


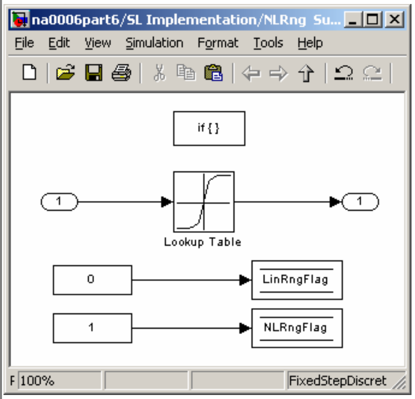
```
TblCalc

Ap
entry: ysf = 0;

[TblCalcCond]
[ResetCond]

Cp
during: Tbl_In1 = u1;...
 Tbl_In2 = u2;...
 MyTblLkUpFC;...
ysf = u1;
;
```



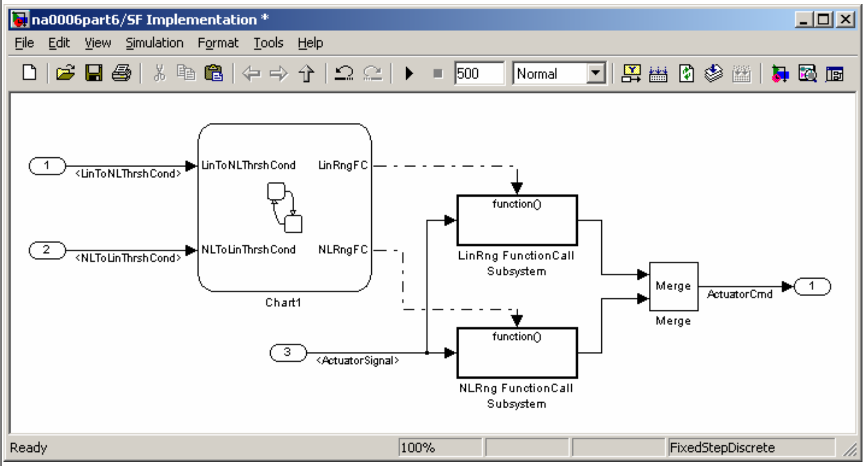
- Stateflow should be used to implement modal logic – where the control function to be performed at the current time depends on a combination of *past and present logical conditions*. (If there is a need to store the result of a logical condition test in Simulink, for example, by storing a flag, this is one indicator of the presence of modal logic – that would be better modeled in Stateflow.)

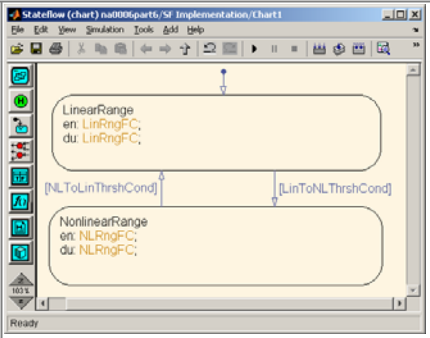
Incorrect


na0006part6/SL Implementation
File Edit View Simulation Format Tools Help
500
Normal
LinRngFlag
InLinRng_prev
AND
1
<LinToNLThrshCond>
OR
u1
if(u1)
else
NLRngFlag
InNLRng_prev
AND
2
<NLToLinThrshCond>
NOT
if { }
NLRng
Subsystem
Merge
ActuatorCmd
1
LinRngFlag
NLRngFlag
3
<ActuatorSignal>
else { }
LinRng
Subsystem
Ready
100%
FixedStepDiscrete


na0006part6/SL Implementation/NLRng Su...
File Edit View Simulation Format Tools Help
if { }
1
1
Lookup Table
0
LinRngFlag
1
NLRngFlag
F 100%
FixedStepDiscret

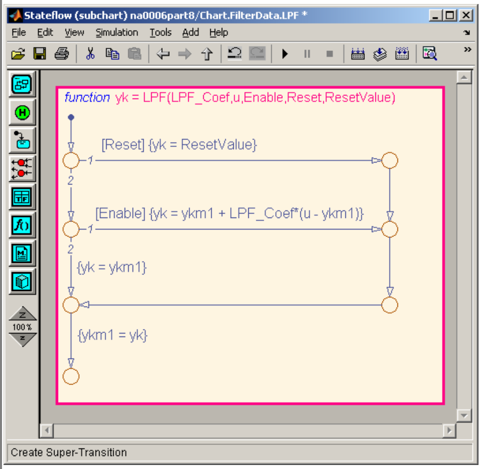
Correct


na0006part6/SF Implementation *
File Edit View Simulation Format Tools Help
500
Normal
1
<LinToNLThrshCond>
LinToNLThrshCond
LinRngFC
function()
LinRng FunctionCall
Subsystem
2
<NLToLinThrshCond>
NLToLinThrshCond
NLRngFC
Chart1
Merge
ActuatorCmd
1
Merge
3
<ActuatorSignal>
function()
NLRng FunctionCall
Subsystem
Ready
100%
FixedStepDiscrete

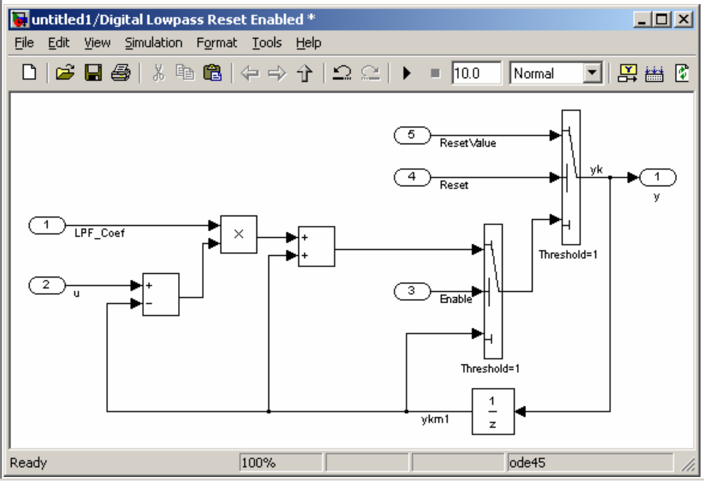


- Simulink should be used to implement numerical expressions containing continuously-valued states, e.g., difference equations, integrals, derivatives, and filters.

Incorrect


Stateflow (subchart) na0006part8/Chart.FilterData.LPF *
File Edit View Simulation Tools Add Help
function yk = LPF(LPF_Coef,u,Enable,Reset,ResetValue)
[Reset] {yk = ResetValue}
1
2
[Enable] {yk = ykm1 + LPF_Coef*(u - ykm1)}
1
2
{yk = ykm1}
{ykm1 = yk}
100%
Create Super-Transition

Correct



Rationale	☑ Readability ☑ Workflow ☑ Simulation ☑ Verification and Validation ☑ Code Generation
Last Change	V2.0

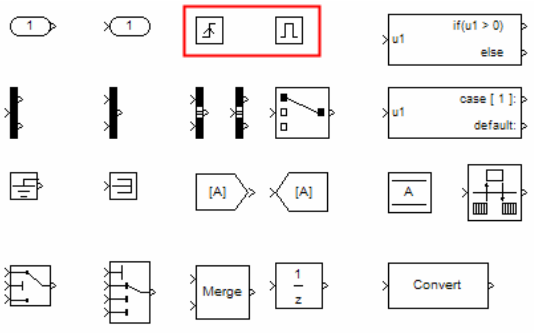
4.1.2. na_0007: Guidelines for use of Flow Charts, Truth Tables and State Machines

ID: Title	**na_0007: Guidelines for use of Flow Charts, Truth Tables and State Machines**
Priority	strongly recommended
Scope	MAAB
MATLAB Version	All
Prerequisites	na_0006: Guidelines for Mixed use of Simulink and Stateflow
Description	Within Stateflow, the choice of whether to utilize a flow chart or a state chart to model a given portion of the control algorithm functionality should be driven by the nature of the behavior being modeled. • If the primary nature of the function segment is to calculate modes of operation or discrete-valued states, then state charts should be used. Some examples are a diagnostic model with pass, fail, abort, and conflict states, or a model that calculates different modes of operation for a control algorithm. • If the primary nature of the function segment involves if-then-else statements, then flowcharts or truth tables should be used. Specifics: • If the primary nature of the function segment is to calculate modes or states, but if-then-else statements are required, it is recommended that a flow chart be added to a state within the state chart. (refer to 7.5 Flowchart Patterns)
Rationale	☑ Readability ☑ Workflow ☑ Simulation ☑ Verification and Validation ☑ Code Generation
Last Change	V2.0

4.2. Subsystem Hierarchies

4.2.1. db_0143: Similar block types on the model levels

ID: Title	**db_0143: Similar block types on the model levels**
Priority	strongly recommended
Scope	NA-MAAB
MATLAB Version	All
Prerequisites	
Description	Every level of a model must be designed with building blocks of the same type. (i.e. only subsystems or only basic blocks). **Blocks which can be placed on every model level:**

	Inport Outport Enable (not on highest model level) Trigger (not on highest model level) Mux Demux Bus Selector Bus Creator Selector Ground Terminator From Goto Switch Multiport Switch Merge Unit Delay Rate Transition Type Conversion Data Store Memory If block Case block	Note: Trigger and Enable blocks cannot be placed at the root level.  1 1 u1 if(u1 > 0) else u1 case [1]: default: [A] [A] A Merge 1 z Convert
Rationale	☑ Readability ☑ Verification and Validation ☑ Workflow □ Code Generation □ Simulation	
Last Change	V2.0	

4.2.2. db_0144: Use of Subsystems

ID: Title	**db_0144: Use of Subsystems**
Priority	strongly recommended
Scope	MAAB
MATLAB Version	All
Prerequisites	
Description	Blocks in a Simulink diagram should be grouped together into subsystems based upon a functional decomposition of the algorithm, or portion thereof, represented in the diagram. Grouping blocks into subsystems primarily for the purpose of saving space in the diagram should be avoided. Each subsystem in the diagram should represent a unit of functionality required to accomplish the purpose of the model or sub model.
Rationale	☑ Readability ☑ Verification and Validation ☑ Workflow ☑ Code Generation □ Simulation
Last Change	V2.0

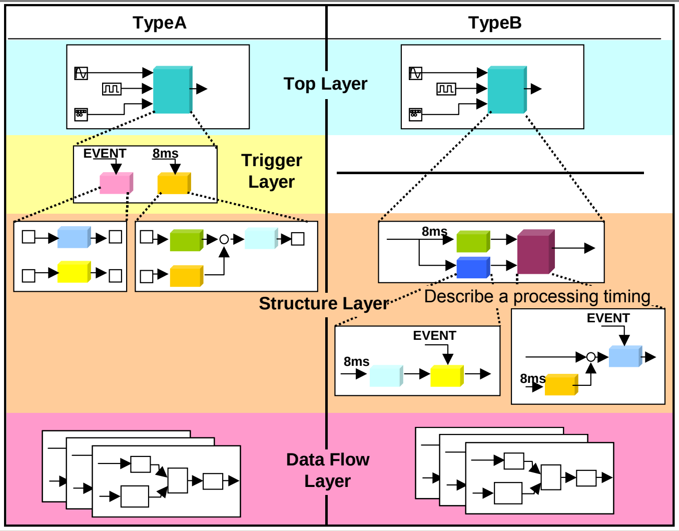
4.2.3. db_0040: Model hierarchy

ID: Title	**db_0040: Model hierarchy**
Priority	strongly recommended
Scope	MAAB
MATLAB Version	All
Prerequisites	
Description	The model hierarchy should correspond to the functional structure of the control system.
Rationale	☑ Readability ☑ Workflow ☐ Simulation ☑ Verification and Validation ☑ Code Generation
Last Change	V2.0

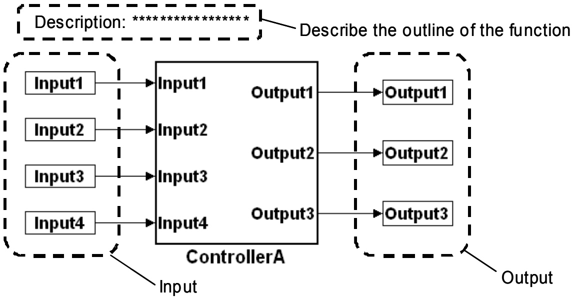
4.3. J-MAAB Model Architecture Decomposition

4.3.1. jc_0301: Controller model

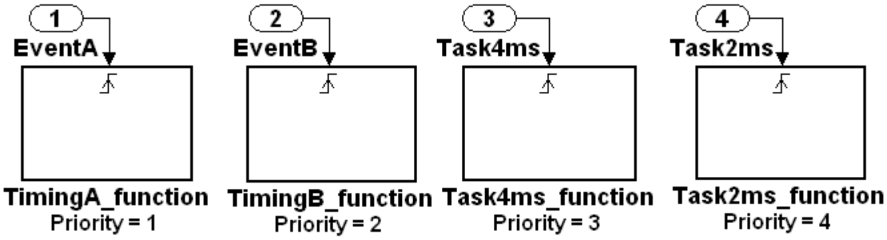
ID: Title	**jc_0301: Controller model**
Priority	mandatory
Scope	J-MAAB
MATLAB Version	All
Prerequisites	
Description	Control models are organized using the following hierarchical structure. Details on each layer are provided in the latter rules. • Top layer / root level • Trigger layer • Structure layer • Data flow layer Use of the Trigger level is optional. In the diagram below “Type A” shows the use of a trigger level while “Type B“ shows a model without a trigger level.

	 TypeA TypeB Top Layer EVENT 8ms Trigger Layer 8ms Structure Layer Describe a processing timing EVENT 8ms EVENT 8ms Data Flow Layer
Rationale	☐ Readability ☐ Verification and Validation ☑ Workflow ☐ Code Generation ☐ Simulation
Last Change	V2.0

4.3.2. jc_0311: Top layer / root level

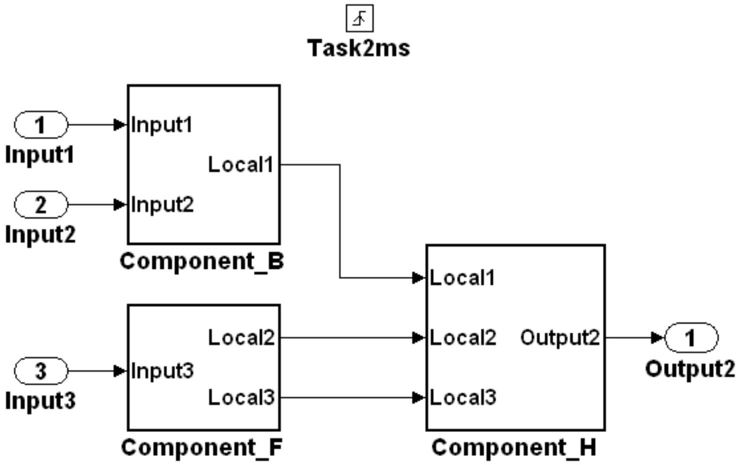
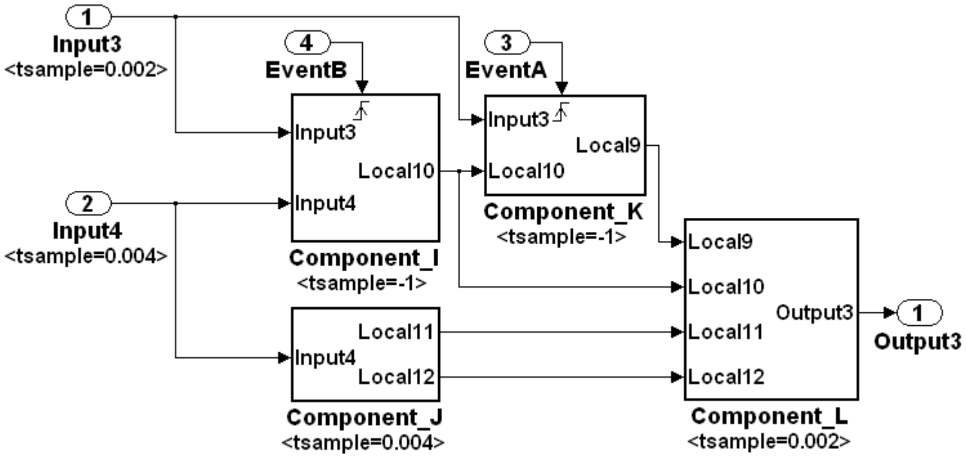
ID: Title	**jc_0311: Top layer / root level**
Priority	mandatory
Scope	J-MAAB
MATLAB Version	All
Prerequisites	
Description	Items to describe in a top layer are as follows. • Overview: Explanation of model feature overview • Input: Input variables • Output: Output variables  Description: ****************** Describe the outline of the function Input1 Input2 Input3 Input4 Input1 Input2 Input3 Input4 Output1 Output2 Output3 ControllerA Output1 Output2 Output3 Input Output Top Layer Example
Rationale	☐ Readability ☐ Verification and Validation ☑ Workflow ☐ Code Generation ☐ Simulation
Last Change	V2.0

4.3.3. jc_0321: Trigger layer

ID: Title	**jc_0321: Trigger layer**
Priority	mandatory
Scope	J-MAAB
MATLAB Version	All
Prerequisites	
Description	A trigger layer indicates the processing timing by using Triggered Subsystem or Function-Call Subsystem. • The blocks should set Priority if needed. • The priority value must be displayed as a Block Annotation. The user should be able to understand the priority based order without having to open the block.  1 EventA 2 EventB 3 Task4ms 4 Task2ms TimingA_function Priority = 1 TimingB_function Priority = 2 Task4ms_function Priority = 3 Task2ms_function Priority = 4 Trigger Layer Example
Rationale	☑ Readability ☑ Workflow ☐ Simulation ☐ Verification and Validation ☑ Code Generation
Last Change	V2.0

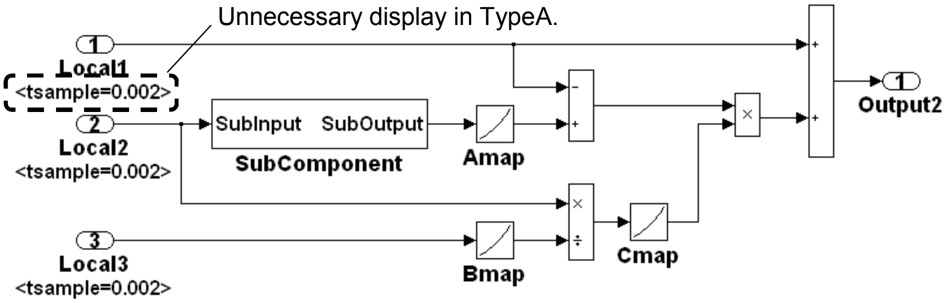
4.3.4. jc_0331: Structure layer

ID: Title	**jc_0331: Structure layer**
Priority	mandatory
Scope	J-MAAB
MATLAB Version	All
Prerequisites	
Description	1. Describe a structure layer like the following description example. • In case of Type B, specify sample time at a Inport block or a Subsystem to define task time of the Subsystem. • In case of Type B, use a Block Annotation at an Inport block or a Subsystem and display sample time to clarify task time of the Subsystem 2. Subsystem of a structure layer should be Atomic Subsystem.

	 Task2ms 1 Input1 2 Input2 Input1 Input2 Local1 Component_B 3 Input3 Input3 Local2 Local3 Component_F Local1 Local2 Local3 Output2 Component_H 1 Output2 Structured Layer Example (Type A: No description of processing timing)  1 Input3 <tsample=0.002> 4 EventB 3 EventA Input3 Local10 Input4 Component_I <tsample=-1> Input3 Local9 Local10 Component_K <tsample=-1> 2 Input4 <tsample=0.004> Local11 Input4 Local12 Component_J <tsample=0.004> Local9 Local10 Local11 Local12 Output3 Component_L <tsample=0.002> 1 Output3 Structured Layer Example (Type B: Description of processing timing)
Rationale	☑ Readability ☐ Verification and Validation ☑ Workflow ☑ Code Generation ☐ Simulation
Last Change	V2.0

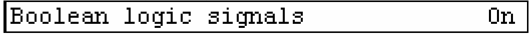
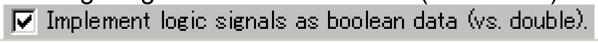
4.3.5. jc_0341: Data flow layer

ID: Title	**jc_0341: Data flow layer**
Priority	mandatory
Scope	J-MAAB
MATLAB Version	All
Prerequisites	
Description	Describe a data flow layer as in the following example. • In case of Type A, use a Block Annotation at an Inport block and display its sample time to clarify execution timing of the signal

	 Unnecessary display in TypeA. 1 Local1 <tsample=0.002> 2 Local2 <tsample=0.002> 3 Local3 <tsample=0.002> SubInput SubOutput SubComponent Amap Bmap Cmap - + × ÷ 1 Output2 Data Flow Layer Example
Rationale	□ Readability ☑ Workflow □ Simulation □ Verification and Validation □ Code Generation
Last Change	V2.0

5.Model Configuration Options

5.1.1. jc_0011: Optimization parameters for Boolean data types

<table>
<tr><th>ID:Title</th><th>jc_0011: Optimization parameters for Boolean data types</th></tr>
<tr><td>Priority</td><td>strongly recommended</td></tr>
<tr><td>Scope</td><td>MAAB</td></tr>
<tr><td>MATLAB Version</td><td>All</td></tr>
<tr><td>Prerequisites</td><td>na_0002: Appropriate implementation of fundamental logical and numerical operations</td></tr>
<tr><td>Description</td><td>The optimization option for Boolean data tyypes must be enabled (on).
<table>
<tr><th>MATLAB version</th><th>Option Name</th></tr>
<tr><td>R13SP2 and earlier</td><td>Boolean Logic signals
Boolean logic signals On</td></tr>
<tr><td>R14 and later</td><td>Use logic signals as Boolean data. (vs. double)
☑ Implement logic signals as boolean data (vs. double).</td></tr>
</table></td></tr>
<tr><td>Rationale</td><td>☐ Readability
☑ Workflow
☐ Simulation
☐ Verification and Validation
☑ Code Generation</td></tr>
<tr><td>Last Change</td><td>V2.0</td></tr>
</table>

5.1.2. jc_0021: Model diagnostic settings

ID:Title	jc_0021: Model diagnostic settings
Priority	strongly recommended
Scope	MAAB
MATLAB Version	All
Prerequisites	

Description	The following diagnostics must be enabled. An enabled diagnostic is set to either “warning” or “error”. Setting the diagnostic option to “none” is not permitted. Diagnostics that are not listed can be set to any value (none, warning or error). • **Solver Diagnostics** • Algebraic loop • Minimize algebraic loop • **Sample Time Diagnostics** • Multitask rate transition • **Data Validity Diagnostics** • Inf or NaN block output • Duplicate data store names • **Connectivity** • Unconnected block input ports • Unconnected block output ports • Unconnected line • Unspecified bus object at root Outport block • Mux blocks used to create bus signals • Invalid function-call connection • Element name mismatch
Rationale	☐ Readability ☐ Verification and Validation ☑ Workflow ☑ Code Generation ☐ Simulation
Last Change	V2.0

6.Simulink

6.1. Diagram Appearance

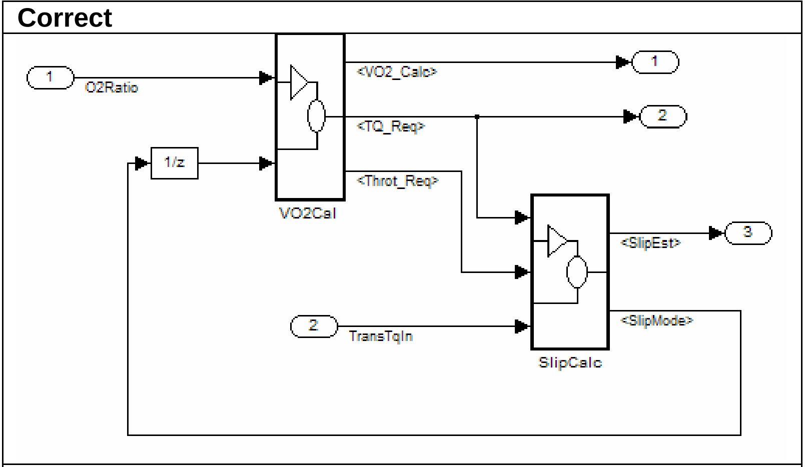
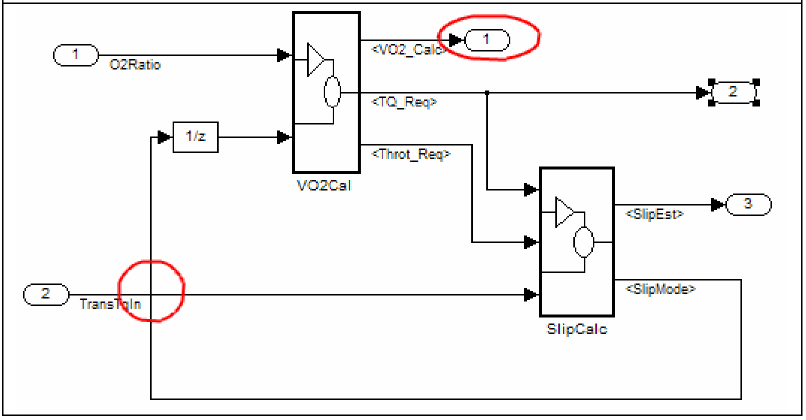
6.1.1. na_0004: Simulink model appearance

<table>
<tr><td><b>ID: Title</b></td><td><b>na_0004 Simulink model appearance</b></td></tr>
<tr><td>Priority</td><td>Recommended</td></tr>
<tr><td>Scope</td><td>MAAB</td></tr>
<tr><td>MATLAB Version</td><td>All</td></tr>
<tr><td>Prerequisites</td><td></td></tr>
<tr><td>Description</td><td>The model appearance settings should conform to the following guidelines when the model is released. The user is free to change the settings during the development process.
<table>
<tr><td><b>View Options</b></td><td><b>Setting</b></td></tr>
<tr><td>Model Browser</td><td>unchecked</td></tr>
<tr><td>Screen color</td><td>white</td></tr>
<tr><td>Status Bar</td><td>checked</td></tr>
<tr><td>Toolbar</td><td>checked</td></tr>
<tr><td>Zoom factor</td><td>Normal (100%)</td></tr>
<tr><td><b>Block Display Options</b></td><td><b>Setting</b></td></tr>
<tr><td>Background Color</td><td>white</td></tr>
<tr><td>Foreground Color</td><td>black</td></tr>
<tr><td>Execution Context Indicator</td><td>unchecked</td></tr>
<tr><td>Library Link Display</td><td>none</td></tr>
<tr><td>Linearization Indicators</td><td>checked</td></tr>
<tr><td>Model/Block I/O Mismatch</td><td>unchecked</td></tr>
<tr><td>Model Block Version</td><td>unchecked</td></tr>
<tr><td>Sample Time Colors</td><td>unchecked</td></tr>
<tr><td>Sorted Order</td><td>unchecked</td></tr>
<tr><td><b>Signal Display Options</b></td><td><b>Setting</b></td></tr>
<tr><td>Port Data Types</td><td>unchecked</td></tr>
<tr><td>Signal Dimensions</td><td>unchecked</td></tr>
<tr><td>Storage Class</td><td>unchecked</td></tr>
<tr><td>Test point Indicators</td><td>checked</td></tr>
<tr><td>Viewer Indicators</td><td>checked</td></tr>
<tr><td>Wide Non-scalar Lines</td><td>checked</td></tr>
</table></td></tr>
<tr><td>Rationale</td><td>☑ Readability
☑ Workflow
□ Simulation
□ Verification and Validation
□ Code Generation</td></tr>
<tr><td>Last Change</td><td>V2.0</td></tr>
</table>

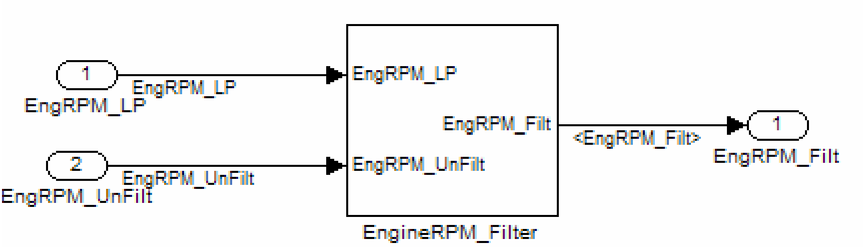
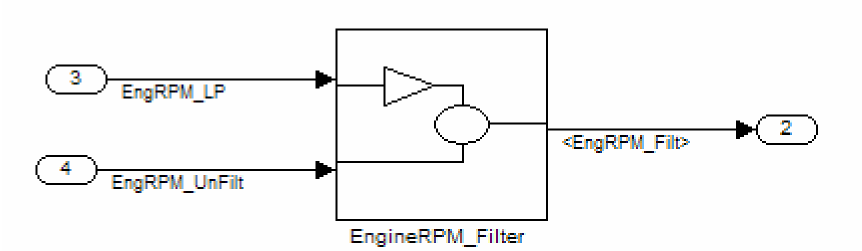
6.1.2. db_0043: Simulink font and font size

ID: Title	**db_0043: Simulink font and font size**
Priority	strongly recommended
Scope	MAAB
MATLAB Version	All
Prerequisites	
Description	All text elements (block names, block annotations and signal labels) except free text annotations within a model must have the same font style and font size. Fonts and font size should be selected for legibility. Note: The selected font should be directly portable (e.g. Simulink/Stateflow default font) or convertible between platforms (e.g. Arial/Helvetica 12pt).
Rationale	☑ Readability ☑ Workflow ☐ Simulation ☐ Verification and Validation ☐ Code Generation
Last Change	V2.0

6.1.3. db_0042: Port block in Simulink models

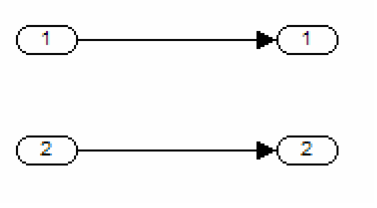
ID: Title	**db_0042: Port block in Simulink models**
Priority	strongly recommended
Scope	MAAB
MATLAB Version	All
Prerequisites	
Description	In a Simulink model, the ports comply with the following rules: • Inports should be placed on the left side of the diagram, but they can be moved in to prevent signal crossings. • Outports should be placed on the right side, but they can be moved in to prevent signal crossings. • Duplicate Inports can be used at the subsystem level if required but should be avoided if possible. o Duplicate Inports cannot be used at the root level. **Correct**  1 O2Ratio 1/z <VO2_Calc> <TQ_Req> <Throt_Req> VO2Cal 1 2 3 <SlipEst> <SlipMode> 2 TransTqIn SlipCalc **Incorrect**  1 O2Ratio 1/z <VO2_Calc> <TQ_Req> <Throt_Req> VO2Cal 1 2 3 <SlipEst> <SlipMode> 2 TransTqIn SlipCalc Notes on the incorrect model • Inport 2 should be moved in so it does not cross the feed back loop lines. • Outport 1 should be moved to the right hand side of the diagram.
Rationale	☑ Readability □ Verification and Validation □ Workflow □ Code Generation □ Simulation
Last Change	V2.0

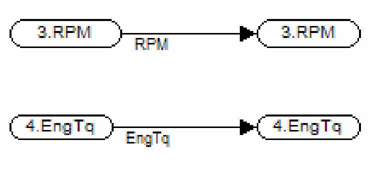
6.1.4. na_0005: Port block name visibility in Simulink models

ID: Title	**na_0005: Port block name visibility in Simulink models**
Priority	strongly recommended
Scope	MAAB
MATLAB Version	All
Prerequisites	
Description	For some items while it is not possible to define a single approach that is applicable to all organizations' internal processes, it is important that at least within a given organization a **single** consistent approach is followed. An organization applying the guidelines must select **one** of these alternatives to enforce. Organizationally-Scoped Alternatives (follow one practice): 1. The name of an Inport or Outport is not hidden. ("Format / Hide Name" is not allowed.)  1 EngRPM_LP EngRPM_LP EngRPM_LP EngRPM_Filt <EngRPM_Filt> 1 EngRPM_Filt 2 EngRPM_UnFilt EngRPM_UnFilt EngRPM_UnFilt EngineRPM_Filter 2. The name of an Inport or Outport must be hidden. ("Format / Hide Name" is used.) *Exception: inside library subsystem blocks, the names may not be hidden.*  3 EngRPM_LP <EngRPM_Filt> 2 4 EngRPM_UnFilt EngineRPM_Filter
Rationale	☑ Readability ☐ Workflow ☐ Simulation ☐ Verification and Validation ☐ Code Generation
Last Change	V2.0

6.1.5. jc_0081: Icon display for Port block

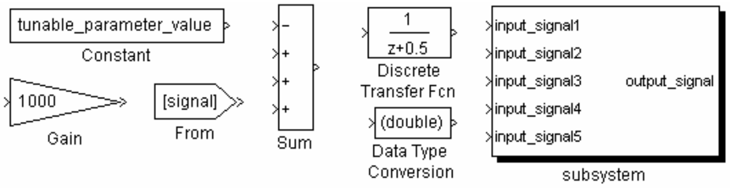
ID: Title	**jc_0081: Icon display for Port block**
Priority	recommended
Scope	MAAB
MATLAB Version	R14 and later
Prerequisites	
Description	The 'Icon display' setting should be set to 'Port number' for Inport and Outport

<table>
<tr><td></td><td>blocks.
<b>Correct</b>


<b>Incorrect</b>

 </td></tr>
<tr><td>Rationale</td><td>☑ Readability
□ Workflow
□ Simulation
□ Verification and Validation
□ Code Generation</td></tr>
<tr><td>Last Change</td><td>V2.0</td></tr>
</table>

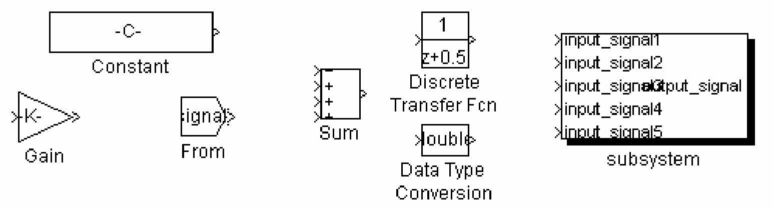
6.1.6. jm_0002: Block resizing

<table>
<tr><td><b>ID: Title</b></td><td><b>jm_0002: Block resizing</b></td></tr>
<tr><td>Priority</td><td>mandatory</td></tr>
<tr><td>Scope</td><td>MAAB</td></tr>
<tr><td>MATLAB Version</td><td>All</td></tr>
<tr><td>Prerequisites</td><td></td></tr>
<tr><td>Description</td><td>All blocks in a model must be sized such that their icon is completely visible and recognizable. In particular, any text displayed (e.g. tunable parameters, filenames, equations) in the icon must be readable.
This guideline requires resizing of blocks with variable icons or blocks with a variable number of inputs and outputs. In some cases it may not be practical or desirable to resize the block icon of a subsystem block so that all of the input and output names within it are readable. In such cases, the user may hide the names in the icon by using a mask or by hiding the names in the subsystem associated with the icon. In this approach, the signal lines coming into and out of the subsystem block should be clearly labeled in close proximity to the block.

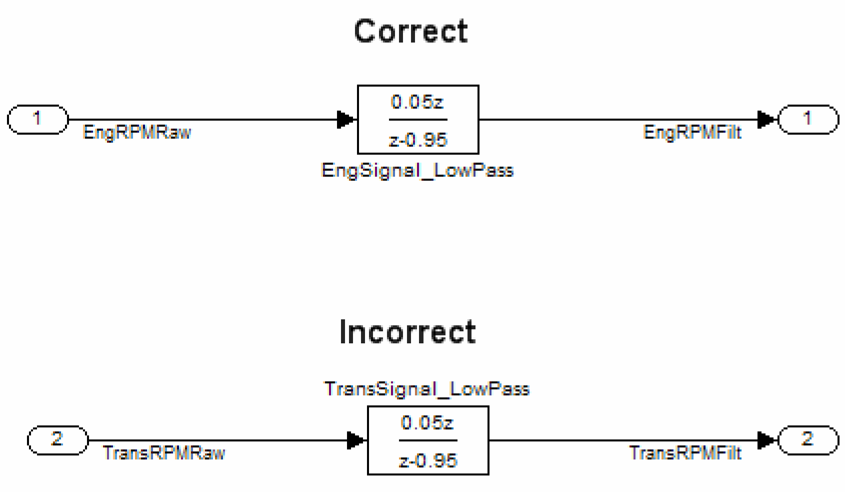
<b>Correct</b>


tunable_parameter_value
Constant
1000
Gain
[signal]
From
-
+
+
+
Sum
1
z+0.5
Discrete Transfer Fcn
(double)
Data Type Conversion
input_signal1
input_signal2
input_signal3
input_signal4
input_signal5
output_signal
subsystem

<b>Incorrect</b></td></tr>
</table>

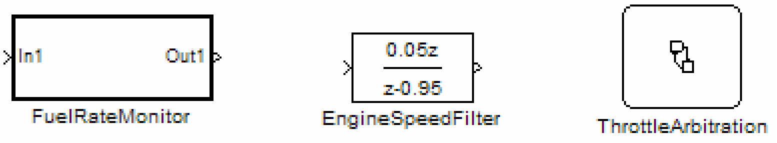
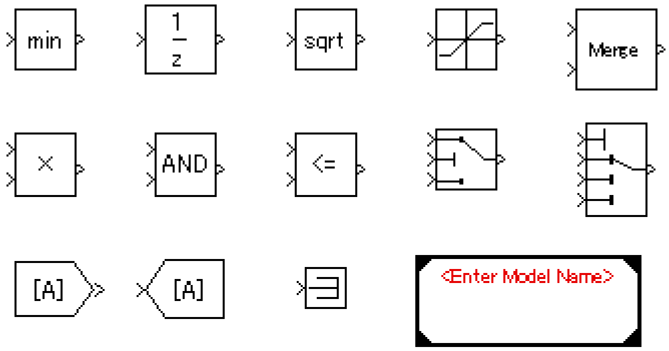
	 -C- Constant K- Gain signal From Sum 1 z+0.5 Discrete Transfer Fcn double Data Type Conversion input_signal1 input_signal2 input_signal3 output_signal input_signal4 input_signal5 subsystem
Rationale	☑ Readability □ Workflow □ Simulation □ Verification and Validation □ Code Generation
Last Change	V2.0

6.1.7. db_0142: Position of block names

ID: Title	**db_0142: Position of block names**
Priority	strongly recommended
Scope	MAAB
MATLAB Version	All
Prerequisites	
Description	If shown the name of each block should be placed below the block.  Correct 1 EngRPMRaw 0.05z z-0.95 EngSignal_LowPass EngRPMFilt 1 Incorrect TransSignal_LowPass 2 TransRPMRaw 0.05z z-0.95 TransRPMFilt 2
Rationale	☑ Readability ☑ Workflow □ Simulation □ Verification and Validation □ Code Generation
Last Change	V2.0

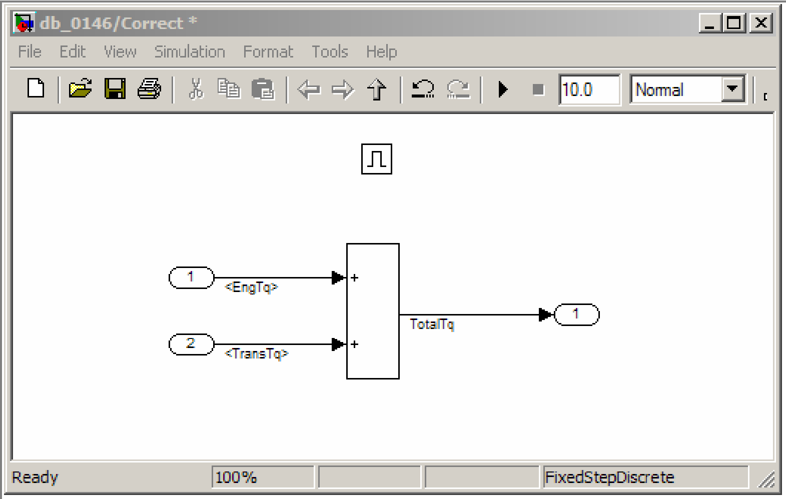
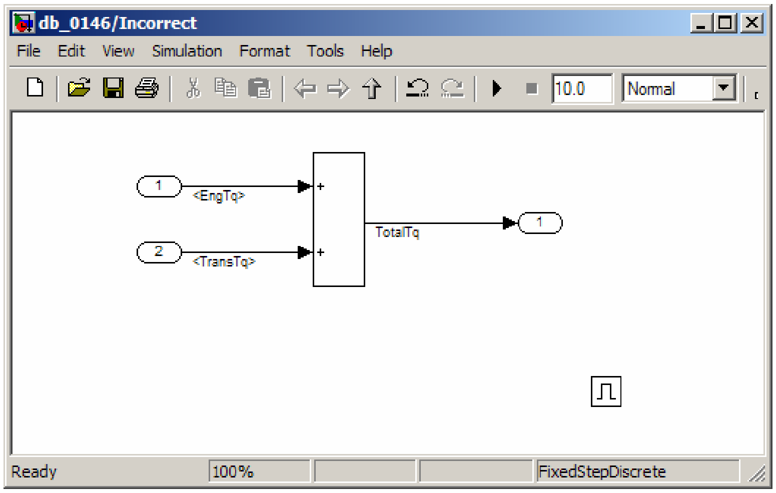
6.1.8. jc_0061: Display of block names

ID: Title	**jc_0061: Display of block names**
Priority	recommended
Scope	MAAB
MATLAB	All

Version	
Prerequisites	
Description	• The block name should be displayed when it provides descriptive information.  In1 Out1 FuelRateMonitor 0.05z z-0.95 EngineSpeedFilter ThrottleArbitration • The block name should not be displayed if the block function is known from its appearance.  min 1 z sqrt Merge × AND <= [A] [A] <Enter Model Name>
Rationale	☑ Readability □ Workflow □ Simulation □ Verification and Validation □ Code Generation
Last Change	V2.0

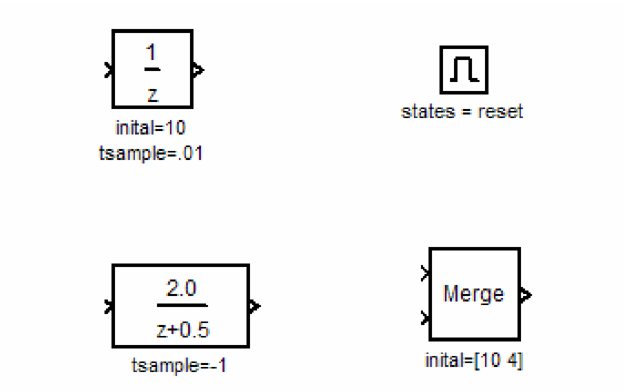
6.1.9. db_0146: Triggered, enabled, conditional Subsystems

ID: Title	**db_0146: Triggered, enabled, conditional Subsystems**
Priority	strongly recommended
Scope	MAAB
MATLAB Version	All
Prerequisites	
Description	The blocks that define subsystems as either conditional or iterative should be located at a consistent location at the top of the subsystem diagram. These are: • Function call • Enabled • Triggered • If / Else Action **Correct**

	 db_0146/Correct * File Edit View Simulation Format Tools Help 10.0 Normal 1 <EngTq> 2 <TransTq> + + TotalTq 1 Ready 100% FixedStepDiscrete **Incorrect**  db_0146/Incorrect File Edit View Simulation Format Tools Help 10.0 Normal 1 <EngTq> 2 <TransTq> + + TotalTq 1 Ready 100% FixedStepDiscrete
Rationale	☑ Readability ☑ Verification and Validation ☑ Workflow □ Code Generation □ Simulation
Last Change	V2.0

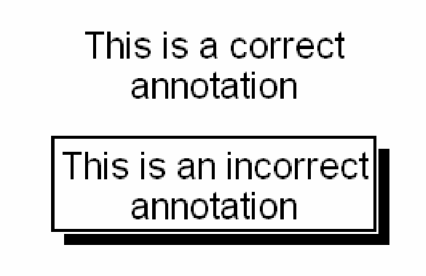
6.1.10. db_0140: Display of basic block parameters

ID: Title	**db_0140: Display of basic block parameters**
Priority	recommended
Scope	MAAB
MATLAB Version	All
Prerequisites	
Description	Important parameters with values other than the block's default values should be displayed. Note: The attribute string is one method to support this. The block annotation tab allows the users to add the desired attribute information. **Correct**

	 1
	z
	inital=10
	tsample=.01
	states = reset
	2.0
	z+0.5
	tsample=-1
	Merge
	inital=[10 4]

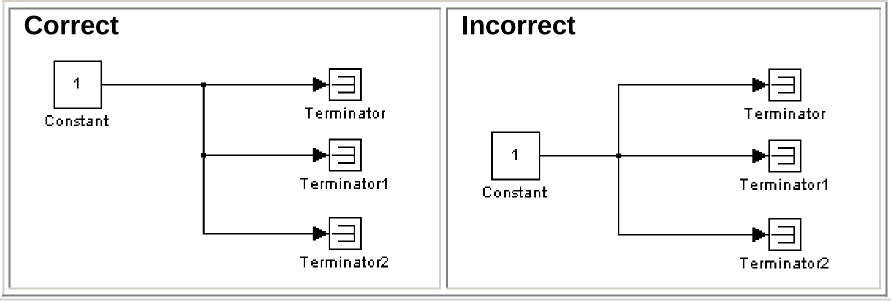
Rationale	☑ Readability ☐ Workflow ☐ Simulation ☑ Verification and Validation ☐ Code Generation
Last Change	V2.0

6.1.11. jm_0013: Annotations

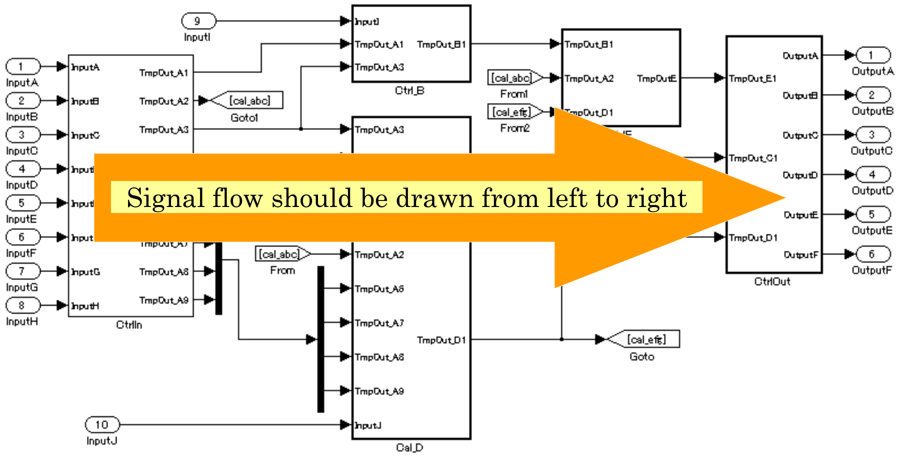
ID: Title	jm_0013: Annotations
Priority	strongly recommended
Scope	MAAB
MATLAB Version	R12.1
Prerequisites	
Description	Annotations should not have a drop shadow on them. ("Format / Show Drop Shadow" is not allowed.)  This is a correct annotation This is an incorrect annotation
Rationale	☑ Readability ☐ Workflow ☐ Simulation ☐ Verification and Validation ☐ Code Generation
Last Change	V2.0

6.1.12. db_0032: Simulink signal appearance

ID: Title	db_0032: Simulink signal appearance
Priority	strongly recommended
Scope	MAAB
MATLAB Version	All

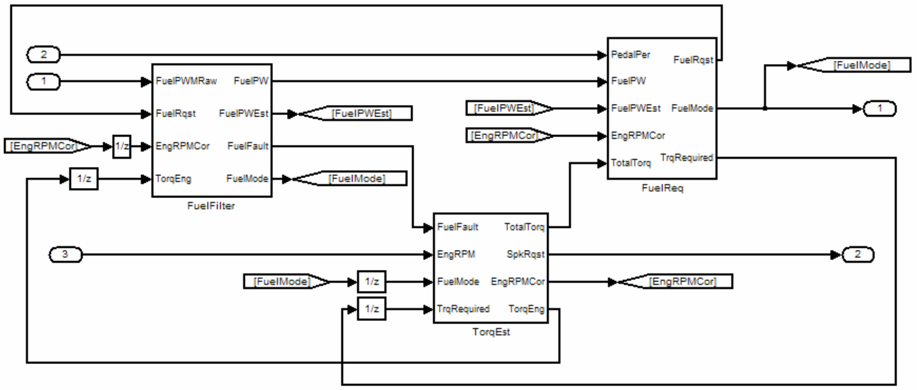
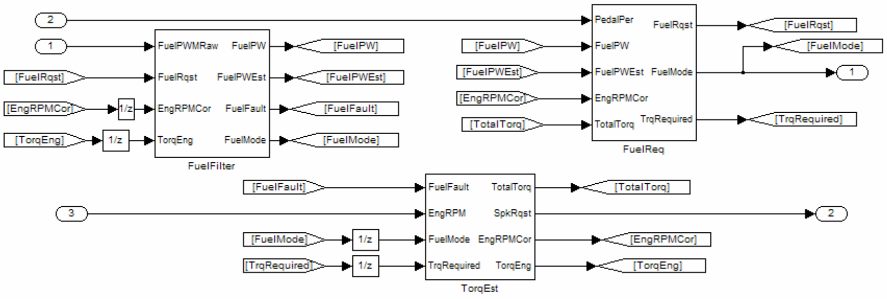
Prerequisites	
Description	Signal lines - Should not cross each other, if possible. - Are drawn with right angles. - Are not drawn one upon the other. - Do not cross any blocks. - Should not split into more than two sub lines at a single branching point.  Correct 1 Constant Terminator Terminator1 Terminator2 Incorrect 1 Constant Terminator Terminator1 Terminator2
Rationale	☑ Readability ☑ Workflow ☐ Simulation ☐ Verification and Validation ☐ Code Generation
Last Change	V2.0

6.1.13. db_0141: Signal flow in Simulink models

ID: Title	**db_0141: Signal flow in Simulink models**
Priority	strongly recommended
Scope	MAAB
MATLAB Version	All
Prerequisites	
Description	- The signal flow in a model is from left to right. - Exception: Feedback loops - Sequential blocks or subsystems are arranged from left to right. - Exception: Feedback loops - Parallel blocks or subsystems are arranged from top to bottom.  Signal flow should be drawn from left to right 9 InputI 1 InputA 2 InputB 3 InputC 4 InputD 5 InputE 6 InputF 7 InputG 8 InputH 10 InputJ CtrlIn TmpOut_A1 TmpOut_A2 TmpOut_A3 TmpOut_A8 TmpOut_A9 [cal_abc] Goto1 Ctrl_B TmpOut_B1 [cal_abc] From1 [cal_efg] From2 TmpOutE TmpOut_D1 [cal_abc] From TmpOut_A6 TmpOut_A7 Cal_D [cal_efg] Goto TmpOut_E1 TmpOut_C1 CtrlOut OutputA OutputB OutputC OutputD OutputE OutputF 1 2 3 4 5 6
Rationale	☑ Readability ☑ Verification and Validation

	☑ Workflow ☐ Code Generation ☐ Simulation
Last Change	V2.0

6.1.14. jc_0171: Maintaining signal flow when using Goto and From blocks

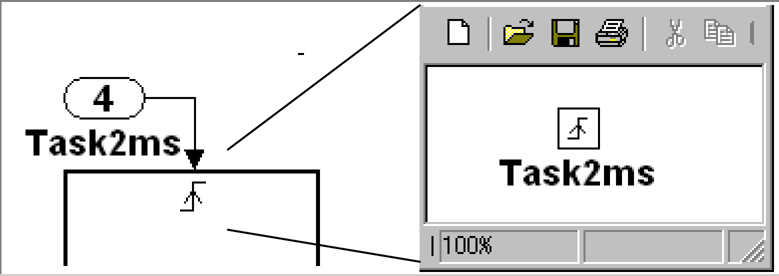
ID: Title	**jc_0171: Maintaining signal flow when using Goto and From blocks**
Priority	strongly recommended
Scope	MAAB
MATLAB Version	All
Prerequisites	
Description	• Visual depiction of signal flow must be maintained between subsystems. • Use of Goto and From blocks is allowed provided that • At least one signal line is used between connected subsystems. • If the subsystems are connected both in a feedforward and feedback loop then at least one signal line for each direction must be connected. **Correct**  2 1 FuelPWMRaw FuelPW FuelRqst FuelPWEst [FuelPWEst] [EngRPMCor] 1/z EngRPMCor FuelFault 1/z TorqEng FuelMode [FuelMode] FuelFilter PedalPer FuelRqst FuelPW [FuelPWEst] FuelPWEst FuelMode [EngRPMCor] EngRPMCor TotalTorq TrqRequired FuelReq [FuelMode] 1 FuelFault TotalTorq 3 EngRPM SpkRqst 2 [FuelMode] 1/z FuelMode EngRPMCor [EngRPMCor] 1/z TrqRequired TorqEng TorqEst **Incorrect**  2 1 FuelPWMRaw FuelPW [FuelPW] [FuelRqst] FuelRqst FuelPWEst [FuelPWEst] [EngRPMCor] 1/z EngRPMCor FuelFault [FuelFault] [TorqEng] 1/z TorqEng FuelMode [FuelMode] FuelFilter PedalPer FuelRqst [FuelRqst] [FuelPW] FuelPW [FuelMode] [FuelPWEst] FuelPWEst FuelMode 1 [EngRPMCor] EngRPMCor [TotalTorq] TotalTorq TrqRequired [TrqRequired] FuelReq [FuelFault] FuelFault TotalTorq [TotalTorq] 3 EngRPM SpkRqst 2 [FuelMode] 1/z FuelMode EngRPMCor [EngRPMCor] [TrqRequired] 1/z TrqRequired TorqEng [TorqEng] TorqEst
Rationale	☑ Readability ☑ Verification and Validation ☑ Workflow ☐ Code Generation ☐ Simulation
Last Change	V2.0

6.1.15. jm_0010: Port block names in Simulink models

ID: Title	**jm_0010: Port block names in Simulink models**
Priority	strongly recommended
Scope	MAAB
MATLAB Version	All
Prerequisites	db_0042: Ports in Simulink models na_0005: Port block name visibility in Simulink models
Description	For some items while it is not possible to define a single approach that is applicable to all organizations' internal processes, it is important that at least within a given organization a **single** consistent approach is followed. An organization applying the guidelines must select **one** of these alternatives to enforce. 1. The names of Inport blocks and Outport blocks must match the corresponding signal or bus names. **Exceptions:** o When any combination of an Inport block, an Outport block, and any other block have the same block name, a suffix or prefix should be used on the Inport and Outport blocks. o One common suffix / prefix is "_in" for Inports and "_out" for Outports. o Any suffix or prefix can be used on the ports, however the selected prefix should be consistent. o Library blocks and reusable subsystems that encapsulate generic functionality. 2. When the names of Inport and Outport blocks are hidden, the user should apply a consistent naming practice for these blocks. Suggested practices include leaving the names as their default names (e.g., Out1), giving them the same name as the associated signal or giving them a shortened or mangled version of the name of the associated signal.
Rationale	☑ Readability ☐ Verification and Validation ☑ Workflow ☐ Code Generation ☑ Simulation
Last Change	V2.0

6.1.16. jc_0281: Naming of Trigger Port block and Enable Port block

ID: Title	**jc_0281: Naming of Trigger Port block and Enable Port block**
Priority	strongly recommended
Scope	J-MAAB
MATLAB Version	All
Prerequisites	
Description	For Trigger port blocks and Enable port blocks • The block name should match the name of the signal triggering the subsystem.

	
Rationale	☑ Readability ☐ Workflow ☐ Simulation ☐ Verification and Validation ☐ Code Generation
Last Change	V2.0

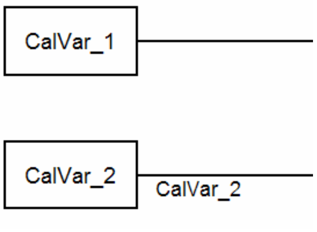
6.2. Signals

Signal labels are used to make model functionality more understandable from the Simulink diagram. They can also be used to control the variable names used in simulation and code generation. Signal labels should be entered only once (at the point of signal origination). Often it is desirable to also display the signal name elsewhere in the model. In these cases, the signal name should be inherited until the signal is functionally transformed. (Passing a signal through an integrator is functionally transforming. Passing a signal through an Inport into a nested subsystem is not.) Once a named signal is functionally transformed, a new name should be associated with it.

Signals may be scalars, vectors, or busses. They may carry data or control flows. Unless explicitly stated otherwise, the following naming rules apply to all types of signals.

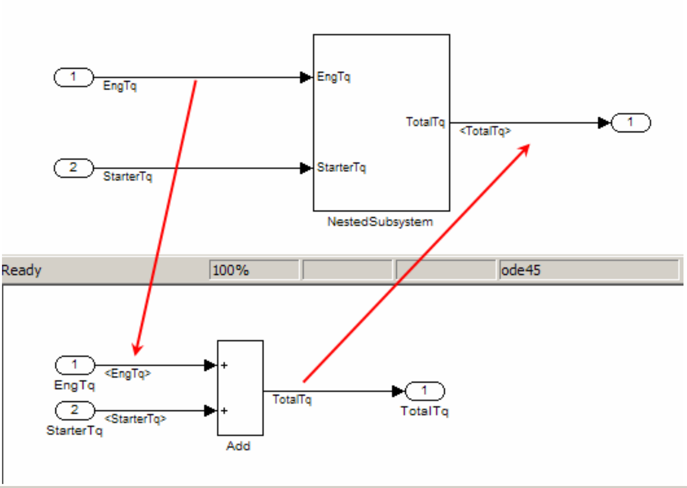
6.2.1. na_0008: Display of labels on signals

ID: Title	**na_0008: Display of labels on signals**
Priority	recommended
Scope	MAAB
MATLAB Version	All
Prerequisites	
Description	A label must be displayed on any signal originating from the following blocks: • Inport block • From block (block icon exception applies – see Note below) • Data Store Read block (block icon exception applies) • Subsystem block or Stateflow chart block (block icon exception applies) • Constant block (block icon exception applies) • Bus Selector block (the tool forces this to happen) • Demux block • Selector block A label must be displayed on any signal connected to the following destination blocks (directly or via a basic block that performs a non transformative operation):

	• Outport block • Goto block • Data Store Write block • Bus Creator block • Mux block • Subsystem block • Chart block Note: Block icon exception (applicable only where called out above): If the signal label is visible in the originating block icon display, the connected signal need not also have the label displayed *unless* the signal label is needed elsewhere due to a destination-based rule. • In addition, a label *may* be displayed on any other signal of interest to the user or the user's customers. 
Rationale	☑ Readability ☑ Workflow ☐ Simulation ☑ Verification and Validation ☑ Code Generation
Last Change	V2.0

6.2.2. na_0009: Entry versus propagation of signal labels

ID: Title	**Na_0009: Entry versus propagation of signal labels**
Priority	strongly recommended
Scope	MAAB
MATLAB Version	All
Prerequisites	na_0008: Display of labels on signals

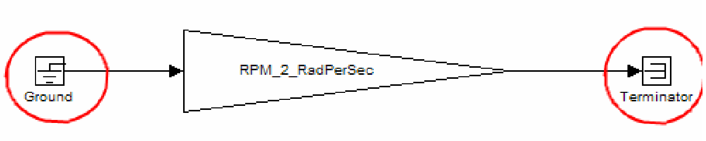
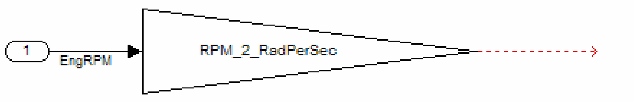
Description	If a label is present on a signal, the following rules define whether that label shall be created there (entered directly on the signal) or propagated from its true source (inherited from elsewhere in the model by using the '<' character). 1. Any displayed signal label must be *entered* for signals that: a. Originate from an Inport at the Root (top) Level of a model b. Originate from a basic block that performs a transformative operation (For the purpose of interpreting this rule only, the Bus Creator block, Mux block and Selector block shall be considered to be included among the blocks that perform transformative operations.) 2. Any displayed signal label must be *propagated* for signals that: a. Originate from an Inport block in a nested subsystem **Exception:** If the nested subsystem is a library subsystem, a label may be *entered* on the signal coming from the Inport to accommodate reuse of the library block. b. Originate from a basic block that performs a non-transformative operation c. Originate from a Subsystem or Stateflow chart block **Exception:** If the connection originates from the output of a library subsystem block instance, a new label may be *entered* on the signal to accommodate reuse of the library block.  1 EngTq 2 StarterTq EngTq StarterTq TotalTq <TotalTq> 1 NestedSubsystem Ready 100% ode45 1 EngTq <EngTq> 2 StarterTq <StarterTq> + + Add TotalTq 1 TotalTq
Rationale	☑ Readability ☑ Verification and Validation ☑ Workflow ☑ Code Generation ☐ Simulation
Last Change	V2.0

6.2.3. db_0097: Position of labels for signals and busses

ID: Title	**db_0097: Position of labels for signals and busses**
Priority	strongly recommended
Scope	MAAB
MATLAB Version	All
Prerequisites	
Description	The labels must be visually associated with the corresponding signal and not overlap other labels, signals or blocks.

	Labels should be located consistently below horizontal lines and close to the corresponding source or destination block.
Rationale	☑ Readability ☑ Workflow ☐ Simulation ☐ Verification and Validation ☐ Code Generation
Last Change	V2.0

6.2.4. db_0081: Unconnected signals, block inputs and block outputs

ID: Title	**db_0081: Unconnected signals and block inputs / outputs**
Priority	Mandatory
Scope	MAAB
MATLAB Version	All
Prerequisites	
Description	A system must not have any: - Unconnected subsystem or basic block inputs. - Unconnected subsystem or basic block outputs - Unconnected signal lines - An otherwise unconnected input should be connected to a ground block - An otherwise unconnected output should be connected to a terminator block **Correct**  **Incorrect** 
Rationale	☑ Readability ☑ Workflow ☐ Simulation ☑ Verification and Validation ☐ Code Generation
Last Change	V2.0

6.3. Block Usage

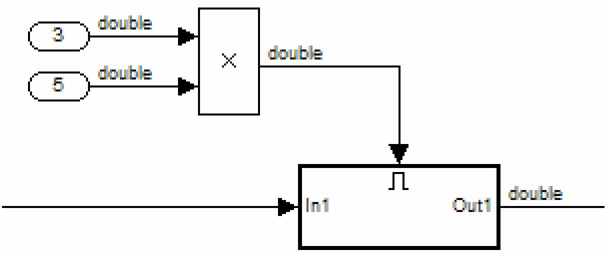
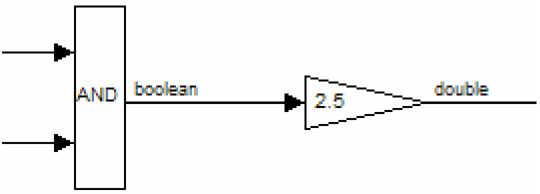
6.3.1. na_0003: Simple logical expressions in If Condition block

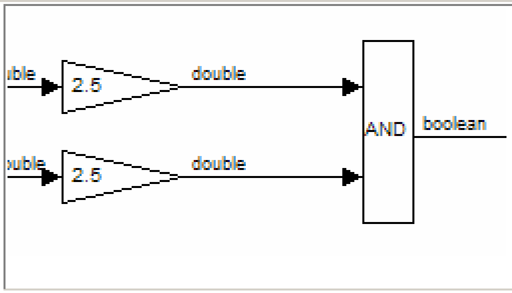
ID: Title	**na_0003: Simple logical expressions in If Condition block**
Priority	mandatory
Scope	MAAB

MATLAB Version	All
Prerequisites	
Description	A logical expression may be implemented within an If Condition block instead of building it up with logical operation blocks if the expression contains two or fewer primary expressions. A primary expression is defined here to be one of the following: • An input • A constant • A constant parameter • A parenthesized expression containing no operators except zero or one instances of the following operators: < , <= , > , >= , ~=, ==, ~ . (See below for examples) **Exception:** A logical expression may contain more than two primary expressions if both of the following are true: • The primary expressions are all inputs • Only one type of logical operator is present Examples of acceptable exceptions: • u1 | u2 | u3 | u4 | u5 • u1 & u2 & u3 & u4 Examples of primary expressions include: • u1 • 5 • K • (u1 > 0) • (u1 <= G) • (u1 > U2) • (~u1) Examples of acceptable logical expressions include: • u1 | u2 • (u1 > 0) & (u1 < 20) • (u1 > 0) & (u2 < u3) • (u1 > 0) & (~u2) Examples of unacceptable logical expressions include: • u1 & u2 | u3 (too many primary expressions) • u1 & (u2 | u3) (unacceptable operator within primary expression) • (u1 > 0) & (u1 < 20) & (u2 > 5) (too many primary expressions that are not inputs) • (u1 > 0) & ((2*u2) > 6) (unacceptable operator within primary expression)

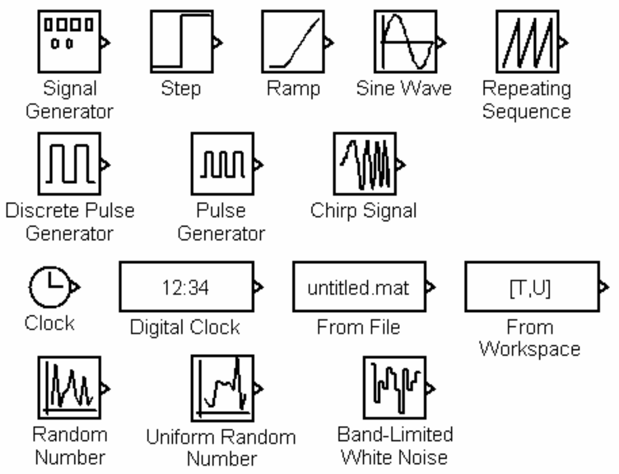
Rationale	☑ Readability ☐ Verification and Validation ☑ Workflow ☐ Code Generation ☐ Simulation
Last Change	V2.0

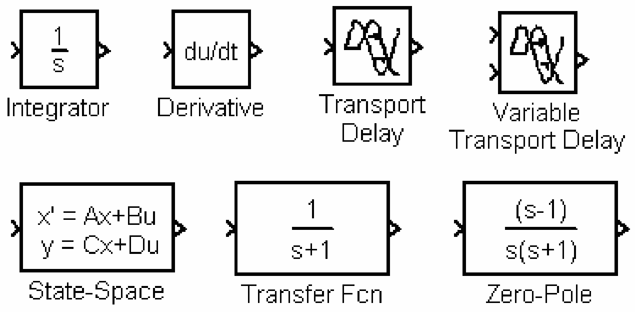
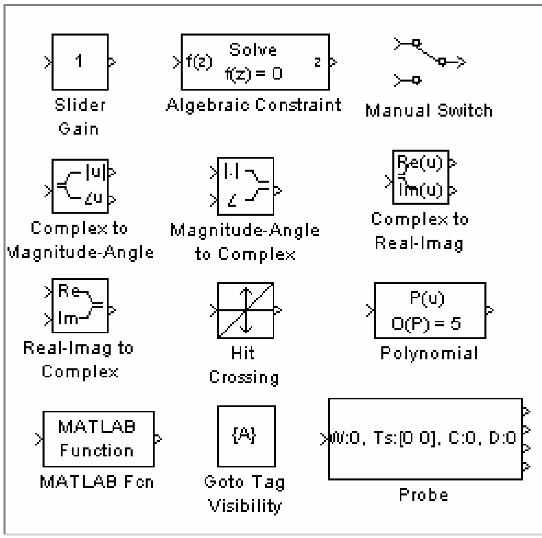
6.3.2. na_0002: Appropriate implementation of fundamental logical and numerical operations

ID: Title	**na_0002: Appropriate implementation of fundamental logical and numerical operations**
Priority	mandatory
Scope	MAAB
MATLAB Version	All
Prerequisites	
Description	- Blocks that are intended to perform numerical operations must not be used to perform logical operations. **Incorrect**  3 double 5 double × double In1 Out1 double - A logical output should never be directly connected to the input of blocks that operate on numerical inputs. - The result of a logical expression fragment should never be operated on by a numerical operator. **Incorrect**  - Blocks that are intended to perform logical operations must not be used to perform numerical operations. - A numerical output should never be connected to the input of blocks that operate on logical inputs. **Incorrect**

	 ible 2.5 double ouble 2.5 double AND boolean
Rationale	☑ Readability ☑ Workflow ☐ Simulation ☐ Verification and Validation ☐ Code Generation
Last Change	V2.0

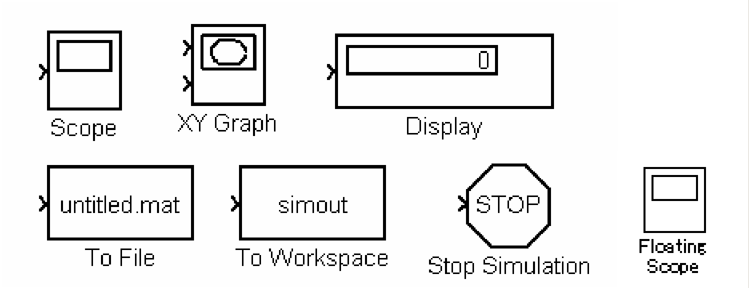
6.3.3. jm_0001: Prohibited Simulink standard blocks inside controllers

ID: Title	**jm_0001: Prohibited Simulink standard blocks inside controllers**
Priority	mandatory
Scope	MAAB
MATLAB Version	All
Prerequisites	
Description	**Controller models must be designed from discrete blocks.** **Sources are not allowed:** Signal Generator Step Ramp Sine Wave Repeating Sequence Discrete Pulse Generator Pulse Generator Chirp Signal Clock Digital Clock From File From Workspace Random Number Uniform Random Number Band-Limited White Noise  Signal Generator Step Ramp Sine Wave Repeating Sequence Discrete Pulse Generator Pulse Generator Chirp Signal Clock 12:34 Digital Clock untitled.mat From File [T,U] From Workspace Random Number Uniform Random Number Band-Limited White Noise **Continuous blocks are not allowed:**

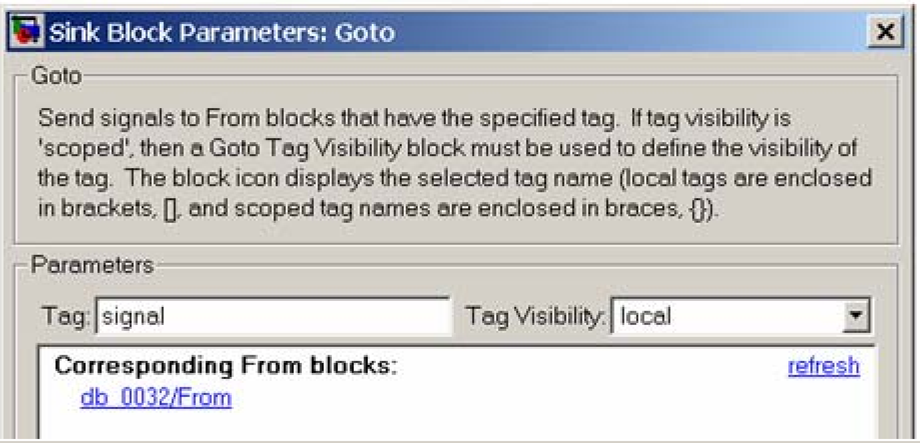
Integrator Derivative Transport Delay Variable Transport Delay State-Space Transfer Fcn Zero-Pole	 1/s Integrator du/dt Derivative Transport Delay Variable Transport Delay x' = Ax+Bu y = Cx+Du State-Space 1/s+1 Transfer Fcn (s-1)/s(s+1) Zero-Pole
Additional blocks that are not allowed: The MAAB Style guide group recommends not using the following blocks. The list can be extended by individual companies.	
Slider Gain Algebraic Constraint Manual Switch Complex to Magnitude-Angle Magnitude-Angle to Complex Complex to Real-Imag Real-Imag to Complex Hit Crossing Polynomial MATLAB Fcn Goto Tag Visibility Probe	 1 Slider Gain f(z) Solve f(z) = 0 z Algebraic Constraint Manual Switch |u| ∠u Complex to Magnitude-Angle |·| ∠ Magnitude-Angle to Complex Re(u) Im(u) Complex to Real-Imag Re Im Real-Imag to Complex Hit Crossing P(u) O(P) = 5 Polynomial MATLAB Function MATLAB Fcn {A} Goto Tag Visibility W:0, Ts:[0 0], C:0, D:0 Probe

Rationale	☑ Readability ☑ Workflow ☐ Simulation	☐ Verification and Validation ☑ Code Generation
Last Change	V2.0	

6.3.4. hd_0001: Prohibited Simulink sinks

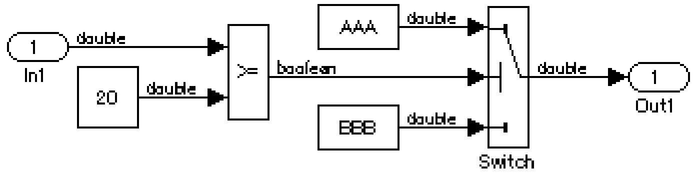
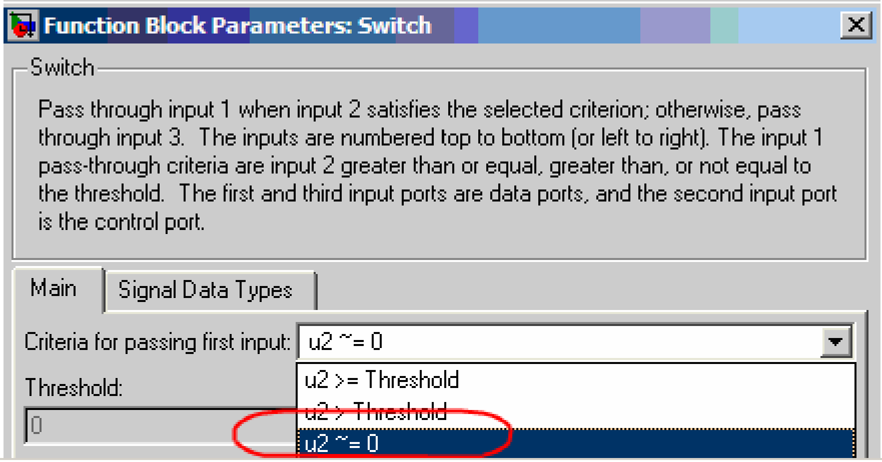
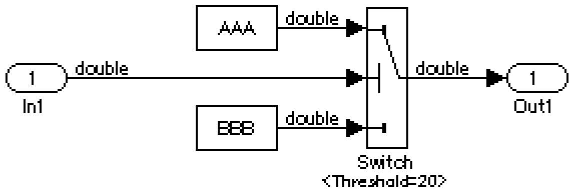
ID: Title	**hd_0001: Prohibited Simulink sinks**
Priority	strongly recommended
Scope	MAAB
MATLAB Version	All
Prerequisites	
Description	**Controller models must be designed from discrete blocks.** **Sinks are not allowed:** Scope XY Graph Display To File To Workspace Stop Simulation Floating Scope  Scope XY Graph 0 Display untitled.mat To File simout To Workspace STOP Stop Simulation Floating Scope
Rationale	☑ Readability ☑ Workflow □ Simulation □ Verification and Validation □ Code Generation
Last Change	V2.0

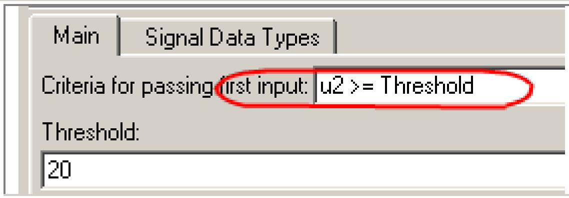
6.3.5. na_0011: Scope of Goto and From blocks

ID: Title	**na_0011: Scope of Goto and From blocks**
Priority	strongly recommended
Scope	MAAB
MATLAB Version	All
Prerequisites	
Description	For signal flows the following rules apply: • From and Goto blocks must use local scope. Note: Control flow signals may use global scope.  Sink Block Parameters: Goto Goto Parameters refresh Send signals to From blocks that have the specified tag. If tag visibility is 'scoped', then a Goto Tag Visibility block must be used to define the visibility of the tag. The block icon displays the selected tag name (local tags are enclosed in brackets, [], and scoped tag names are enclosed in braces, {}). Tag: signal Tag Visibility: local Corresponding From blocks: db_0032/From

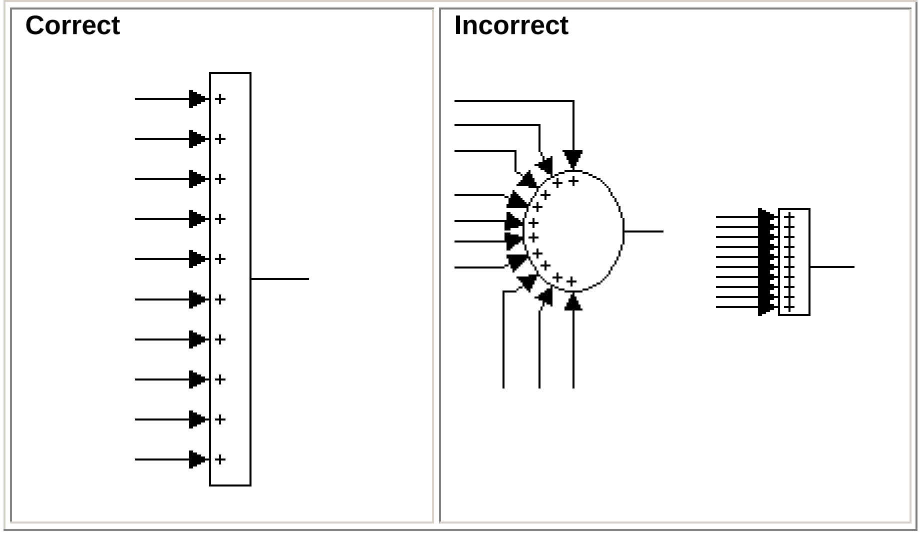
Rationale	☑ Readability ☐ Verification and Validation ☑ Workflow ☑ Code Generation ☐ Simulation
Last Change	V2.0

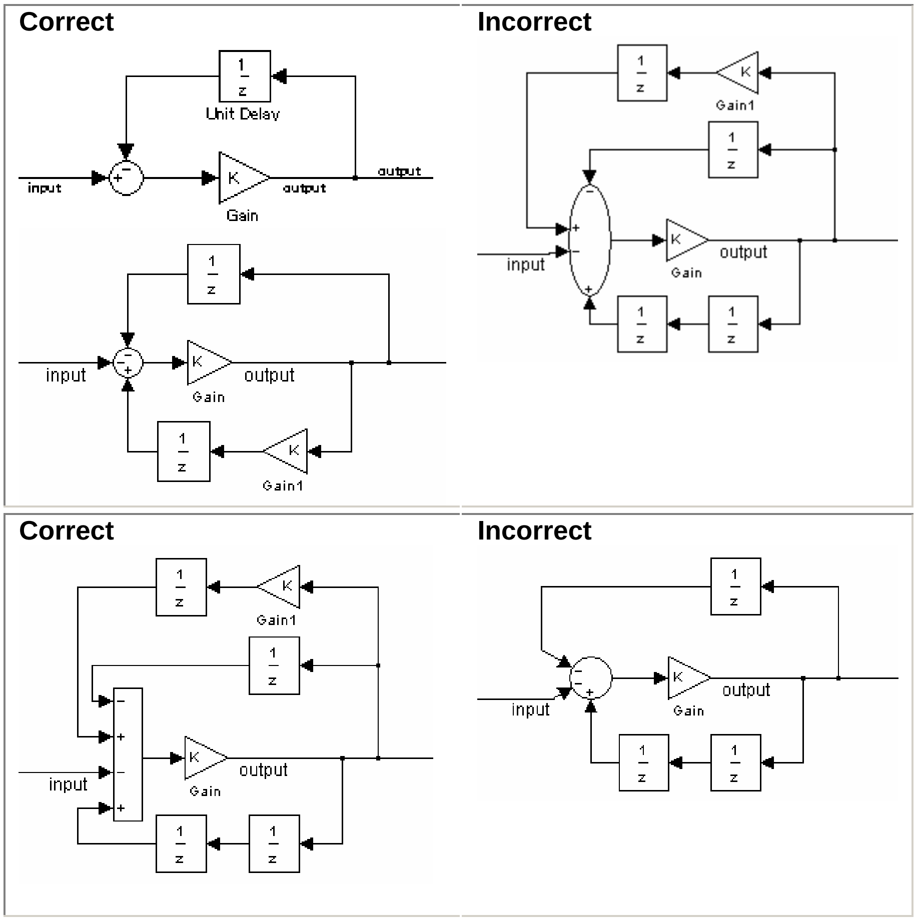
6.3.6. jc_0141: Use of the Switch block

ID: Title	**jc_0141: Use of the Switch block**
Priority	strongly recommended
Scope	MAAB
MATLAB Version	All
Prerequisites	
Description	The switch condition, input 2, must be a Boolean value. The block parameter “Criteria for passing first input” should be set to u2~=0. The block parameter “Criteria for passing first input” must not be set to u2>Threshold for R13 versions of MATLAB. **Correct**  1 In1 double 20 double >= boolean AAA double BBB double Switch double 1 Out1  Function Block Parameters: Switch Switch Main Signal Data Types Pass through input 1 when input 2 satisfies the selected criterion; otherwise, pass through input 3. The inputs are numbered top to bottom (or left to right). The input 1 pass-through criteria are input 2 greater than or equal, greater than, or not equal to the threshold. The first and third input ports are data ports, and the second input port is the control port. Criteria for passing first input: u2 ~= 0 Threshold: 0 **Incorrect**  AAA double 1 In1 double BBB double Switch <Threshold=20> double 1 Out1

	 Main | Signal Data Types Criteria for passing first input: u2 >= Threshold Threshold: 20
Rationale	☑ Readability ☑ Workflow ☐ Simulation ☐ Verification and Validation ☐ Code Generation
Last Change	V2.0

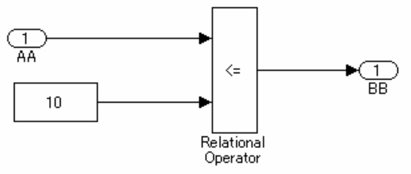
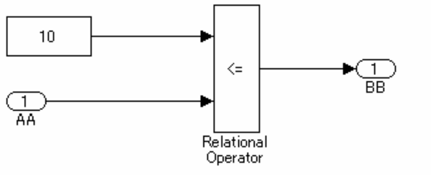
6.3.7. jc_0121: Use of the Sum block

ID: Title	**Jc_0121: Use of the Sum block**
Priority	recommended
Scope	MAAB
MATLAB Version	All
Prerequisites	
Description	Sum blocks should: • Use the “rectangular” shape. • Be sized so that the input signals do not overlap.  • The round shape can be used in feedback loops. • There should be no more then 3 inputs. • The inputs may be positioned at 90,180,270 degrees. • The output should be positioned at 0 degrees.

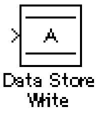
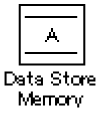
	 Correct Incorrect Correct Incorrect 1 z Unit Delay input output K Gain Gain1
Rationale	☑ Readability ☐ Workflow ☐ Simulation ☐ Verification and Validation ☐ Code Generation
Last Change	V2.0

6.3.8. jc_0131: Use of Relational Operator block

ID: Title	**jc_0131: Use of Relational Operator block**
Priority	recommended
Scope	J-MAAB
MATLAB Version	All
Prerequisites	
Description	When the relational operator is used to compare a signal to a constant value the constant input should be the second (lower) input.

	Correct  **Incorrect** 
Rationale	☑ Readability ☐ Verification and Validation ☐ Workflow ☑ Code Generation ☐ Simulation
Last Change	V2.0

6.3.9. jc_0161: Use of Data Store Read/Write/Memory blocks

ID: Title	**jc_0161: Use of Data Store Read / Write / Memory blocks**
Priority	strongly recommended
Scope	J-MAAB
MATLAB Version	All
Prerequisites	Jc_0341: Data flow layer
Description	Data Read A Data Store Read Data Store Write  Data Store Memory  • Prohibited in a data flow layer. • Allowed between subsystems running at different rates.
Rationale	☑ Readability ☐ Verification and Validation ☑ Workflow ☐ Code Generation ☐ Simulation
Last Change	V2.0

6.4. Block Parameters

6.4.1. db_0112: Indexing

ID: Title	**db_0112: Indexing**
Priority	strongly recommended
Scope	MAAB
MATLAB Version	All
Prerequisites	
Description	One based indexing [1, 2, 3,…] is used for • MATLAB • Workspace variables and structures • Local variables of m-functions

	• Global variables • Simulink • Signal vectors and matrices • Parameter vectors and matrices • M-coded S-Function input and output signal vectors and matrices • M-coded S-Function parameter vectors and matrices • M-coded S-Function local variables • Stateflow • Input and output signal vectors and matrices • Parameter vectors and matrices • Local variables Zero based Indexing [0, 1, 2, ...] is used for • Simulink • C-coded S-Function input and output signal vectors and matrices • C-coded S-Function input parameters • C-coded S-Function parameter vectors and matrices • C-coded S-Function local variables • Stateflow • Custom c-code variables and structures • C-Code • Local variables and structures • Global variables
Rationale	☑ Readability ☑ Workflow ☐ Simulation ☐ Verification and Validation ☑ Code Generation
Last Change	V2.0

6.4.2. na_0010: Grouping data flows into signals

ID: Title	**na_0010: Grouping data flows into signals**
Priority	strongly recommended
Scope	MAAB
MATLAB Version	All
Prerequisites	
Description	Vectors The individual scalar signals composing a vector must have common functionality, data types, dimensions and units. The most common example of a vector signal is sensor or actuator data that is grouped into an array indexed by location. The output of a Mux block must always be a vector. The inputs to a Mux block must always be scalars. Busses Signals that do not meet the vectorization criteria described above must only be grouped into bus signals. Bus selector blocks may only be used with a bus signal input; they must not be used to extract scalar signals from vector signals. Examples Some examples of vector signals include:

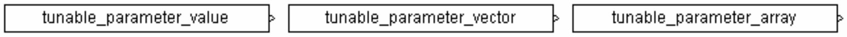
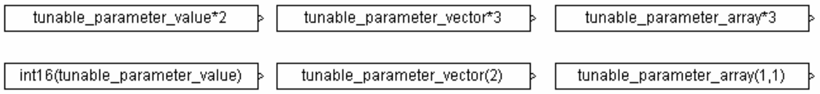
Row vector	[1 n]
Column vector	[n 1]
Wheel speed vector	[1 Number of wheels]
Cylinder vector	[1 Number of cylinders]
Position vector based on 2-D coordinates	[1 2]
Position vector based on 3-D coordinates	[1 3]

Some examples of bus signals include:

Bus Type	Elements
Sensor Bus	Force Vector [Fx, Fy, Fz]
	Position
	Wheel Speed Vector $[\Theta_{lf}, \Theta_{rf}, \Theta_{lr}, \Theta_{rr}]$
	Acceleration
	Pressure
Controller Bus	Sensor Bus
	Actuator Bus
Serial Data Bus	Coolant Temperature

Rationale	☑ Readability ☑ Workflow □ Simulation □ Verification and Validation □ Code Generation
Last Change	V2.0

6.4.3. db_0110: Tunable parameters in basic blocks

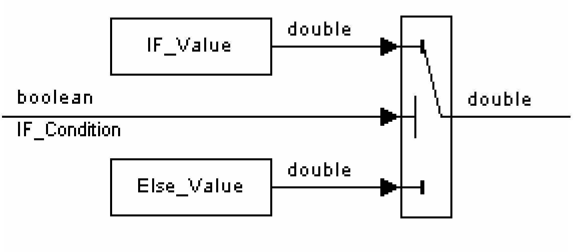
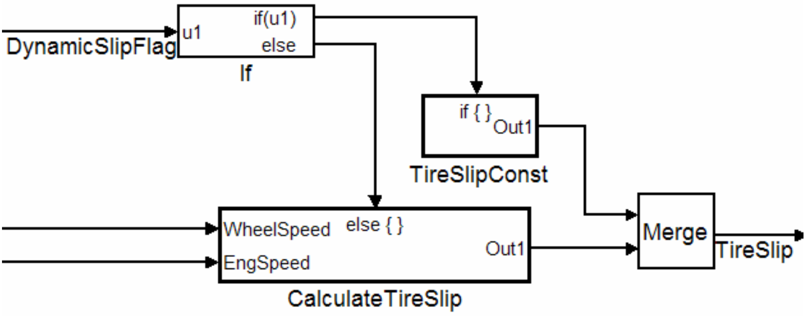
ID: Title	**db_0110: Tunable parameters in basic blocks**
Priority	strongly recommended
Scope	MAAB
MATLAB Version	All
Prerequisites	
Description	To insure that a parameter is tunable it must be entered in the basic block • Without any expression. • Without a data type conversion. • Without selection of rows or columns. **Correct**  tunable_parameter_value tunable_parameter_vector tunable_parameter_array **Incorrect**  tunable_parameter_value*2 tunable_parameter_vector*3 tunable_parameter_array*3 int16(tunable_parameter_value) tunable_parameter_vector(2) tunable_parameter_array(1,1)

Rationale	☑ Readability ☐ Verification and Validation ☑ Workflow ☑ Code Generation ☐ Simulation
Last Change	V2.0

6.5. Simulink Patterns

The following rules illustrate sample patterns used in Simulink diagrams. As such they would normally be part of a much larger Simulink diagram.

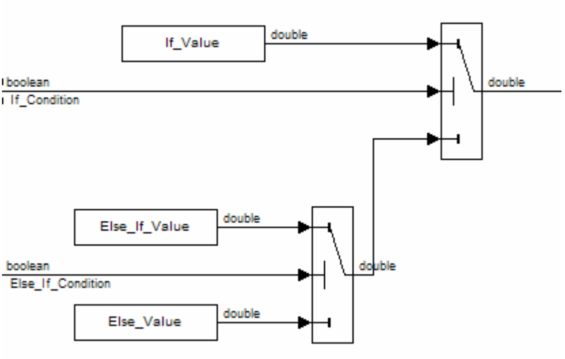
6.5.1. na_0012: Use of Switch vs. If-Then-Else Action Subsystem

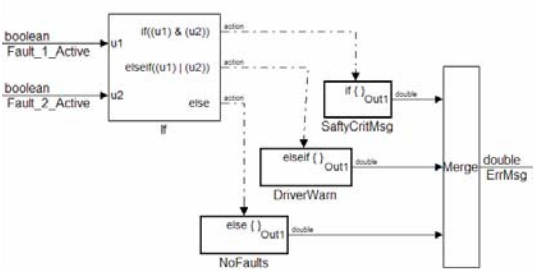
ID: Title	**na_0012: Use of Switch vs. If-Then-Else Action Subsystem**
Priority	strongly recommended
Scope	MAAB
MATLAB Version	All
Prerequisites	
Description	The **Switch** block: • Should be used for modeling simple *if-then-else* structures if the associated *then* and *else* actions involve only the assignment of constant values.  IF_Value double boolean IF_Condition double Else_Value double The **if-then-else action subsystem** construct: • Should be used for modeling *if-then-else structures* if the associated *then* and/or *else* actions require complicated computations. This will maximize simulation efficiency and the efficiency of generated code (Note that even a basic block, for example a table look-up, can require fairly complicated computations.)  DynamicSlipFlag u1 if(u1) else If if { } Out1 TireSlipConst WheelSpeed EngSpeed else { } Out1 CalculateTireSlip Merge TireSlip • Must be used for modeling *if-then-else* structures if the purpose of the construct is to avoid an undesirable numerical computation, such as division by zero. • Should be used for modeling *if-then-else* structures if the explicit or implied

	then or the *else* action is just to hold the associated output value(s). In other cases, the degree of complexity of the *then* and/or *else* action computations and the intelligence of the Simulink simulation and code generation engines will determine the appropriate construct. These statements also apply to more complicated nested and cascaded *if-then-else* structures and *case* structure implementations.
Rationale	☑ Readability □ Verification and Validation ☑ Workflow □ Code Generation □ Simulation
Last Change	V2.0

6.5.2. db_0114: Simulink patterns for If-then-else-if constructs

<table>
<tr><td><b>ID: Title</b></td><td><b>db_0114: Simulink patterns for If-then-else-if constructs</b></td></tr>
<tr><td>Priority</td><td>strongly recommended</td></tr>
<tr><td>Scope</td><td>MAAB</td></tr>
<tr><td>MATLAB Version</td><td>All</td></tr>
<tr><td>Prerequisites</td><td></td></tr>
<tr><td>Description</td><td>The following patterns should be used for If-then-else-if constructs within Simulink:
<table>
<tr><td>Equivalent Functionality</td><td>Simulink pattern</td></tr>
<tr><td>IF THEN ELSE IF with blocks

<i>if (If_Condition) {</i>
<i>output_signal = If_Value;</i>
<i>}</i>
<i>else if (Else_If_Condition) {</i>
<i>output_signal = Else_If_Value;</i>
<i>}</i>
<i>else {</i>
<i>output_signal = Else_Value;</i>
<i>}</i></td><td>
</td></tr>
</table></td></tr>
</table>

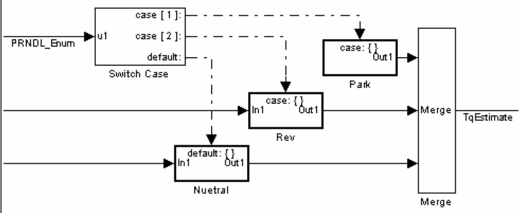
	IF THEN ELSE IF
	with if/then/else subsystems:
	if(Fault_1_Active & Fault_2_Active)
	{
	ErrMsg = SaftyCrit;
	}
	else if (Fault_1_Active | Fault_2_Active)
	
	{
	ErrMsg = DriveWarn;
	}
	else
	{
	ErrMsg = NoFaults;
	}
		 boolean
		Fault_1_Active
		boolean
		Fault_2_Active
		u1
		u2
		if((u1) & (u2))
		elseif((u1) | (u2))
		else
		If
		action
		action
		action
		if { }
		Out1
		SaftyCritMsg
		elseif { }
		Out1
		DriverWarn
		else { }
		Out1
		NoFaults
		double
		double
		double
		Merge
		double
		ErrMsg

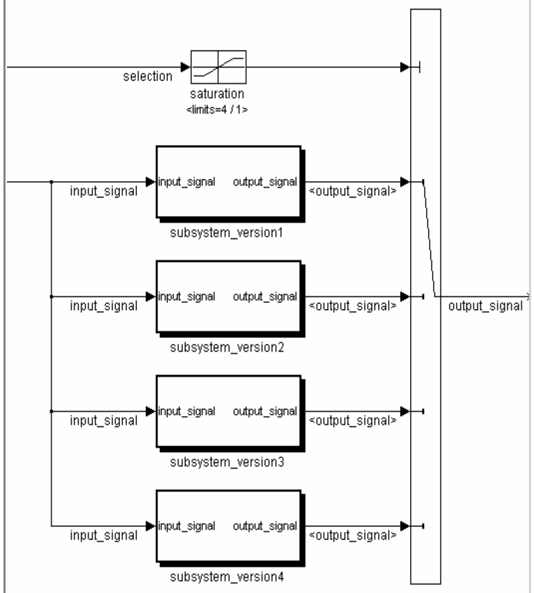
Rationale	☑ Readability ☑ Workflow ☐ Simulation	☐ Verification and Validation ☑ Code Generation
Last Change	V2.0	

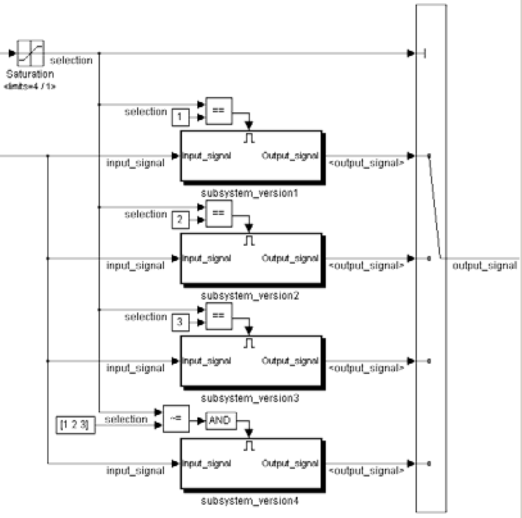
6.5.3. db_0115: Simulink patterns for case constructs

ID: Title	**db_0115: Simulink patterns for case constructs**
Priority	strongly recommended
Scope	MAAB
MATLAB Version	All
Prerequisites	
Description	The following patterns are used for case constructs within Simulink:

Equivalent Functionality	Simulink Pattern

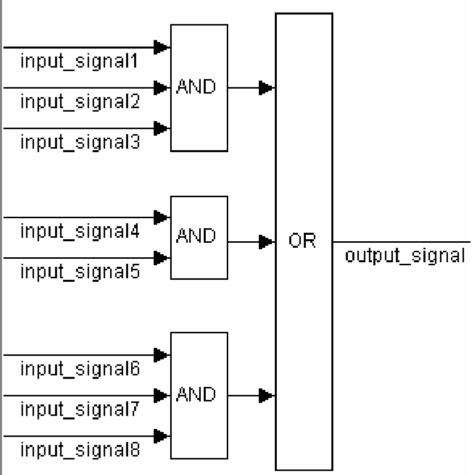
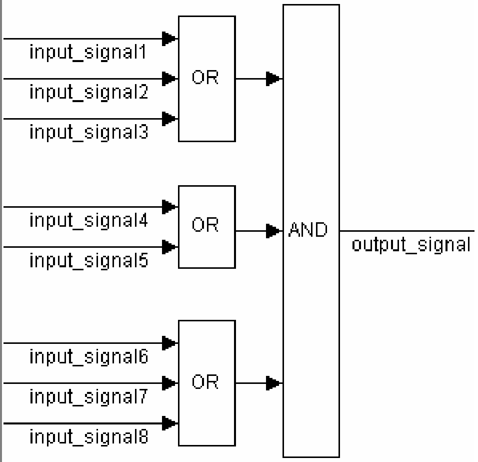
Case
With switch case block
 	
switch (PRNDL_Enum)
{
case 1
TqEstimate = ParkV;
break;
case 2
TqEstimae = RevV;
break;
default
TqEstimate = NeutralV;
break;
}
	 PRNDL_Enum
	u1
	case [1]:
	case [2]:
	default:
	Switch Case
	case: { }
	Out1
	Park
	case: { }
	In1
	Out1
	Rev
	default: { }
	In1
	Out1
	Nuetral
	Merge
	Merge
	TqEstimate

	CASE
	with subsystems:
	
	output_version1 =
	function_version1(input_signal);
	output_version2 =
	function_version2(input_signal);
	output_version3 =
	function_version3(input_signal);
	output_version4 =
	function_version4(input_signal);
	
	switch (selection) {
	case 1:
	output_signal = output_version1;
	break;
	case 2:
	output_signal = output_version2;
	break;
	case 3:
	output_signal = output_version3;
	break;
	case 4:
	output_signal = output_version4;
	}
		 selection
		saturation
		<limits=4 / 1>
		input_signal
		input_signal
		output_signal
		<output_signal>
		subsystem_version1
		input_signal
		input_signal
		output_signal
		<output_signal>
		subsystem_version2
		output_signal
		input_signal
		input_signal
		output_signal
		<output_signal>
		subsystem_version3
		input_signal
		input_signal
		output_signal
		<output_signal>
		subsystem_version4

	CASE
	with enabled subsystems:
	
	switch (selection) {
	case 1:
	output_version1 =
	function_version1(input_signal);
	output_signal = output_version1;
	break;
	case 2:
	output_version2 =
	function_version2(input_signal);
	output_signal = output_version2;
	break;
	case 3:
	output_version3 =
	function_version3(input_signal);
	output_signal = output_version3;
	break;
	default:
	output_version4 =
	function_version4(input_signal);
	output_signal = output_version4;
	}
		 Saturation
		<limits=4 / 1>
		selection
		selection
		1
		==
		input_signal
		Input_signal
		Output_signal
		<output_signal>
		subsystem_version1
		selection
		2
		==
		input_signal
		Input_signal
		Output_signal
		<output_signal>
		subsystem_version2
		output_signal
		selection
		3
		==
		input_signal
		Input_signal
		Output_signal
		<output_signal>
		subsystem_version3
		[1 2 3]
		selection
		~=
		AND
		input_signal
		Input_signal
		Output_signal
		<output_signal>
		subsystem_version4

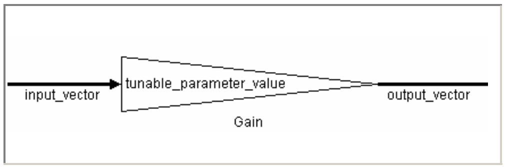
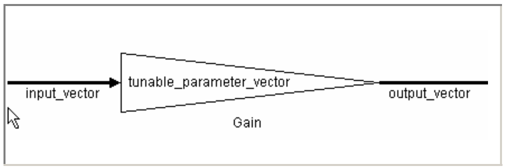
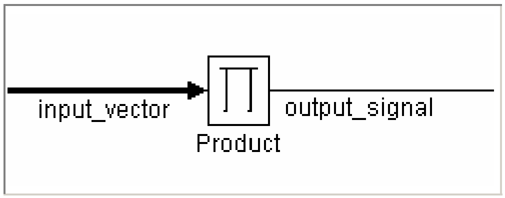
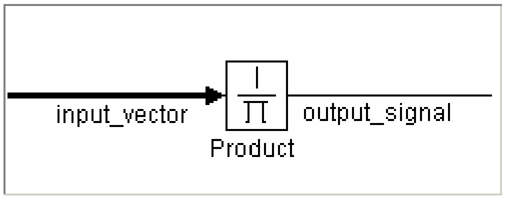
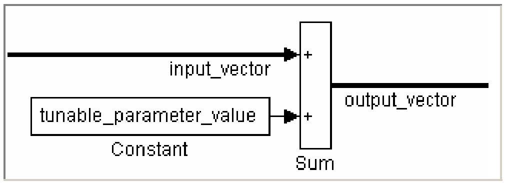
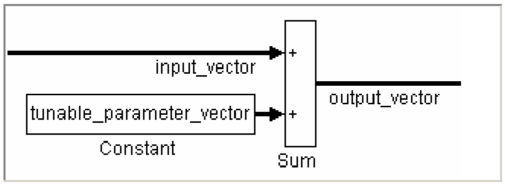
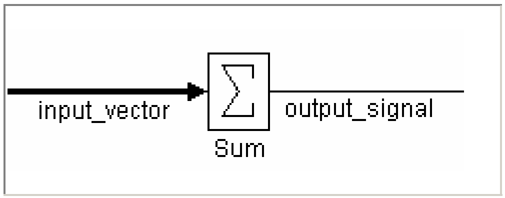
Rationale	☑ Readability ☑ Workflow ☐ Simulation	☑ Verification and Validation ☐ Code Generation
Last Change	V2.0	

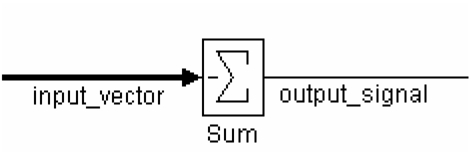
6.5.4. db_0116: Simulink patterns for logical constructs with logical blocks

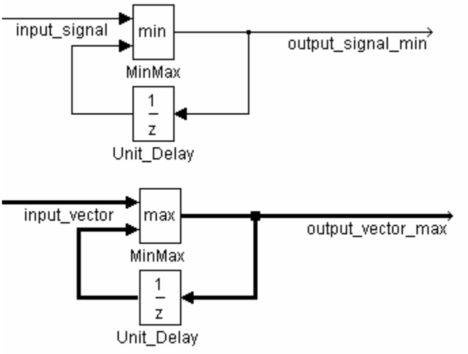
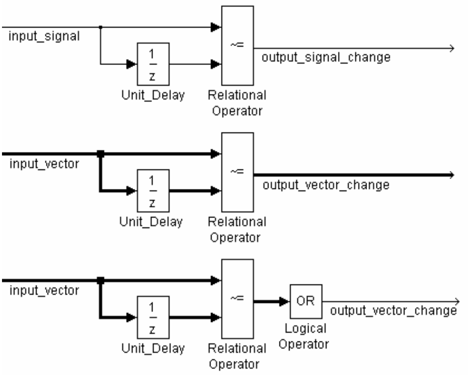
<table>
<tr><td><b>ID: Title</b></td><td><b>db_0116: Simulink patterns for logical constructs with logical blocks</b></td></tr>
<tr><td>Priority</td><td>strongly recommended</td></tr>
<tr><td>Scope</td><td>MAAB</td></tr>
<tr><td>MATLAB Version</td><td>All</td></tr>
<tr><td>Prerequisites</td><td></td></tr>
<tr><td>Description</td><td>
<table>
<tr><td colspan="2">The following patterns are used for logical combinations within Simulink:</td></tr>
<tr><th>Equivalent Functionality</th><th>Simulink pattern</th></tr>
<tr><td>Combination of logical signals: conjunctive</td><td>
</td></tr>
<tr><td>Combination of logical signals: disjunctive</td><td>
</td></tr>
</table>
</td></tr>
<tr><td>Rationale</td><td>☑ Readability
☑ Workflow
☐ Simulation
☑ Verification and Validation
☐ Code Generation</td></tr>
<tr><td>Last Change</td><td>V1.00</td></tr>
</table>

6.5.5. db_0117: Simulink patterns for vector signals

ID: Title	**db_0117: Simulink patterns for vector signals**

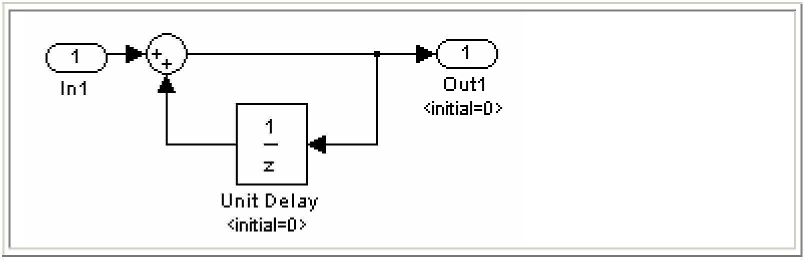
<table>
<tr><td>Priority</td><td>strongly recommended</td></tr>
<tr><td>Scope</td><td>MAAB</td></tr>
<tr><td>MATLAB Version</td><td>All</td></tr>
<tr><td>Prerequisites</td><td></td></tr>
<tr><td>Description</td><td>The following patterns are used for vector signals within Simulink:
<table>
<tr><th>Equivalent Functionality</th><th>Simulink Pattern</th></tr>
<tr><td>Vector loop:
for (i=0; i>input_vector_size; i++) {
output_vector(i) = input_vector(i) * tunable_parameter_value;
}</td><td>
</td></tr>
<tr><td>Vector loop:
for (i=0; i>input_vector_size; i++) {
output_vector(i) = input_vector(i) * tunable_parameter_vector(i);
}</td><td>
</td></tr>
<tr><td>Vector loop:
output_signal = 1;
for (i=0; i>input_vector_size; i++) {
output_signal = output_signal * input_vector(i);
}</td><td>
</td></tr>
<tr><td>Vector loop:
output_signal = 1;
for (i=0; i>input_vector_size; i++) {
output_signal = output_signal / input_vector(i);
}</td><td>
</td></tr>
<tr><td>Vector loop:
for (i=0; i>input_vector_size; i++) {
output_vector(i) = input_vector(i) + tunable_parameter_value;
}</td><td>
</td></tr>
<tr><td>Vector loop:
for (i=0; i>input_vector_size; i++) {
output_vector(i) = input_vector(i) + tunable_parameter_vector(i);
}</td><td>
</td></tr>
<tr><td>Vector loop:
output_signal = 0;
for (i=0; i>input_vector_size; i++) {
output_signal = output_signal + input_vector(i);
}</td><td>
</td></tr>
</table></td></tr>
</table>

	Vector loop:
	output_signal = 0;
	for (i=0; i>input_vector_size; i++) {
	output_signal = output_signal -
	input_vector(i);
	}
		

	Minimum or maximum of a signal or a vector over time:	 input_signal min MinMax output_signal_min 1 z Unit_Delay input_vector max MinMax output_vector_max 1 z Unit_Delay
	Change event of a signal or a vector:	 input_signal 1 z Unit_Delay ~= Relational Operator output_signal_change input_vector 1 z Unit_Delay ~= Relational Operator output_vector_change input_vector 1 z Unit_Delay ~= Relational Operator OR Logical Operator output_vector_change
Rationale	☑ Readability ☑ Workflow ☐ Simulation	☑ Verification and Validation ☑ Code Generation
Last Change	V1.00	

6.5.6. jc_0351: Methods of initialization

ID: Title	**jc_0351: Methods of initialization**
Priority	recommended
Scope	MAAB
MATLAB Version	All
Prerequisites	db_0140: Display of block parameters
Description	**Simple initialization:** • Blocks such as the Unit Delay, that have an initial value field can be used to set simple initial values. • To determine if the initial value needs to be displayed see db_0140. **Example**

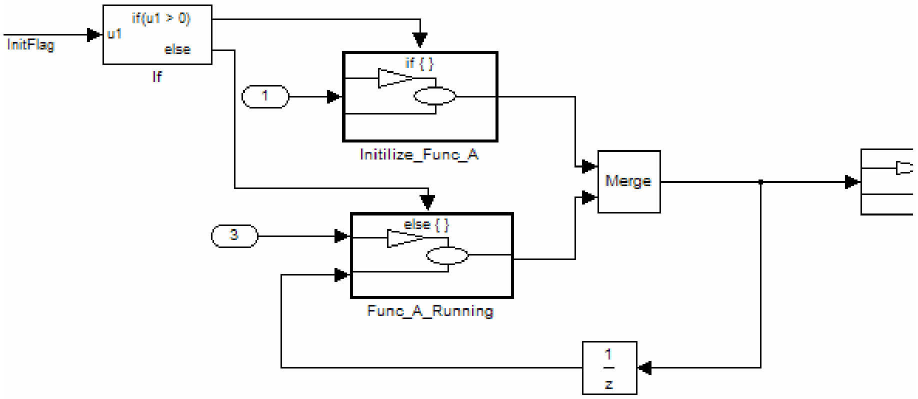


Initialization that requires computation:
For complex initializations the following rules hold.

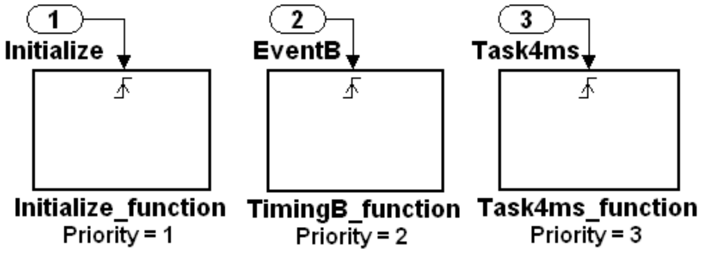
- The initialization should be performed in a separate subsystem.
- The initialization subsystem should have a name that indicates that initialization is performed by the subsystem.

Complex initializations can either be done at a local level (Example A) or at a global level (Example B) or a combination.

Example A



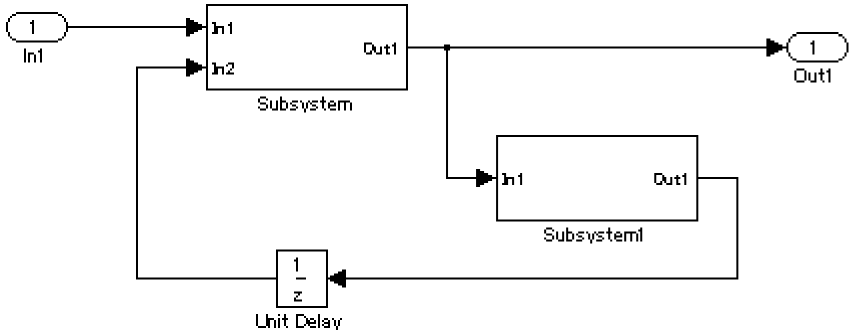
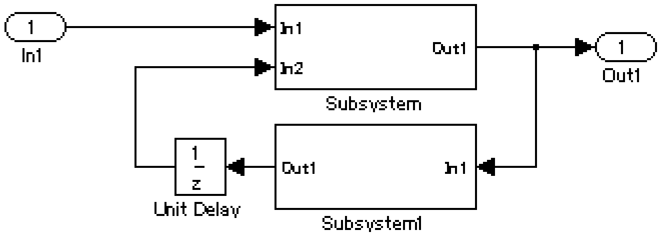
Example B



Rationale	☐ Readability ☑ Workflow ☐ Simulation ☐ Verification and Validation ☐ Code Generation
Last Change	V2.0

6.5.7. jc_0111: Direction of Subsystem

ID: Title	jc_0111: Direction of Subsystem
Priority	strongly recommended
Scope	J-MAAB
MATLAB	All

Version	
Prerequisites	
Description	Subsystem must not be reversed. **Correct**  1 In1 In1 In2 Out1 Subsystem 1 Out1 In1 Out1 Subsystem1 1 z Unit Delay **Incorrect**  1 In1 In1 In2 Out1 Subsystem 1 Out1 1 z Unit Delay Out1 In1 Subsystem1
Rationale	☑ Readability □ Workflow □ Simulation □ Verification and Validation □ Code Generation
Last Change	V2.0

7.Stateflow

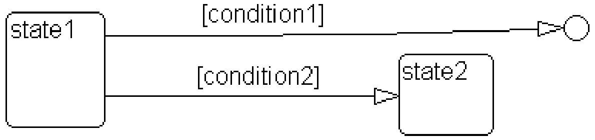
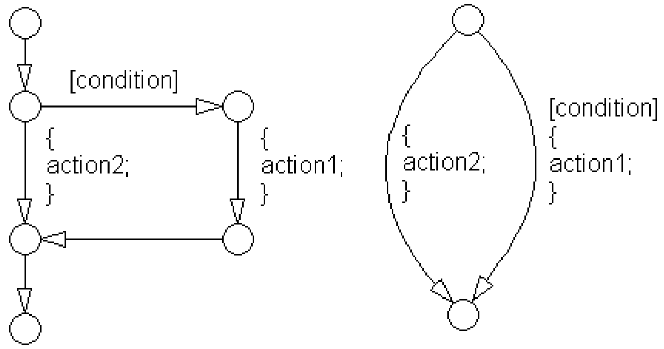
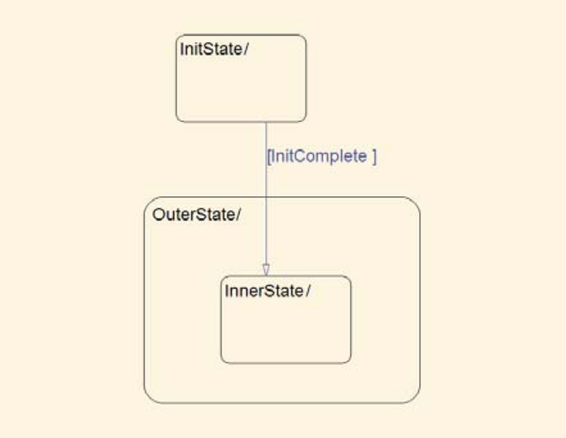
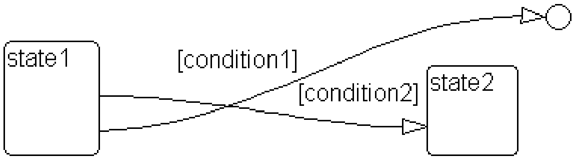
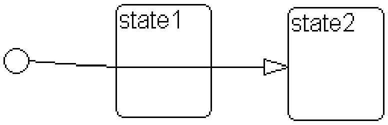
7.1. Chart Appearance

7.1.1. db_0123: Stateflow port names

ID: Title	**db_0123: Stateflow port names**
Priority	strongly recommended
Scope	MAAB
MATLAB Version	All
Prerequisites	
Description	The name of a Stateflow input/output should be the same as the corresponding signal. Exception: Reusable Stateflow blocks may have different port names.
Rationale	☑ Readability ☑ Workflow ☐ Simulation ☐ Verification and Validation ☐ Code Generation
Last Change	V1.00

7.1.2. db_0129: Stateflow transition appearance

ID: Title	**db_0129: Stateflow transition appearance**
Priority	strongly recommended
Scope	MAAB
MATLAB Version	All
Prerequisites	
Description	Transitions in Stateflow: • Do not cross each other, if possible. • Are not drawn one upon the other. • Do not cross any states, junctions or text fields. • Are allowed if transitioning to an internal state. Transition labels can be visually associated to the corresponding transition. **Correct**

	
	 [condition]
	{
	action2;
	}
	{
	action1;
	}
	{
	action2;
	}
	[condition]
	{
	action1;
	}
	
	Incorrect
	
	

Rationale	☑ Readability ☐ Verification and Validation ☑ Workflow ☐ Code Generation ☐ Simulation
Last Change	V2.0

7.1.3. db_0137: States in state machines

ID: Title	db_0137: States in state machines
Priority	mandatory
Scope	MAAB

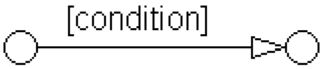
MATLAB Version	All
Prerequisites	db_0149: Flowchart patterns for condition actions
Description	In state machines: • There are at least two exclusive states. • A state cannot have only one substate. • The initial state of a hierarchical level with exclusive states is clearly defined by a default transition.
Rationale	☑ Readability ☑ Verification and Validation ☑ Workflow ☐ Code Generation ☐ Simulation
Last Change	V2.0

7.1.4. db_0133: Use of patterns for Flowcharts

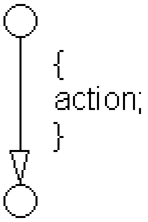
ID: Title	**db_0133: Use of patterns for Flowcharts**
Priority	strongly recommended
Scope	MAAB
MATLAB Version	All
Prerequisites	
Description	A Flowchart is built with the help of Flowchart patterns (e.g. IF-THEN-ELSE, FOR LOOP, etc.): • The data flow is oriented from the top to the bottom. • Patterns are connected with empty transitions.
Rationale	☑ Readability ☑ Verification and Validation ☑ Workflow ☐ Code Generation ☐ Simulation
Last Change	V1.00

7.1.5. db_0132: Transitions in Flowcharts

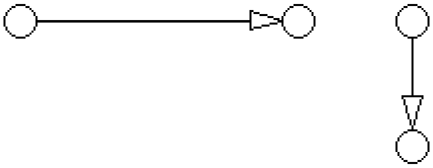
ID: Title	**db_0132: Transitions in Flowcharts**
Priority	strongly recommended
Scope	MAAB
MATLAB Version	All
Prerequisites	
Description	The following rules apply to transitions in Flowcharts: • Conditions are drawn on the horizontal. • Actions are drawn on the vertical. • Loop constructs are intentional exceptions to this rule. A transition in a Flowchart has a condition, a condition action or an empty transition. Transition with condition:



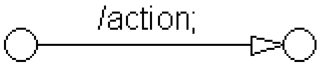
Transition with condition action:



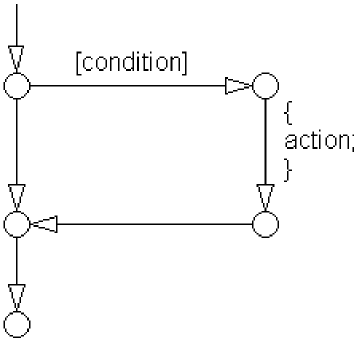
Empty transition:



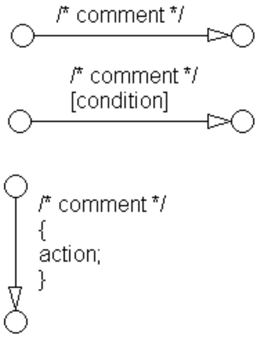
Transition actions are not used in Flowcharts. Transition actions are only valid when used in transitions between states in a state machine, otherwise they are not activated because of the inherent dependency on a valid state to state transition to activate them.
Transition action:



At every junction, except for the last junction of a flow diagram, exactly one unconditional transition begins. Every decision point (junction) must have a default path.



A transition may have a comment:

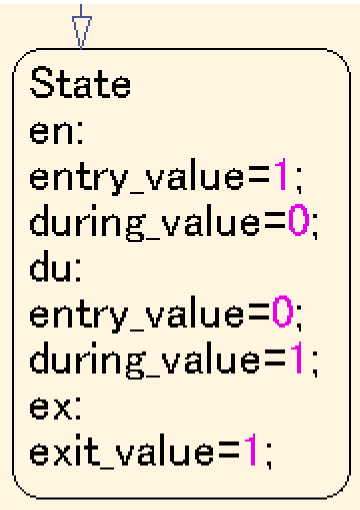


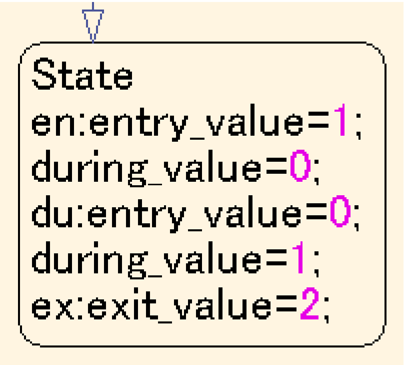
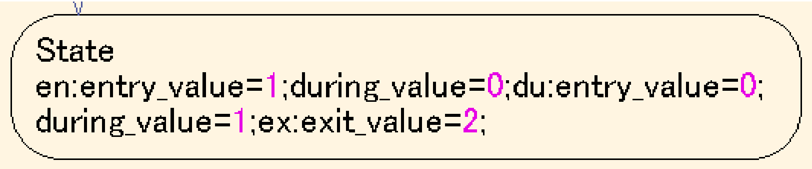
Rationale	☑ Readability ☑ Verification and Validation

	☑ Workflow ☐ Code Generation ☐ Simulation
Last Change	V2.0

7.1.6. jc_0501: Format of entries in a State block

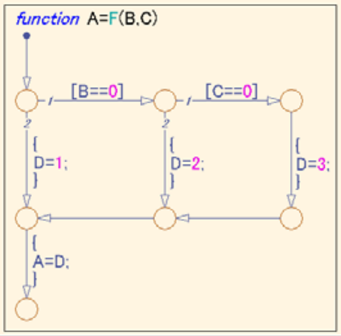
ID: Title	**jc_501: Format of entries in a State block**
Priority	recommended
Scope	MAAB
MATLAB Version	All
Prerequisites	

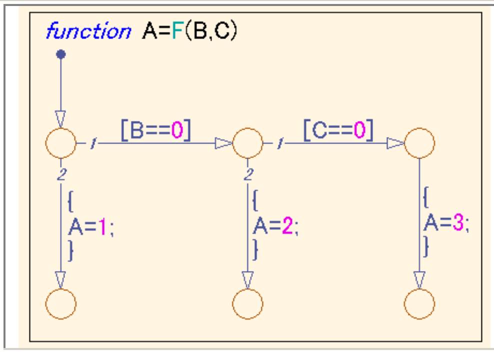
Description	A new line should be:
	- Started after the entry (en) during (du), and exit (ex) statements.
	- Started after the completion of an assignment statement ";".
	Correct
	
	State
	en:
	entry_value=1;
	during_value=0;
	du:
	entry_value=0;
	during_value=1;
	ex:
	exit_value=1;

	Incorrect
	Failed to start a new line after en, du and ex.
	
	State
	en:entry_value=1;
	during_value=0;
	du:entry_value=0;
	during_value=1;
	ex:exit_value=2;
	Incorrect
	Failed to start a new line after the completion of an assignment statement ";".
	
	State
	en:entry_value=1;during_value=0;du:entry_value=0;
	during_value=1;ex:exit_value=2;

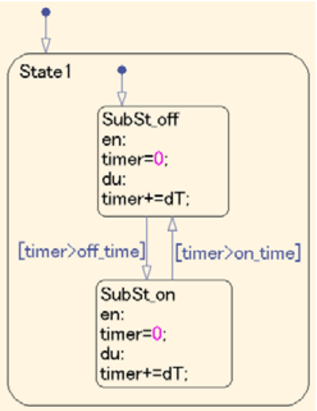
Rationale	☑ Readability ☐ Workflow ☐ Simulation ☐ Verification and Validation ☐ Code Generation
Last Change	V2.0

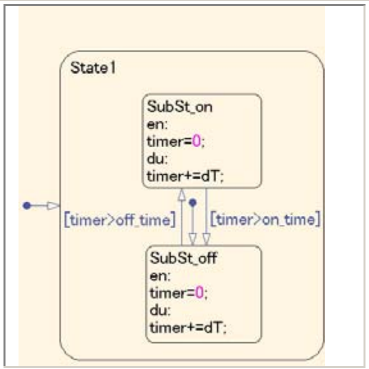
7.1.7. jc_0511: Setting the return value from a graphical function

ID: Title	**jc_0511: Setting the return value from a graphical function**
Priority	mandatory
Scope	J-MAAB
MATLAB Version	All
Prerequisites	
Description	The return value from a graphical function must be set in only one place. **Correct** Return value A is set in one place  function A=F(B,C) [B==0] [C==0] 2 2 { D=1; } { D=2; } { D=3; } { A=D; } **Incorrect** Return value A is set in multiple places.

<table>
<tr><td></td><td>
</td></tr>
<tr><td>Rationale</td><td>☐ Readability
☑ Workflow
☐ Simulation
☐ Verification and Validation
☑ Code Generation</td></tr>
<tr><td>Last Change</td><td>V2.0</td></tr>
</table>

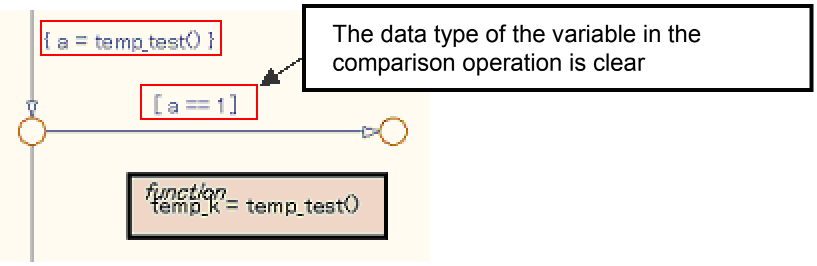
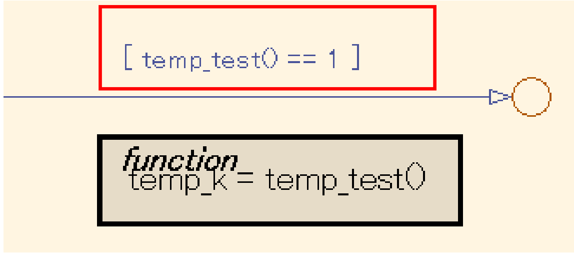
7.1.8. jc_0531: Placement of the default transition

<table>
<tr><td><b>ID: Title</b></td><td><b>jc_0531: Placement of the default transition</b></td></tr>
<tr><td>Priority</td><td>recommended</td></tr>
<tr><td>Scope</td><td>J-MAAB</td></tr>
<tr><td>MATLAB Version</td><td>All</td></tr>
<tr><td>Prerequisites</td><td></td></tr>
<tr><td>Description</td><td>
<ul>
<li>Default transition is connected at the top of the state.</li>
<li>The destination state of the default transition is put above the other states in the same hierarchy.</li>
</ul>
<table>
<tr><td><b>Correct</b>

</td><td>
<ul>
<li>The default transition is connected at the top of the state.</li>
<li>The destination state of the default transition is put above the other states in the same hierarchy.</li>
</ul></td></tr>
<tr><td><b>Incorrect</b></td><td>
<ul>
<li>Default transition is connected at the side of the state (State 1).</li>
<li>The destination state of the default transition is lower than the other states in the same hierarchy (SubSt_off).</li>
</ul></td></tr>
</table>
</td></tr>
</table>

	 State1
	SubSt_on
	en:
	timer=0;
	du:
	timer+=dT;
	[timer>off_time]
	[timer>on_time]
	SubSt_off
	en:
	timer=0;
	du:
	timer+=dT;

Rationale	☑ Readability ☐ Workflow ☐ Simulation ☐ Verification and Validation ☐ Code Generation
Last Change	V2.0

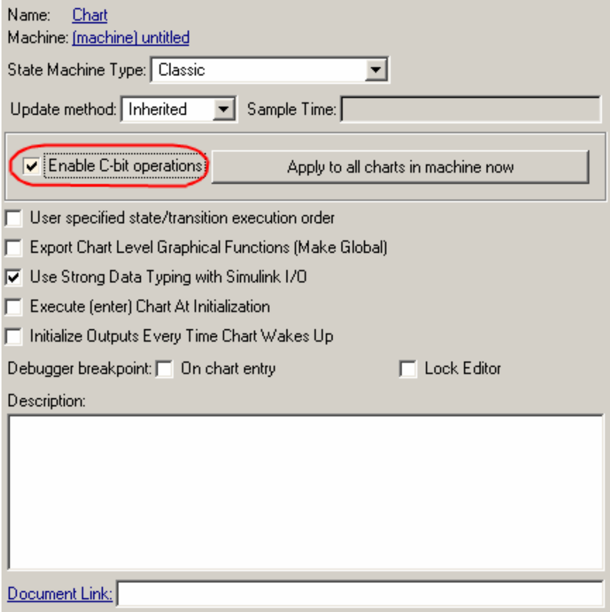
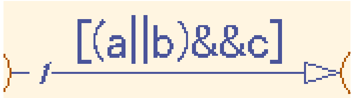
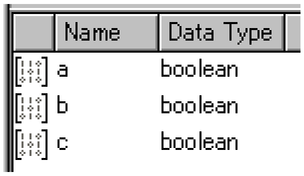
7.1.9. jc_0521: Use of the return value from graphical functions

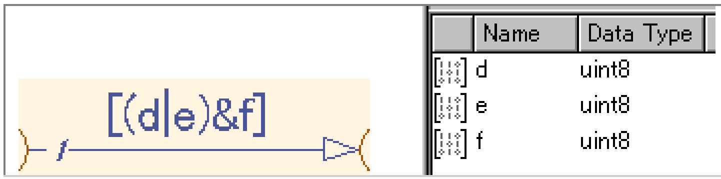
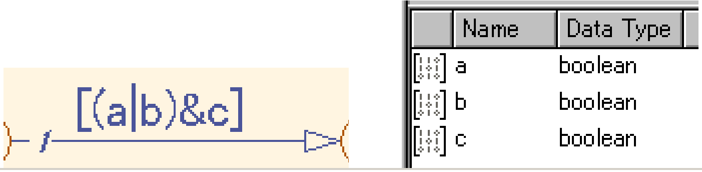
ID: Title	jc_0521: Use of the return value from graphical functions
Priority	recommended
Scope	J-MAAB
MATLAB Version	All
Prerequisites	
Description	The return value from a graphical function should not be used directly in a comparison operation. **Correct** An intermediate variable is used in the conditional expression after the assignment of the return value from the function "temp_test" to the intermediate variable "a".  { a = temp_test() } [a == 1] function temp_k = temp_test() The data type of the variable in the comparison operation is clear **Incorrect** Return value of the function “temp_test” is used in the conditional expression. 

Rationale	☑ Readability □ Workflow □ Simulation □ Verification and Validation □ Code Generation
Last Change	V2.0

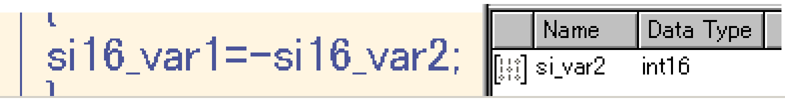
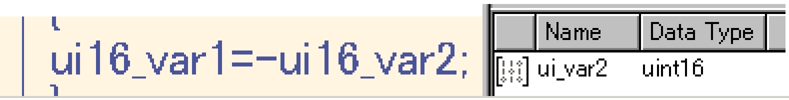
7.2. Stateflow data and operations

7.2.1. na_0001: Bitwise Stateflow operators

ID: Title	**na_0001: Bitwise Stateflow operators**
Priority	strongly recommended
Scope	MAAB
Prerequisites	
Description	The bitwise Stateflow operators (&, |, and ^) should not be used in Stateflow charts unless bitwise operations are desired. If bitwise operations are desired, the “Enable C-bit Operations” needs to be enabled. 1. From the File Menu \ Chart Properties. 2. Select Enable C-bit operations.  Name: Chart Machine: (machine) untitled State Machine Type: Classic Update method: Inherited Sample Time: ☑ Enable C-bit operations □ User specified state/transition execution order □ Export Chart Level Graphical Functions (Make Global) ☑ Use Strong Data Typing with Simulink I/O □ Execute (enter) Chart At Initialization □ Initialize Outputs Every Time Chart Wakes Up Debugger breakpoint: □ On chart entry □ Lock Editor Description: Document Link: **Correct** Use “&&” and “II” for Boolean operation.   Name Data Type a boolean b boolean c boolean Use “&” and “I” for bit operation.

<table>
<tr><td></td><td>
[(d|e)&f]
<table><tr><th>Name</th><th>Data Type</th></tr><tr><td>d</td><td>uint8</td></tr><tr><td>e</td><td>uint8</td></tr><tr><td>f</td><td>uint8</td></tr></table>
<b>Incorrect</b>
Use “&” and “I” for Boolean operation.

[(a|b)&c]
<table><tr><th>Name</th><th>Data Type</th></tr><tr><td>a</td><td>boolean</td></tr><tr><td>b</td><td>boolean</td></tr><tr><td>c</td><td>boolean</td></tr></table></td></tr>
<tr><td>Rational</td><td>□ Readability
□ Workflow
☑ Simulation
□ Verification and Validation
☑ Code Generation</td></tr>
<tr><td>Last Change</td><td>V 2.0</td></tr>
</table>

7.2.2. jc_0451: Use of unary minus on unsigned integers in Stateflow

<table>
<tr><td><b>ID: Title</b></td><td><b>jc_0451: Use of unary minus on unsigned integers in Stateflow</b></td></tr>
<tr><td>Priority</td><td>recommended</td></tr>
<tr><td>Scope</td><td>MAAB</td></tr>
<tr><td>MATLAB Version</td><td>All</td></tr>
<tr><td>Prerequisites</td><td></td></tr>
<tr><td>Description</td><td>Do not perform unary minus on unsigned integers.
<b>Correct</b>

{
si16_var1=-si16_var2;
}
<table><tr><th>Name</th><th>Data Type</th></tr><tr><td>si_var2</td><td>int16</td></tr></table>
<b>Incorrect</b>

{
ui16_var1=-ui16_var2;
}
<table><tr><th>Name</th><th>Data Type</th></tr><tr><td>ui_var2</td><td>uint16</td></tr></table></td></tr>
<tr><td>Rationale</td><td>☑ Readability
☑ Workflow
□ Simulation
□ Verification and Validation
☑ Code Generation</td></tr>
<tr><td>Last Change</td><td>V2.0</td></tr>
</table>

7.2.3. na_0013: Comparison operation in Stateflow

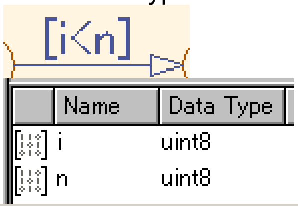
ID: Title	**na_0013: Comparison operation in Stateflow**
Priority	recommended
Scope	MAAB
MATLAB Version	All

<table>
<tr><td>Prerequisites</td><td></td></tr>
<tr><td>Description</td><td>

- Comparisons should be made only between variables of the same data type.
- If comparisons are made between variables of different data types then the variables need to be explicitly type cast to matching data types.

<table>
<tr><td>

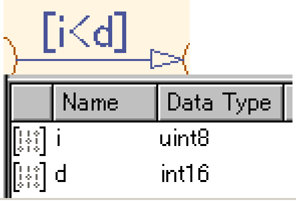
Correct
Same data type in “i” and “n”



Name	Data Type
i	uint8
n	uint8

</td><td>

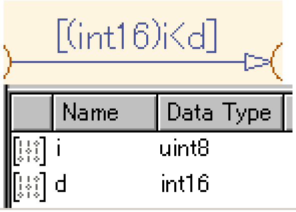
Incorrect
Different data type in “i” and “d”



Name	Data Type
i	uint8
d	int16

</td></tr>
<tr><td>

Correct



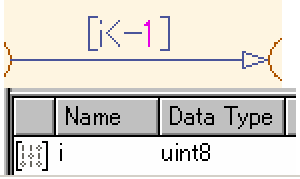
Name	Data Type
i	uint8
d	int16

</td><td></td></tr>
</table>

- Do not make comparisons between unsigned integers and negative numbers.

<table>
<tr><td>

Incorrect



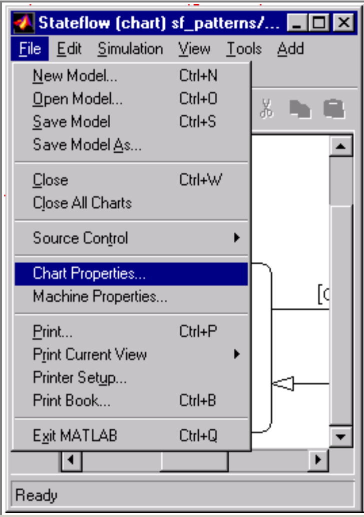
Name	Data Type
i	uint8

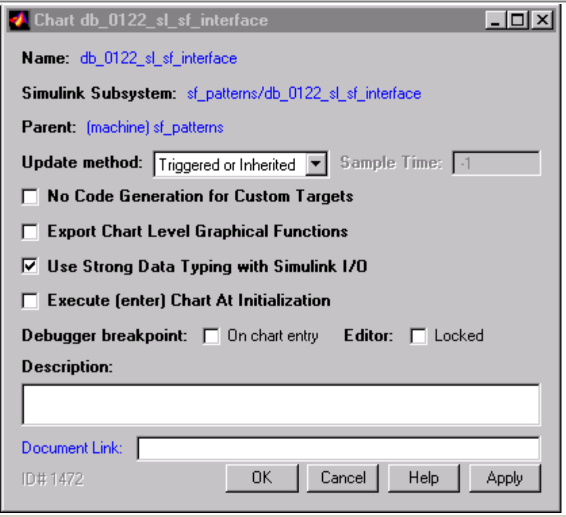
</td></tr>
</table>

</td></tr>
<tr><td>Rationale</td><td>☐ Readability ☐ Verification and Validation
☑ Workflow ☑ Code Generation
☐ Simulation</td></tr>
<tr><td>Last Change</td><td>V2.0</td></tr>
</table>

7.2.4. db_0122: Stateflow and Simulink interface signals and parameters

ID: Title	**db_0122: Stateflow and Simulink interface signals and parameters**
Priority	strongly recommended
Scope	MAAB
MATLAB Version	All
Prerequisites	
Description	A Chart uses strong data typing with Simulink (The option "Use Strong Data Typing with Simulink I/O" must be selected).

<table>
<tr><td></td><td>




Name: db_0122_sl_sf_interface
Simulink Subsystem: sf_patterns/db_0122_sl_sf_interface
Parent: (machine) sf_patterns
Update method: Triggered or Inherited Sample Time: -1
□ No Code Generation for Custom Targets
□ Export Chart Level Graphical Functions
☑ Use Strong Data Typing with Simulink I/O
□ Execute (enter) Chart At Initialization
Debugger breakpoint: □ On chart entry Editor: □ Locked
Description:
Document Link:
ID# 1472

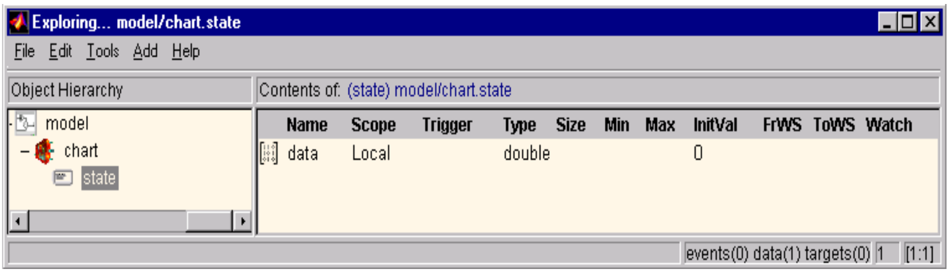
</td></tr>
<tr><td>Rationale</td><td>☑ Readability ☑ Verification and Validation
☑ Workflow □ Code Generation
□ Simulation</td></tr>
<tr><td>Last Change</td><td>V2.0</td></tr>
</table>

7.2.5. db_0125: Scope of internal signals and local auxiliary variables

<table>
<tr><td><b>ID: Title</b></td><td><b>db_0125: Scope of internal signals and local auxiliary variables</b></td></tr>
<tr><td>Priority</td><td>strongly recommended</td></tr>
<tr><td>Scope</td><td>MAAB</td></tr>
<tr><td>MATLAB Version</td><td>All</td></tr>
<tr><td>Prerequisites</td><td></td></tr>
<tr><td>Description</td><td>
Internal signals and local auxiliary variables are "Local data" in Stateflow:

- All local data of a Stateflow block must be defined on the chart level or below the Object Hierarchy.
- There must be no local variables on the machine level (i.e. there is no interaction between local data in different charts).
- Parameters and constants are allowed at the machine level.

<b>Correct</b>

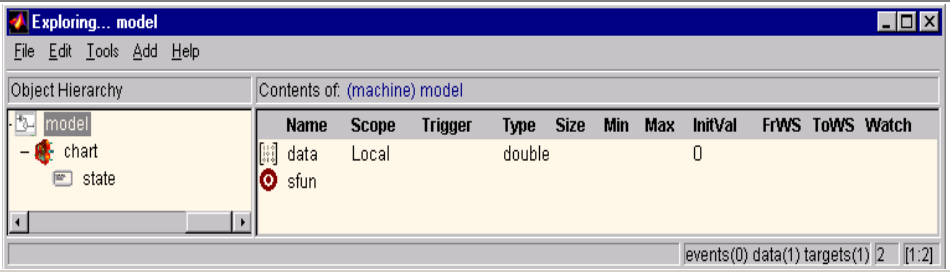


Contents of: (state) model/chart.state

Name	Scope	Trigger	Type	Size	Min	Max	InitVal	FrWS	ToWS	Watch
data	Local		double				0			

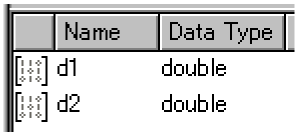
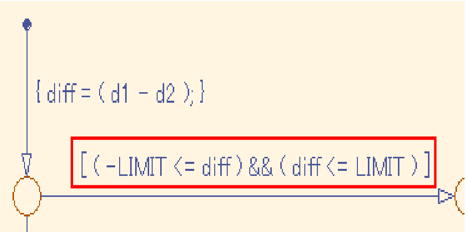
events(0) data(1) targets(0) 1 [1:1]

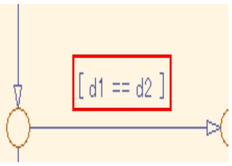
<b>Incorrect</b>
</td></tr>
</table>

<table>
<tr><td></td><td>


Contents of: (machine) model
<table>
<tr><th></th><th>Name</th><th>Scope</th><th>Trigger</th><th>Type</th><th>Size</th><th>Min</th><th>Max</th><th>InitVal</th><th>FrWS</th><th>ToWS</th><th>Watch</th></tr>
<tr><td></td><td>data</td><td>Local</td><td></td><td>double</td><td></td><td></td><td></td><td>0</td><td></td><td></td><td></td></tr>
<tr><td></td><td>sfun</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>
events(0) data(1) targets(1) 2 [1:2]
</td></tr>
<tr><td>Rationale</td><td>☑ Readability ☑ Verification and Validation
☑ Workflow □ Code Generation
□ Simulation</td></tr>
<tr><td>Last Change</td><td>V2.0</td></tr>
</table>

7.2.6. jc_0481: Use of hard equality comparisons for floating point numbers in Stateflow

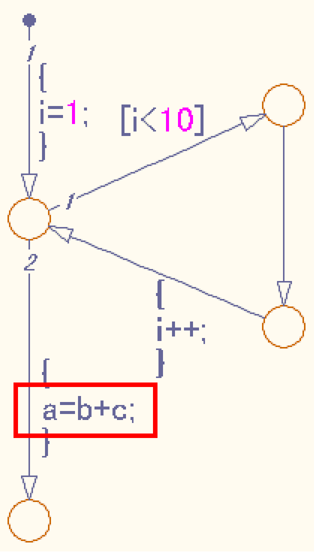
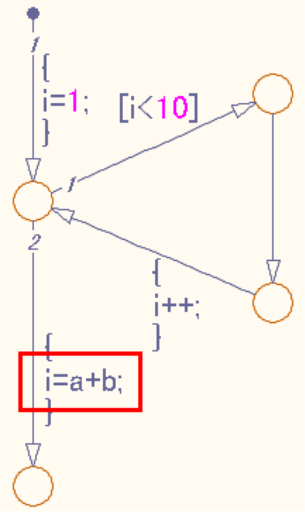
<table>
<tr><td><b>ID: Title</b></td><td><b>jc_0481: Use of hard equality comparisons for floating point numbers in Stateflow</b></td></tr>
<tr><td>Priority</td><td>recommended</td></tr>
<tr><td>Scope</td><td>MAAB</td></tr>
<tr><td>MATLAB Version</td><td>All</td></tr>
<tr><td>Prerequisites</td><td></td></tr>
<tr><td>Description</td><td>
<ul>
<li>Do not use hard equality comparisons (Var1 == Var2) with two floating point numbers.</li>
<li>If a hard comparison is required a margin of error should be defined and used in the comparison (LIMIT in the example).</li>
<li>Hard equality comparisons can be done between two integer data types.</li>
</ul>
<b>Correct</b>

<table>
<tr><th></th><th>Name</th><th>Data Type</th></tr>
<tr><td></td><td>d1</td><td>double</td></tr>
<tr><td></td><td>d2</td><td>double</td></tr>
</table>


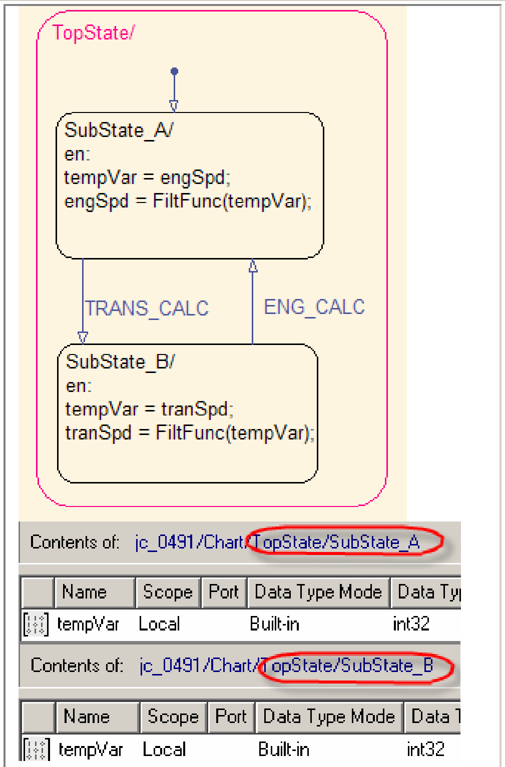
<b>Incorrect</b>


</td></tr>
<tr><td>Rationale</td><td>□ Readability ☑ Verification and Validation</td></tr>
</table>

	☑ Workflow ☑ Code Generation ☐ Simulation
Last Change	V2.0

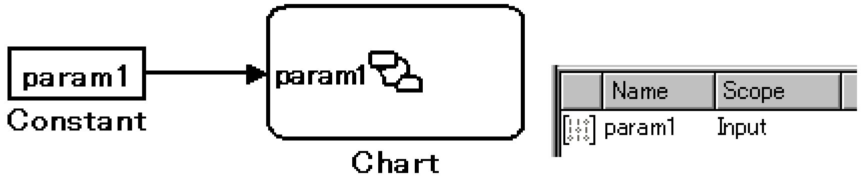
7.2.7. jc_0491: Reuse of variables within a single Stateflow scope

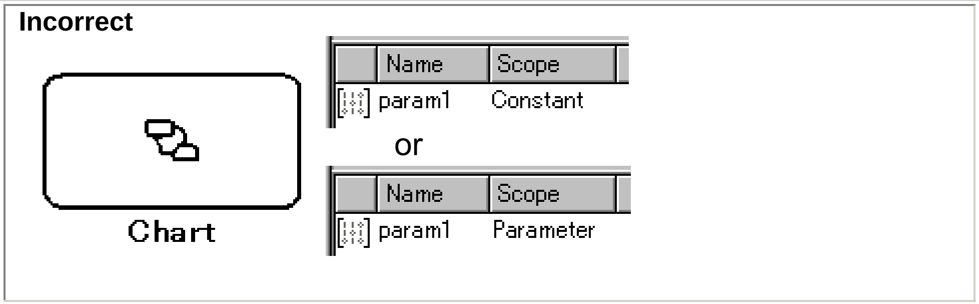
<table>
<tr><td><b>ID: Title</b></td><td><b>jc_0491: Reuse of variables within a single Stateflow scope</b></td></tr>
<tr><td>Priority</td><td>recommended</td></tr>
<tr><td>Scope</td><td>MAAB</td></tr>
<tr><td>MATLAB Version</td><td>All</td></tr>
<tr><td>Prerequisites</td><td></td></tr>
<tr><td>Description</td><td>The same variable should not have multiple meanings (usages) within a single Stateflow scope.
<table>
<tr><td><b>Correct</b>
Variable of loop counter must not be used other than loop counter.

</td><td><b>Incorrect</b>
The meaning of the variable “i” changes from the index of the loop counter to the sum of a+b

</td></tr>
<tr><td><b>Correct</b>
tempVar is defined as local scope in both SubState_A and SubState_B</td><td></td></tr>
</table>
</td></tr>
</table>

	 TopState/
	SubState_A/
	en:
	tempVar = engSpd;
	engSpd = FiltFunc(tempVar);
	TRANS_CALC
	ENG_CALC
	SubState_B/
	en:
	tempVar = tranSpd;
	tranSpd = FiltFunc(tempVar);
	Contents of: jc_0491/Chart/TopState/SubState_A
	Name / Scope / Port / Data Type Mode / Data Ty
	tempVar / Local / / Built-in / int32
	Contents of: jc_0491/Chart/TopState/SubState_B
	Name / Scope / Port / Data Type Mode / Data T
	tempVar / Local / / Built-in / int32

Rationale	☑ Readability ☑ Workflow ☐ Simulation ☐ Verification and Validation ☑ Code Generation
Last Change	V2.0

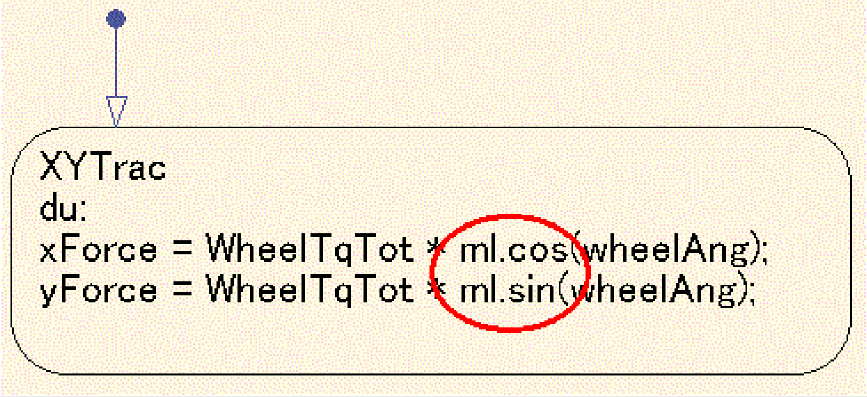
7.2.8. jc_0541: Use of tunable parameters in Stateflow

ID: Title	**jc_0541: Use of tunable parameters in Stateflow**
Priority	strongly recommended
Scope	MAAB
MATLAB Version	All
Prerequisites	
Description	Tunable parameters should be included in a Chart as inputs from the Simulink model. **Correct**  Name / Scope param1 / Input

	Incorrect  Name Scope param1 Constant or Name Scope param1 Parameter
Rationale	☑ Readability ☐ Verification and Validation ☑ Workflow ☑ Code Generation ☐ Simulation
Last Change	V2.0

7.2.9. db_0127: MATLAB commands in Stateflow

ID: Title	**db_0127: MATLAB commands in Stateflow**
Priority	mandatory
Scope	MAAB
MATLAB Version	All
Prerequisites	

Description	The following rules apply to logic in Stateflow:
	• MATLAB functions are not used.
	• MATLAB instructions are not used.
	• MATLAB operators are not used.
	• Project-specific MATLAB functions are not used.
	Incorrect
	
	XYTrac
	du:
	xForce = WheelTqTot * ml.cos(wheelAng);
	yForce = WheelTqTot * ml.sin(wheelAng);

Rationale	☑ Readability ☑ Verification and Validation ☑ Workflow ☑ Code Generation ☐ Simulation
Last Change	V2.0

7.2.10. jm_0011: Pointers in Stateflow

ID: Title	**jm_0011: Pointers in Stateflow**
Priority	strongly recommended
Scope	MAAB
MATLAB Version	All
Prerequisites	
Description	In a Stateflow diagram, pointers to custom code variables are not allowed.
Rationale	☑ Readability ☑ Workflow ☐ Simulation ☑ Verification and Validation ☑ Code Generation
Last Change	V1.00

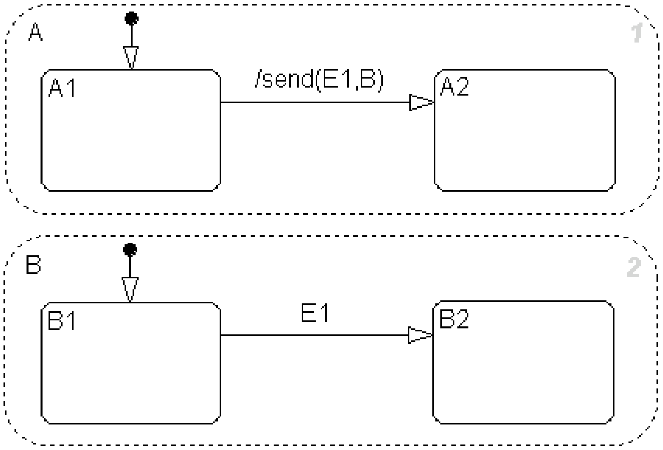
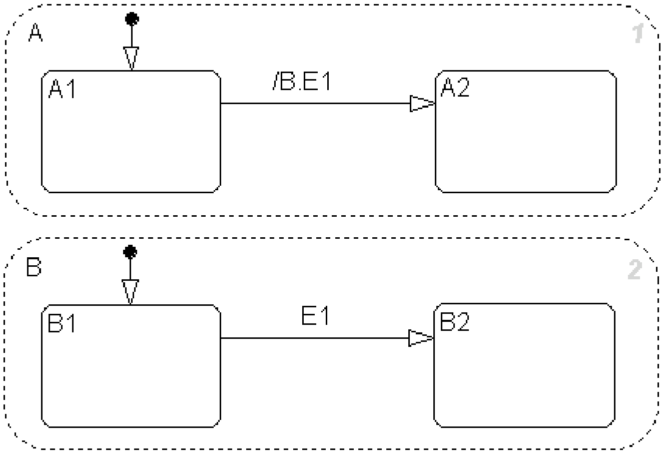
7.3. Events

7.3.1. db_0126: Scope of events

ID: Title	**db_0126: Scope of events**
Priority	Mandatory
Scope	MAAB
MATLAB Version	All
Prerequisites	
Description	The following rules apply to events in Stateflow: • All events of a Chart must be defined on the chart level or lower. • There is no event on the machine level (i.e. there is no interaction with local events between different charts).
Rationale	☑ Readability ☑ Workflow ☐ Simulation ☑ Verification and Validation ☐ Code Generation
Last Change	V2.0

7.3.2. jm_0012: Event broadcasts

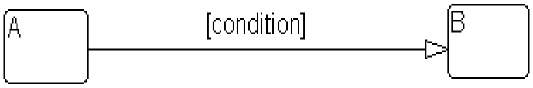
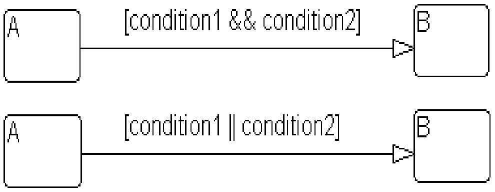
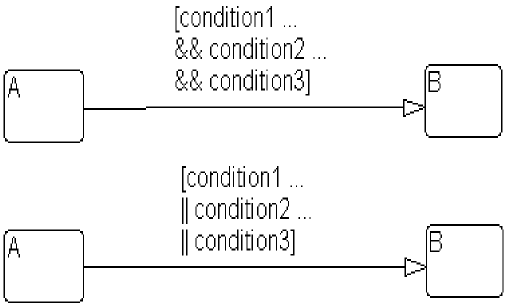
ID: Title	**jm_0012: Event broadcasts**
Priority	strongly recommended
Scope	MAAB
MATLAB Version	All
Prerequisites	db_0126: Scope of events
Description	The following rules apply to event broadcasts in Stateflow: • Directed event broadcasts are the only type of event broadcasts allowed. • The send syntax or qualified event names are used to direct the event to a particular state. • Multiple send statements should be used to direct an event to more than

	one state. Example using the send syntax:  A A1 /send(E1,B) A2 1 B B1 E1 B2 2 Example using qualified event names: 
Rationale	☑ Readability ☑ Workflow ☐ Simulation ☑ Verification and Validation ☑ Code Generation
Last Change	V1.00

7.4. Statechart Patterns

7.4.1. db_0150: State machine patterns for conditions

ID: Title	**db_0150: State machine patterns for conditions**
Priority	strongly recommended
Scope	MAAB
MATLAB Version	All
Prerequisites	
Description	The following patterns are used for conditions within Stateflow state machines:

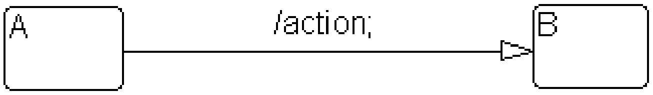
Equivalent Functionality	State Machine Pattern
ONE CONDITION: *(condition)*	
UP TO THREE CONDITIONS, SHORT FORM: (The use of different logical operators in this form is not allowed, use sub conditions instead) *(condition1 && condition2)* *(condition1 || condition2)*	 A [condition1 && condition2] B A [condition1 || condition2] B
TWO OR MORE CONDITIONS, MULTILINE FORM: A sub condition is a set of logical operations, all of the same type, enclosed in parentheses. (The use of different operators in this form is not allowed, use sub conditions instead) *(condition1 ...* *&& condition2 ...* *&& condition3)* *(condition1 ...* *|| condition2 ...* *|| condition3)*	 [condition1 ... && condition2 ... && condition3] A B [condition1 ... || condition2 ... || condition3] A B

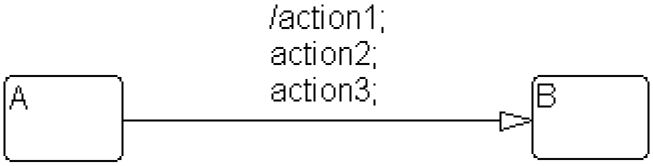
Rationale	☑ Readability ☑ Verification and Validation ☑ Workflow □ Code Generation □ Simulation
Last Change	V2.0

7.4.2. db_0151: State machine patterns for transition actions

ID: Title	**db_0151: State machine patterns for transition actions**
Priority	strongly recommended
Scope	MAAB
MATLAB Version	All
Prerequisites	
Description	The following patterns are used for transition actions within Stateflow state machines:

<table>
<tr><td></td><td>
<table>
<tr><th>Equivalent Functionality</th><th>State Machine Pattern</th></tr>
<tr><td>ONE TRANSITION ACTION:

<em>action;</em></td><td>
</td></tr>
<tr><td>TWO OR MORE TRANSITION ACTIONS, MULTILINE FORM: (Two or more transition actions in one line are not allowed)

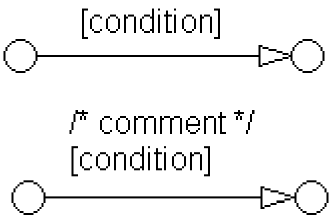
<em>action1;</em>
<em>action2;</em>
<em>action3;</em></td><td>
</td></tr>
</table>
</td></tr>
<tr><td>Rationale</td><td>☑ Readability ☑ Verification and Validation
☑ Workflow ☐ Code Generation
☐ Simulation</td></tr>
<tr><td>Last Change</td><td>V1.00</td></tr>
</table>

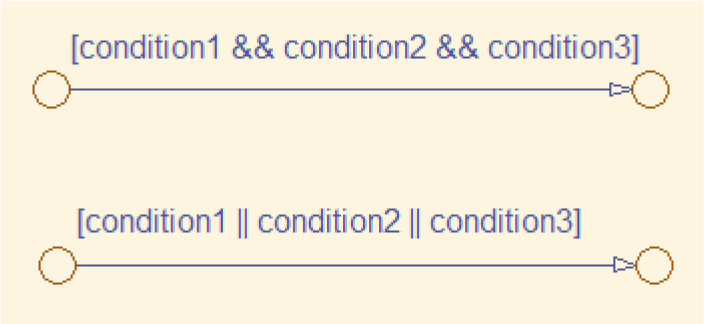
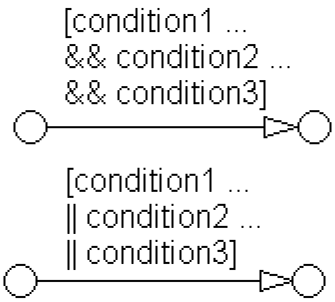
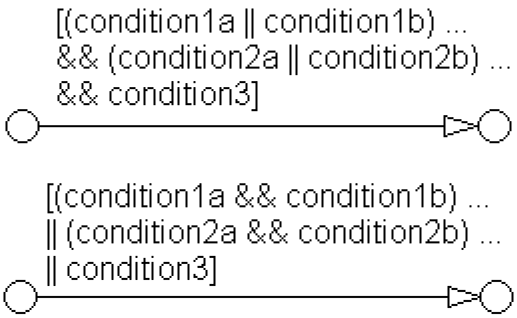
7.5. Flowchart Patterns

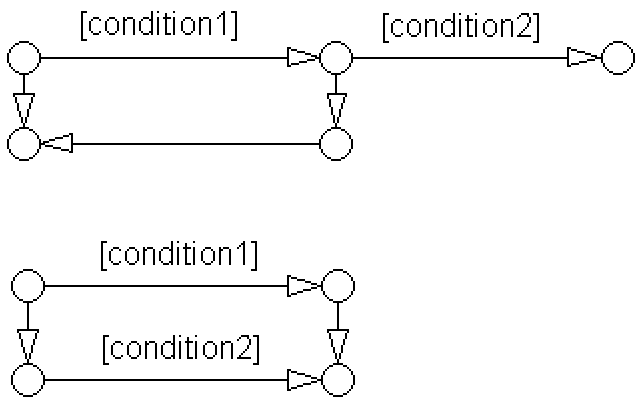
The following rules illustrate sample patterns used in flow charts. As such they would normally be part of a much larger Stateflow diagram.

7.5.1. db_0148: Flowchart patterns for conditions

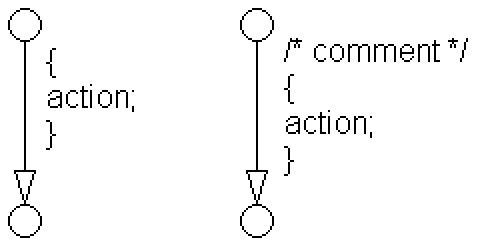
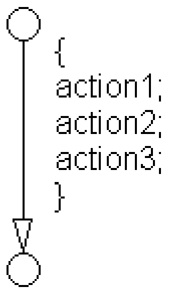
<table>
<tr><td><strong>ID: Title</strong></td><td><strong>db_0148: Flowchart patterns for conditions</strong></td></tr>
<tr><td>Priority</td><td>strongly recommended</td></tr>
<tr><td>Scope</td><td>MAAB</td></tr>
<tr><td>MATLAB Version</td><td>All</td></tr>
<tr><td>Prerequisites</td><td></td></tr>
<tr><td>Description</td><td>The following patterns are used for conditions within Stateflow Flowcharts:
<table>
<tr><th>Equivalent Functionality</th><th>Flowchart Pattern</th></tr>
<tr><td>ONE CONDITION:

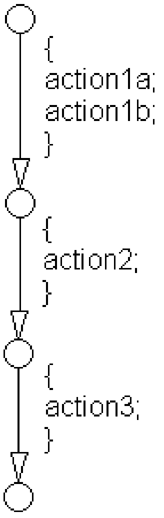
<em>[condition]</em></td><td>
</td></tr>
</table>
</td></tr>
</table>

	UP TO THREE CONDITIONS, SHORT FORM: (The use of different logical operators in this form is not allowed, use sub conditions instead.) *[condition1 && condition2 && condition3]* *[condition1 || condition2 || condition3]*	 [condition1 && condition2 && condition3] [condition1 || condition2 || condition3]
	TWO OR MORE CONDITIONS, MULTILINE FORM: (The use of different logical operators in this form is not allowed, use sub conditions instead.) *[condition1 ...* *&& condition2 ...* *&& condition3]* *[condition1 ...* *|| condition2 ...* *|| condition3]*	 [condition1 ... && condition2 ... && condition3] [condition1 ... || condition2 ... || condition3]
	CONDITIONS WITH SUBCONDITIONS: (The use of different logical operators to connect sub conditions is not allowed. The use of brackets is mandatory.) *[(condition1a || condition1b) ...* *&& (condition2a || condition2b) ...* *&& (condition3)]* *[(condition1a && condition1b) ...* *|| (condition2a && condition2b) ...* *|| (condition3)]*	 [(condition1a || condition1b) ... && (condition2a || condition2b) ... && condition3] [(condition1a && condition1b) ... || (condition2a && condition2b) ... || condition3]

	CONDITIONS, WHICH ARE VISUALLY SEPARATED: (This form can be mixed up with the patterns listed above.) *[condition1 && condition2]* *[condition1* || *condition2]*	 [condition1] [condition2] [condition1] [condition2]
Rationale	☑ Readability ☑ Workflow ☐ Simulation	☑ Verification and Validation ☐ Code Generation
Last Change	V2.0	

7.5.2. db_0149: Flowchart patterns for condition actions

ID: Title	**db_0149: Flowchart patterns for condition actions**	
Priority	strongly recommended	
Scope	MAAB	
MATLAB Version	All	
Prerequisites		
Description	The following patterns are used for condition actions within Stateflow Flowcharts:	
	Equivalent Functionality	**Flowchart Pattern**
	ONE CONDITION ACTION: action;	
	TWO OR MORE CONDITION ACTIONS, MULTILINE FORM: (Two or more condition actions in one line are not allowed.) action1; ... action2; ... action3; ...	

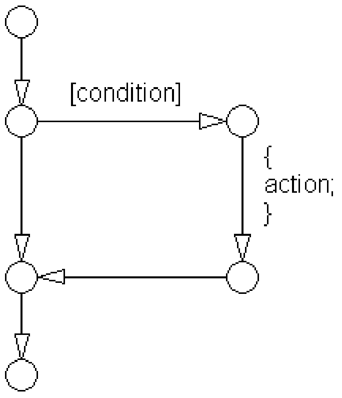
	CONDITION ACTIONS, WHICH ARE VISUALLY SEPARATED:
	(This form can be mixed up with the patterns listed above.)
	action1a;
	action1b;
	action2;
	action3;
		 {
		action1a;
		action1b;
		}
		{
		action2;
		}
		{
		action3;
		}

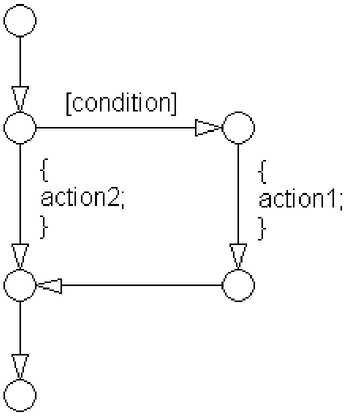
Rationale	☑ Readability ☑ Workflow ☐ Simulation	☑ Verification and Validation ☐ Code Generation
Last Change	V1.00	

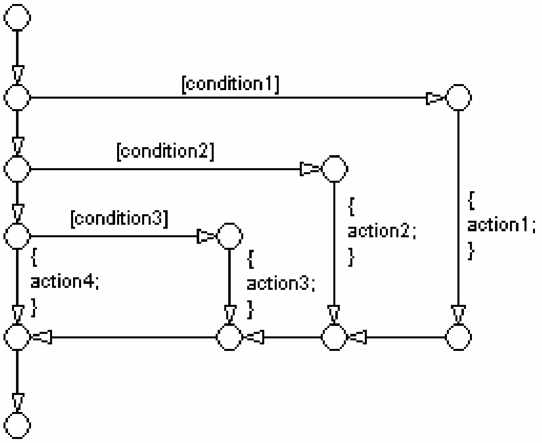
7.5.3. db_0134: Flowchart patterns for If constructs

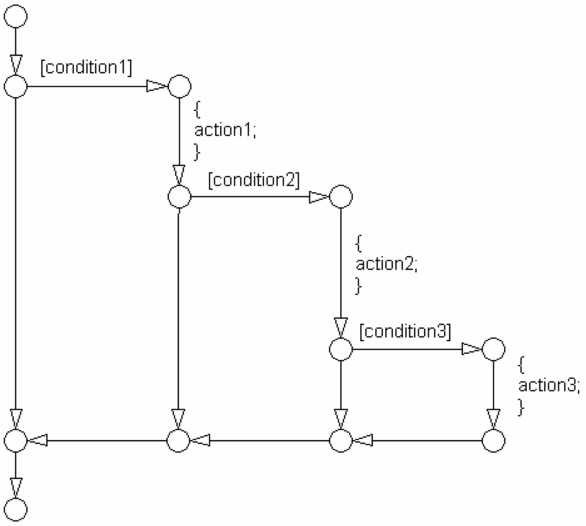
ID: Title	**db_0134: Flowchart patterns for If constructs**
Priority	strongly recommended
Scope	MAAB
MATLAB Version	All
Prerequisites	db_0148: Flowchart patterns for conditions db_0149: Flowchart patterns for condition actions
Description	The following patterns are used for If constructs within Stateflow Flowcharts:

Equivalent Functionality	**Flowchart Pattern**

IF THEN
if (condition){
    action;
}
	

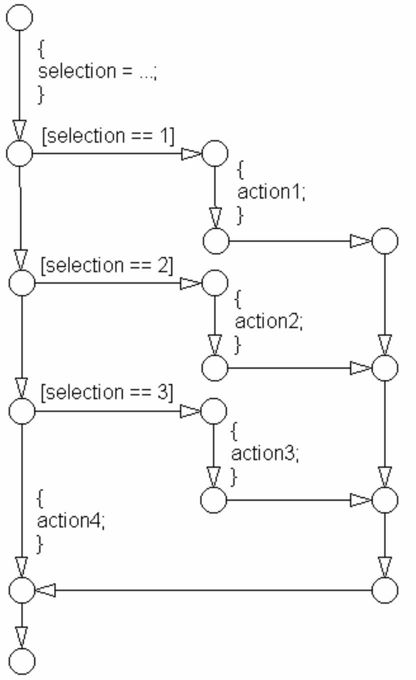
	IF THEN ELSE
	if (condition) {
	    action1;
	}
	else {
	    action2;
	}
		

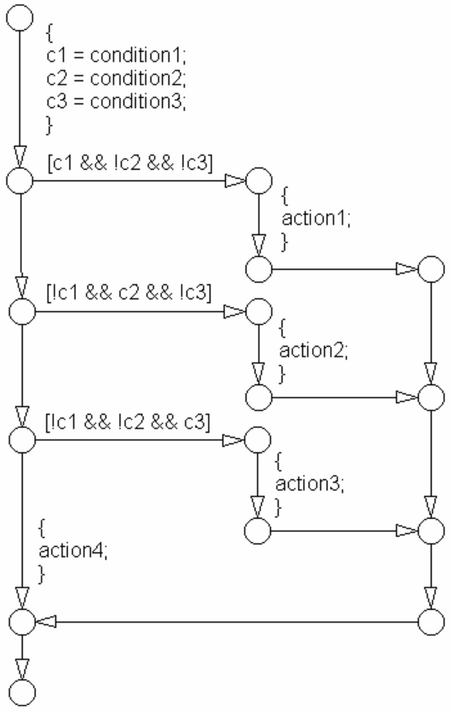
	IF THEN ELSE IF
	if (condition1) {
	    action1;
	}
	else if (condition2) {
	    action2;
	}
	else if (condition3) {
	    action3;
	}
	else {
	    action4;
	}
		 [condition1]
		[condition2]
		[condition3]
		{
		action1;
		}
		{
		action2;
		}
		{
		action3;
		}
		{
		action4;
		}

	Cascade of IF THEN
	if (condition1) {
	    action1;
	    if (condition2) {
	        action2;
	        if (condition3) {
	          action3;
	        }
	    }
	}
		 [condition1]
		{
		action1;
		}
		[condition2]
		{
		action2;
		}
		[condition3]
		{
		action3;
		}

Rationale	☑ Readability ☑ Workflow ☐ Simulation	☑ Verification and Validation ☐ Code Generation
Last Change	V1.00	

7.5.4. db_0159: Flowchart patterns for case constructs

<table>
<tr><th>ID: Title</th><th>db_0159: Flowchart patterns for case constructs</th></tr>
<tr><td>Priority</td><td>strongly recommended</td></tr>
<tr><td>Scope</td><td>MAAB</td></tr>
<tr><td>MATLAB Version</td><td>All</td></tr>
<tr><td>Prerequisites</td><td>db_0148: Flowchart patterns for conditions
db_0149: Flowchart patterns for condition actions</td></tr>
<tr><td>Description</td><td>The following patterns must be used for case constructs within Stateflow Flowcharts:
<table>
<tr><th>Equivalent Functionality</th><th>Flowchart Pattern</th></tr>
<tr><td><pre>
CASE with exclusive
selection
selection = ...;
switch (selection) {
    case 1:
        action1;
    break;
    case 2:
        action2;
    break;
    case 3:
        action3;
    break;
    default:
        action4;
}
</pre></td><td>
</td></tr>
</table></td></tr>
</table>

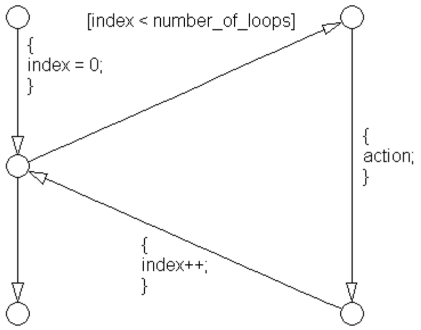
	CASE with exclusive conditions
	c1 = condition1;
	c2 = condition2;
	c3 = condition3;
	if (c1 && !c2 && !c3) {
	action1;
	}
	elseif (!c1 && c2 && !c3) {
	action2;
	}
	elseif (!c1 && !c2 && c3) {
	action3;
	}
	else {
	action4;
	}
		 {
		c1 = condition1;
		c2 = condition2;
		c3 = condition3;
		}
		[c1 && !c2 && !c3]
		{
		action1;
		}
		[!c1 && c2 && !c3]
		{
		action2;
		}
		[!c1 && !c2 && c3]
		{
		action3;
		}
		{
		action4;
		}

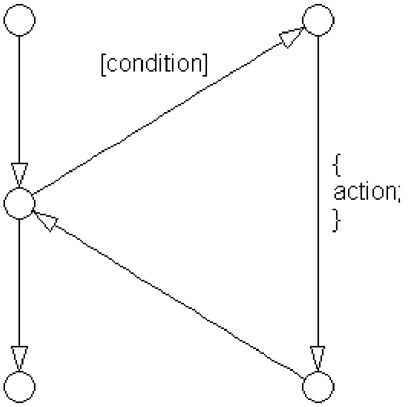
Rationale	☑ Readability ☑ Workflow ☐ Simulation	☑ Verification and Validation ☐ Code Generation
Last Change	V1.00	

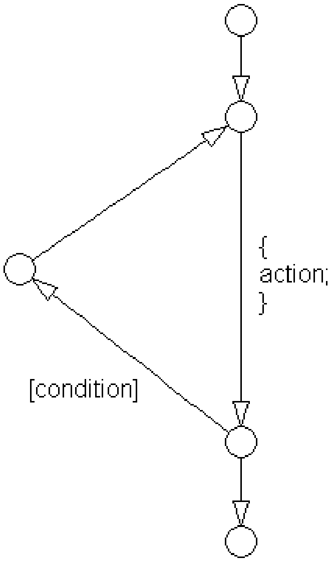
7.5.5. db_0135: Flowchart patterns for loop constructs

ID: Title	**db_0135: Flowchart patterns for loop constructs**
Priority	recommended
Scope	MAAB
MATLAB Version	All
Prerequisites	db_0148: Flowchart patterns for conditions db_0149: Flowchart patterns for condition actions
Description	The following patterns must be used to create Loops within Stateflow Flowcharts:

Equivalent Functionality	**Flowchart Pattern**

FOR LOOP
for
(index=0;index<number_of_loops;index++)
{
action;
}
	 [index < number_of_loops]
	{
	index = 0;
	}
	{
	action;
	}
	{
	index++;
	}

	WHILE LOOP
	while (condition) {
	action;
	}
		

	DO WHILE LOOP
	do {
	action;
	}
	while (condition);
		

Rationale	☑ Readability ☑ Workflow ☐ Simulation	☑ Verification and Validation ☐ Code Generation
Last Change	V1.00	

8.Appendix A: Recommendations for Automation Tools

These recommendations are intended for any company that develops tools that automate checking of the Style Guidelines. These guidelines were developed by the MathWorks Automotive Advisory Board (MAAB), and it is expected that tool vendors will create tools that check models developed by MathWorks tools against these guidelines. In order to provide the maximum information to potential users of the tools, the MAAB strongly recommends that tool vendors provide a compliance matrix that is easily accessible when the tool is running. This information should be available without a need to purchase the tool first.

The compliance matrix should include the following information:

- Version of the guidelines that are checked – shall include the complete title as found on the title page of this document.
    - The MAAB Style Guidelines Title and Version document number will be included
- Table consisting of the following information for each guideline.
    - Guideline ID
    - Guideline Title
    - Level of Compliance
    - Detail

The Guideline ID and Title shall be exactly as included in this document. The Level of Compliance shall be one of the following.

- Correction – The tool checks and automatically or semi-automatically corrects the non-compliance.
- Check – The tool checks and flags non-compliances. It is the developer's responsibility to make the correction.
- Partial – The tool checks part of the guideline. The detail section should clearly identify what is and what is not checked.
- None – the guideline is not checked by the tool. It is highly recommended that the vendor provide a recommendation of how to manually check any guideline not checked by the tool.

9.Appendix B: Guideline Writing

The most important things to address when writing a new guideline are that each guideline should be:

- understandable and unambiguous
- easy to find
- minimal

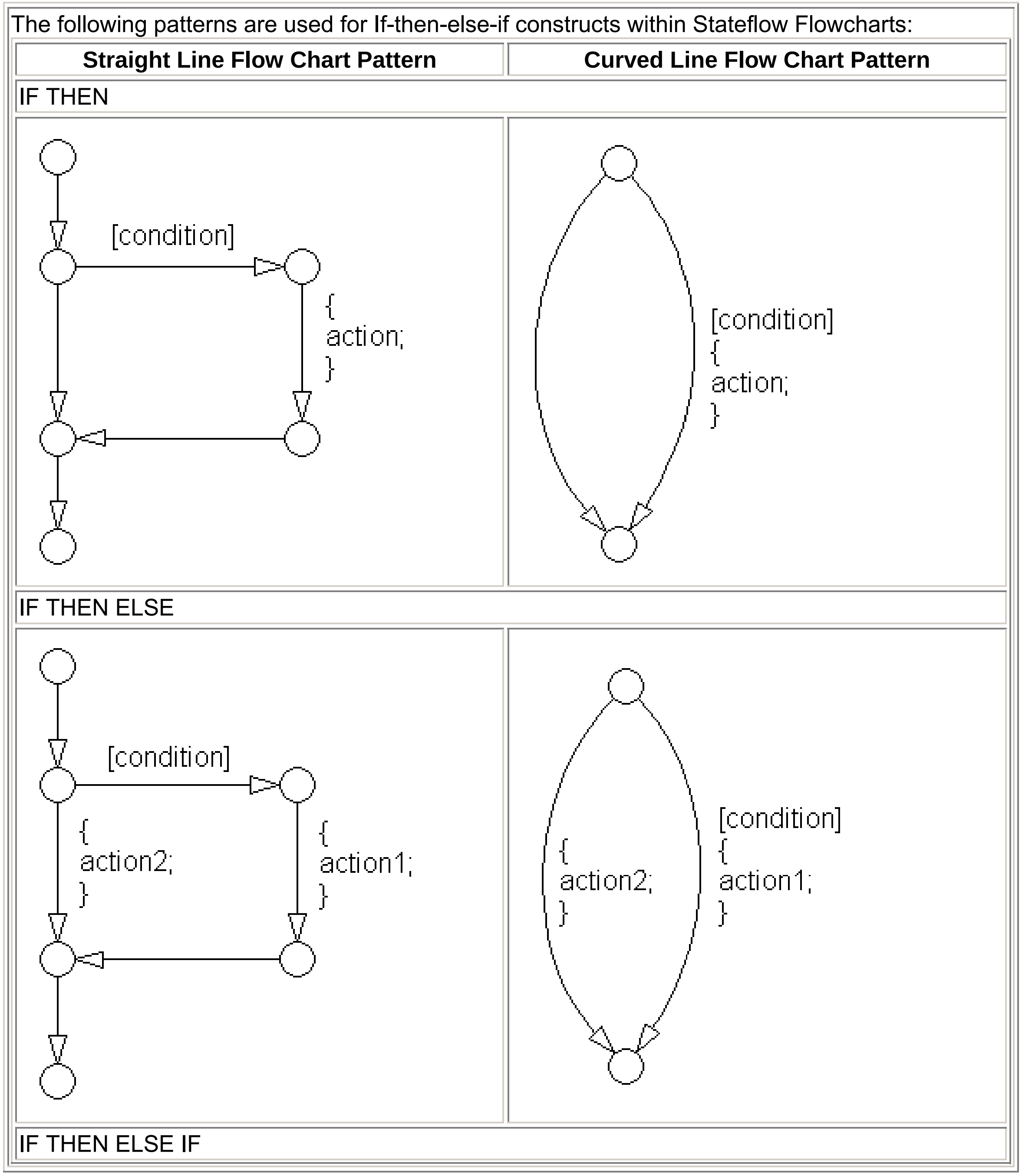
Guidelines with these characteristics are easier to understand and use.

By "understandable and unambiguous" we mean that a guideline's description should be precise, clearly worded, concise and should define an evaluate able property of a model (or part of a model). Use the words "must," "shall," "should," and "may" carefully; they have distinct meanings that are important for model developers and model checkers (human and automated). It is helpful to the reader if the guideline author describes how the conformant state can be reached (e.g. by selecting particular options or clicking a certain button). Examples, counterexamples, pictures, diagrams, and screenshots are also helpful and therefore encouraged. Minimize the allowable exceptions to a guideline; they blur the guideline and make it harder to apply. If a guideline has many allowable exceptions, you may be trying to cover too many characteristics with one guideline - see "minimal" below for some solutions.

By "easy to find" we mean that a guideline should have a clear, stable title and be properly located among all the other guidelines. A guideline's title should describe the topic covered but not the specific evaluation criteria. This makes the title less likely to change over time and therefore easier to find. Specific evaluation criteria should be included in the guideline's description. For example, if a guideline addresses the characters allowed in names, the guideline's title should be something like "Allowed characters in names," and the guideline's description should indicate specifically what characters are or are not to be used. If a guideline has prerequisites, they should appear above or before the dependent guideline. (This may not always be possible if the prerequisite is in a different section.)

Lastly, by "minimal" we mean that a guideline should address only one model characteristic at a time. Guidelines should be atomic. So, for example, instead of writing a big guideline that addresses error prevention and readability at the same time, make two guidelines – one that addresses error prevention and one that addresses readability. Make one a prerequisite of the other if appropriate. Also, big guidelines are more likely than small guidelines to require compromises for wide acceptance. Big guidelines may therefore end up being weaker, less specific, and less beneficial. Small, focused guidelines will be less likely to change due to compromise and easier to adopt.

10.Appendix C: Flowchart Reference



The following patterns are used for If-then-else-if constructs within Stateflow Flowcharts:

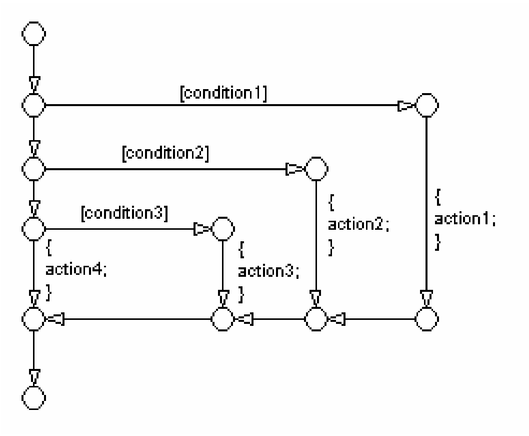
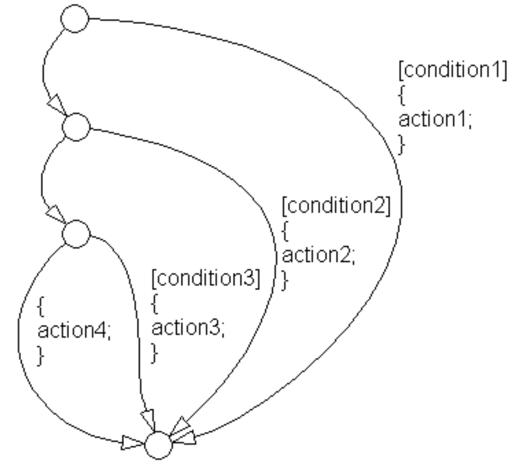
Straight Line Flow Chart Pattern	Curved Line Flow Chart Pattern
IF THEN	

[condition]
{
action;
}
	[condition]
	{
	action;
	}

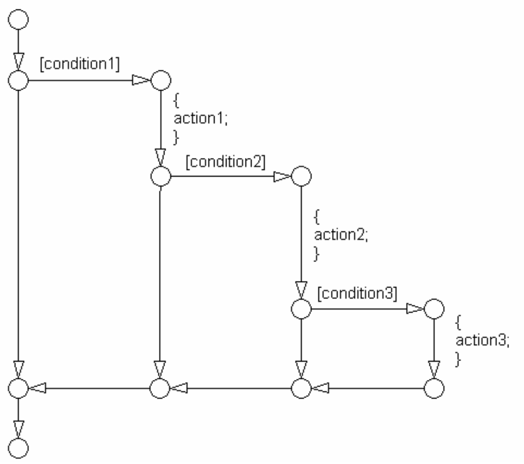
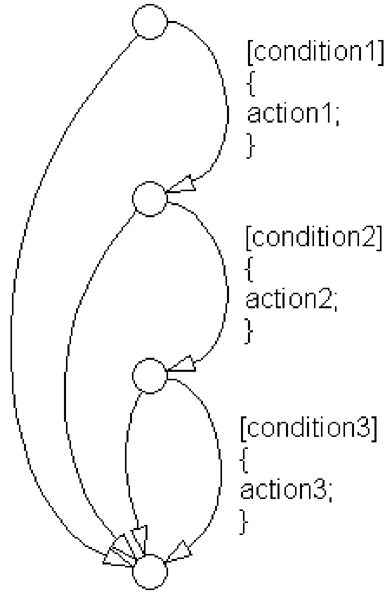
IF THEN ELSE	

[condition]
{
action2;
}
{
action1;
}
	{
	action2;
	}
	[condition]
	{
	action1;
	}

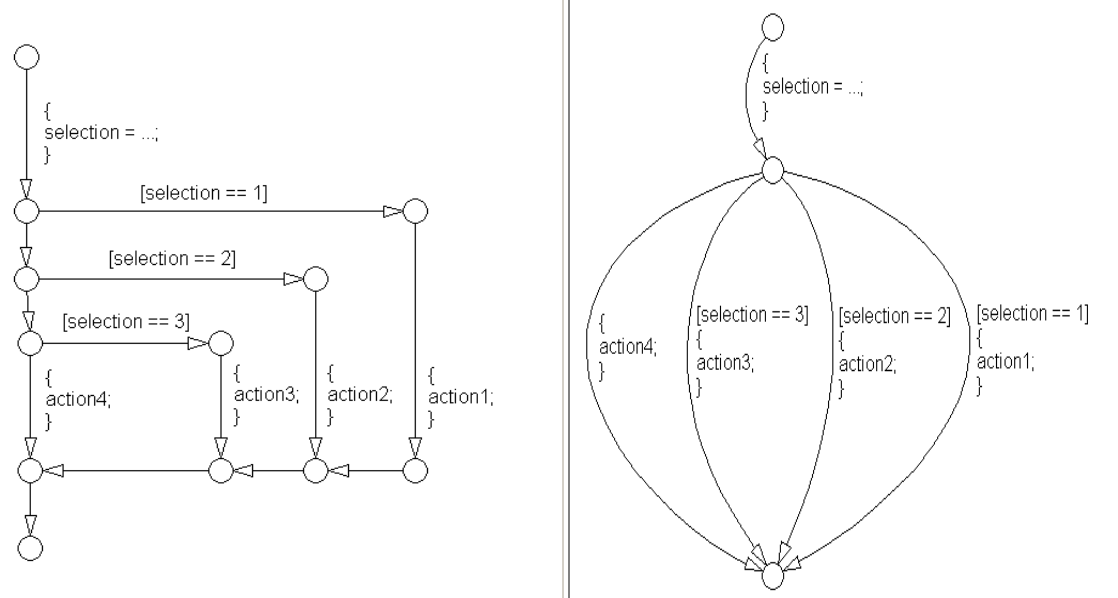
IF THEN ELSE IF	

 [condition1]
[condition2]
[condition3]
{ action1; }
{ action2; }
{ action3; }
{ action4; }
	 [condition1] { action1; }
	[condition2] { action2; }
	[condition3] { action3; }
	{ action4; }

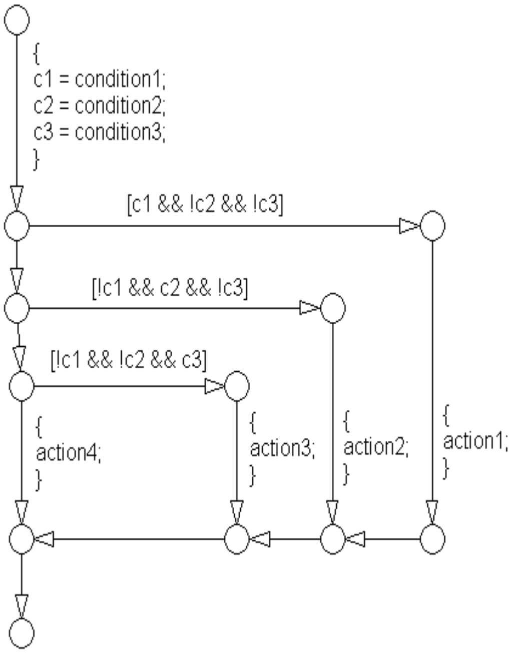
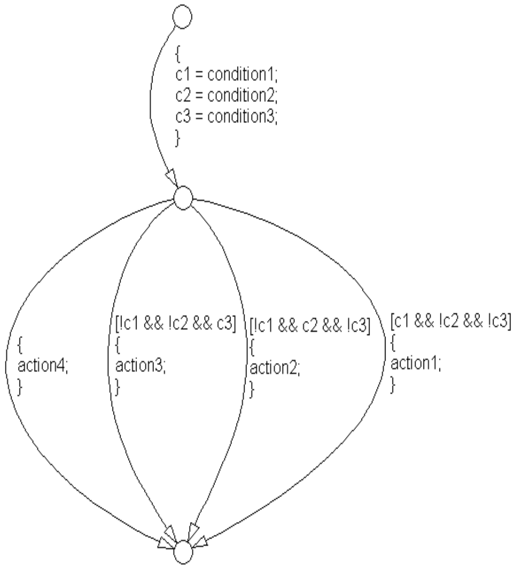
Cascade of IF THEN	

 [condition1]
{ action1; }
[condition2]
{ action2; }
[condition3]
{ action3; }
	 [condition1] { action1; }
	[condition2] { action2; }
	[condition3] { action3; }

The following patterns are used for case constructs within Stateflow Flowcharts:	
Straight Line Flow Chart Pattern	**Curved Line Flow Chart Pattern**
CASE with exclusive selection	

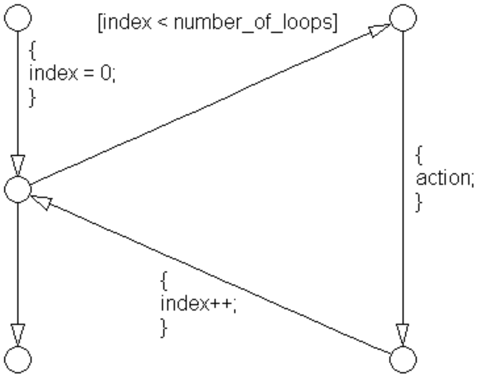
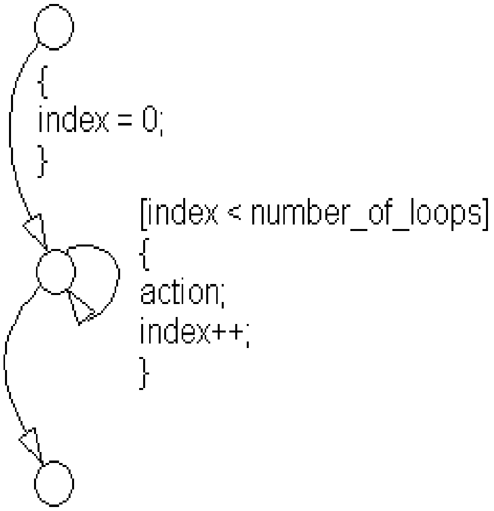


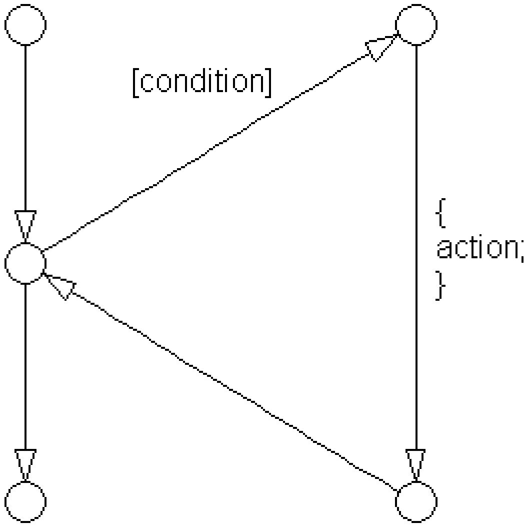
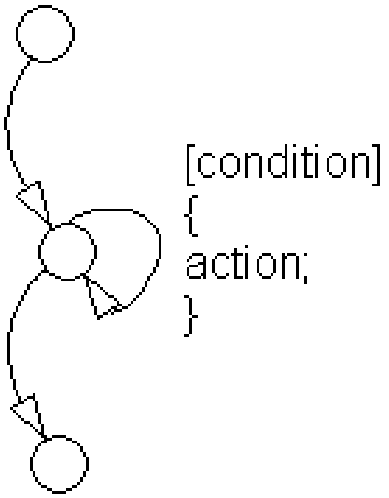
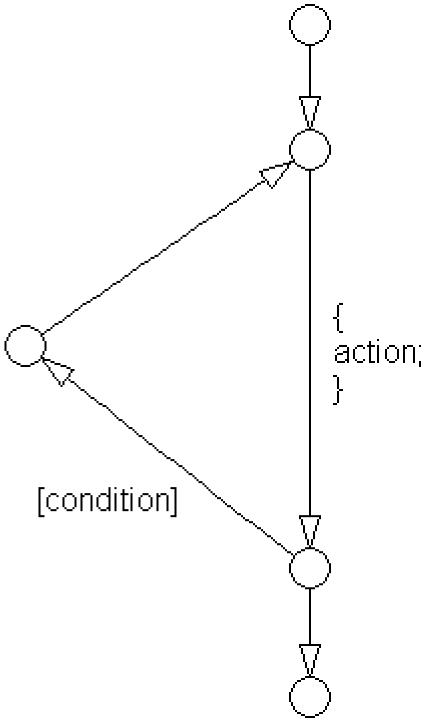
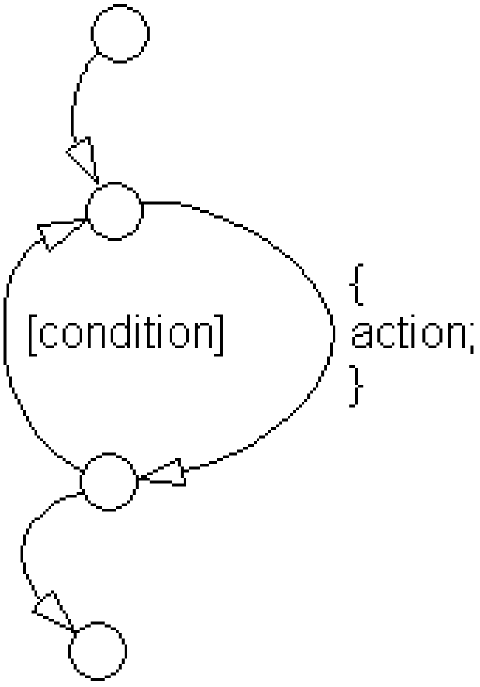
CASE with exclusive conditions

 {
c1 = condition1;
c2 = condition2;
c3 = condition3;
}
[c1 && !c2 && !c3]
[!c1 && c2 && !c3]
[!c1 && !c2 && c3]
{
action4;
}
{
action3;
}
{
action2;
}
{
action1;
}
	 {
	c1 = condition1;
	c2 = condition2;
	c3 = condition3;
	}
	{
	action4;
	}
	[!c1 && !c2 && c3]
	{
	action3;
	}
	[!c1 && c2 && !c3]
	{
	action2;
	}
	[c1 && !c2 && !c3]
	{
	action1;
	}

The following patterns are used for For Loops within Stateflow Flowcharts:

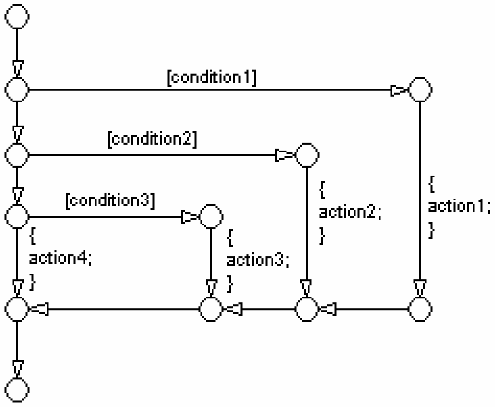
Straight Line Flow Chart Pattern	**Curved Line Flow Chart Pattern**
FOR LOOP	

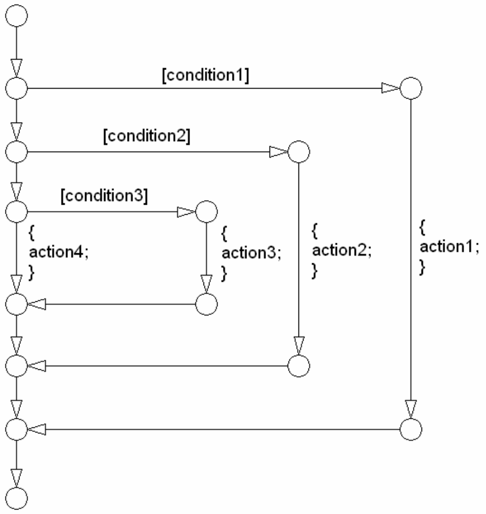
 {
index = 0;
}
[index < number_of_loops]
{
action;
}
{
index++;
}
	 {
	index = 0;
	}
	[index < number_of_loops]
	{
	action;
	index++;
	}

WHILE LOOP	
	
DO WHILE LOOP	
	

The following patterns are alternately used for If-then-else-if constructs within Stateflow Flowcharts:

IF THEN ELSE IF



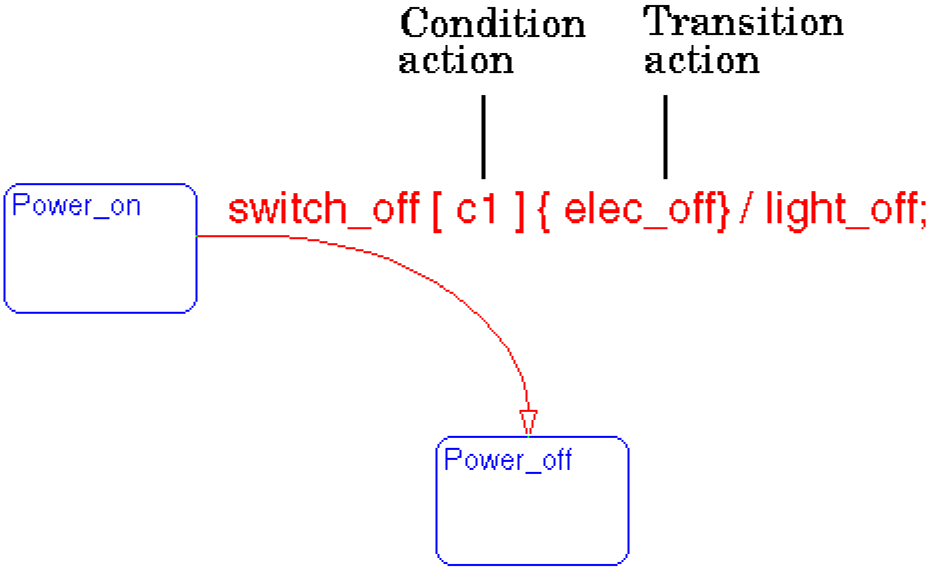


Cascade of IF THEN

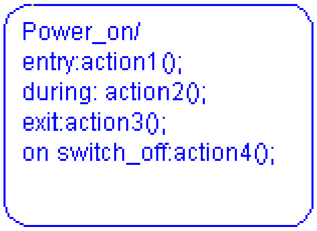
11.Glossary

Actions

Actions take place as part of Stateflow diagram execution. The action can be executed as part of a transition from one state to another, or depending on the activity status of a state. Transitions can have condition actions and transition actions. For example,



States can have entry, during, exit, and, on *event_name* actions. For example,



```
Power_on/
entry:action1();
during: action2();
exit:action3();
on switch_off:action4();
```

If you enter the name and backslash followed directly by an action or actions (without the entry keyword), the action(s) are interpreted as entry action(s). This shorthand is useful if you are only specifying entry actions.

The *action language* defines the categories of actions you can specify and their associated notations. An action can be a function call, an event to be broadcast, a variable to be assigned a value, etc.

Action Language

You sometimes want actions to take place as part of Stateflow diagram execution. The action can be executed as part of a transition from one state to another, or it can depend on the activity status of a state. Transitions can have condition actions and transition actions. States can have entry, during, exit, and, on *event_name* actions.

An action can be a function call, an event to be broadcast, a variable to be assigned a value, etc.

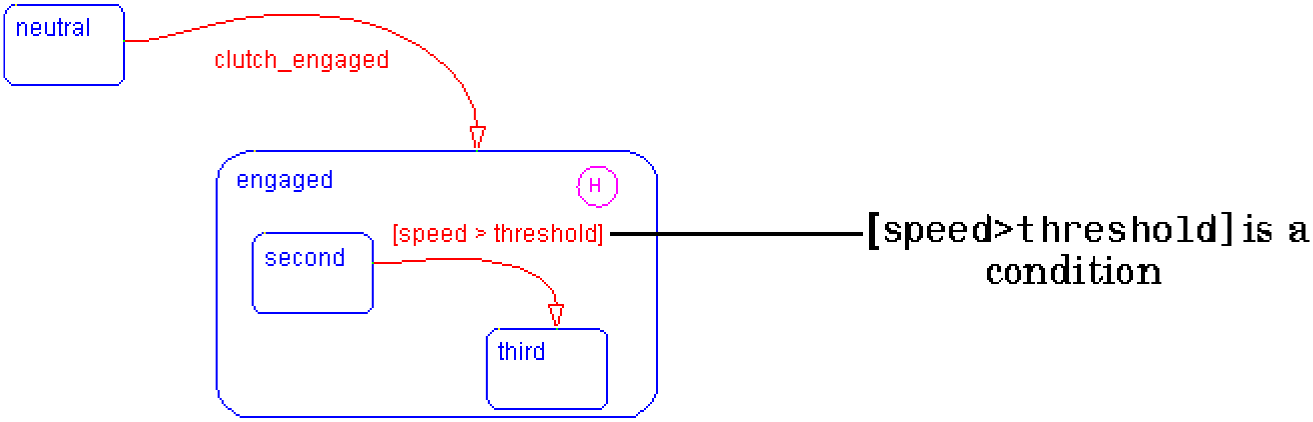
The *action language* defines the categories of actions you can specify and their associated notations. Violations of the action language notation are flagged as errors by the parser. This section describes the action language notation rules.

Chart Instance

A *chart instance* is a link from a Stateflow model to a chart stored in a Simulink library. A chart in a library can have many chart instances. Updating the chart in the library automatically updates all the instances of that chart.

Condition

A *condition* is a Boolean expression to specify that a transition occur given that the specified expression is true. For example,

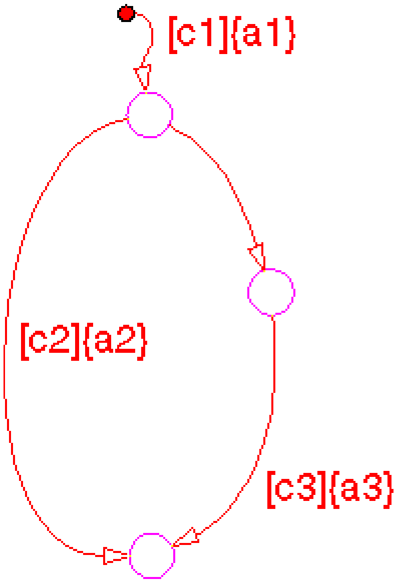


[speed>threshold] is a condition

The action language defines the notation to define conditions associated with transitions.

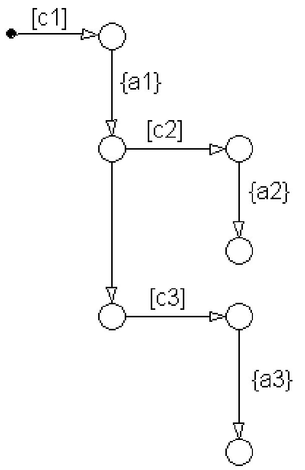
Connective Junction

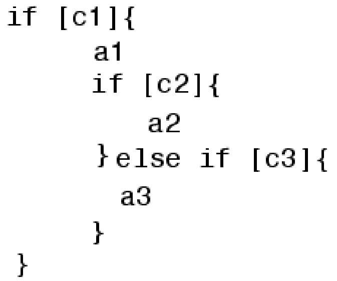
Connective junctions are decision points in the system. A connective junction is a graphical object that simplifies Stateflow diagram representations and facilitates generation of efficient code. Connective junctions provide alternative ways to represent desired system behavior.
This example shows how connective junctions (displayed as small circles) are used to represent the flow of an if code structure.



```
if [c1]{
     a1
     if [c2]{
         a2
     }else if [c3]{
       a3
     }
}
```

Or the equivalent squared style





```
if [c1]{
     a1
     if [c2]{
        a2
     }else if [c3]{
       a3
     }
 }
```

Name	Button Icon	Description
Connective junction		One use of a Connective junction is to handle situations where transitions out of one state into two or more states are taken based on the same event but guarded by different conditions.

Data

Data objects store numerical values for reference in the Stateflow diagram.

Defining Data

A state machine can store and retrieve data that resides internally in its own workspace. It can also access data that resides externally in the Simulink model or application that embeds the state machine. When creating a Stateflow model, you must define any internal or external data referenced by the state machine's actions

Data Dictionary

The *data dictionary* is a database where Stateflow diagram information is stored. When you create Stateflow diagram objects, the information about those objects is stored in the data dictionary once you save the Stateflow diagram.

Decomposition

A state has *decomposition* when it consists of one or more substates. A Stateflow diagram that contains at least one state also has decomposition. Representing hierarchy necessitates some rules around how states can be grouped in the hierarchy. A superstate has either parallel (AND) or exclusive (OR) decomposition. All substates at a particular level in the hierarchy must be of the same decomposition.

Parallel (AND) State Decomposition. Parallel (AND) state decomposition is indicated when states have dashed borders. This representation is appropriate if all states at that same level in the hierarchy are active at the same time. The activity within parallel states is essentially independent.
Exclusive (OR) State Decomposition. Exclusive (OR) state decomposition is represented by states with solid borders. Exclusive (OR) decomposition is used to describe system modes that are mutually exclusive. Only one state, at the same level in the hierarchy, can be active at a time.

Default Transition

Default transitions are primarily used to specify which exclusive (OR) state is to be entered when there is ambiguity among two or more neighboring exclusive (OR) states. For example, default transitions specify which substate of a superstate with exclusive (OR) decomposition the system enters by default in the absence of any other information. Default transitions are also used to specify that a junction should be entered by default. A default transition is represented by selecting the default transition object from the toolbar and then dropping it to attach to a destination object. The default transition object is a transition with a destination but no source object.

Name	Button Icon	Description
Default transition		Use a Default transition to indicate, when entering this level in the hierarchy, which state becomes active by default.

Events

Events drive the Stateflow diagram execution. All events that affect the Stateflow diagram must be defined. The occurrence of an event causes the status of the states in the Stateflow diagram to be evaluated. The broadcast of an event can trigger a transition to occur and/or can trigger an action to be executed. Events are broadcast in a top-down manner starting from the event's parent in the hierarchy.

Finite State Machine

A *finite state machine* (FSM) is a representation of an event-driven system. FSMs are also used to describe reactive systems. In an event-driven or reactive system, the system transitions from one mode or state, to another prescribed mode or state, provided that the condition defining the change is true.

Flow Graph

A *flow graph* is the set of Flowcharts that start from a transition segment that, in turn, starts from a state or a default transition segment.

Flowchart (also known as Flow Path)

A *Flowchart* is an ordered sequence of transition segments and junctions where each succeeding segment starts on the junction that terminated the previous segment.

Flow Subgraph

A f*low subgraph* is the set of Flowcharts that start on the same transition segment.

Hierarchy

Hierarchy enables you to organize complex systems by placing states within other higher-level states. A hierarchical design usually reduces the number of transitions and produces neat, more manageable diagrams.

History Junction

A *History Junction* provides the means to specify the destination substate of a transition based on historical information. If a superstate has a History Junction, the transition to the destination substate is defined to be the substate that was most recently visited. The History Junction applies to the level of the hierarchy in which it appears.

Name	Button Icon	Description

History Junction	Ⓗ	Use a History Junction to indicate, when entering this level in the hierarchy, that the last state that was active becomes the next state to be active.

Inner Transitions

An *inner transition* is a transition that does not exit the source state. Inner transitions are most powerful when defined for superstates with XOR decomposition. Use of inner transitions can greatly simplify a Stateflow diagram.

Library Link

A *library link* is a link to a chart that is stored in a library model in a Simulink block library.

Library Model

A Stateflow *library model* is a Stateflow model that is stored in a Simulink library. You can include charts from a library in your model by copying them. When you copy a chart from a library into your model, Stateflow does not physically include the chart in your model. Instead, it creates a link to the library chart. You can create multiple links to a single chart. Each link is called a *chart instance*. When you include a chart from a library in your model, you also include its state machine. Thus, a Stateflow model that includes links to library charts has multiple state machines. When Stateflow simulates a model that includes charts from a library model, it includes all charts from the library model even if there are links to only some of its models. However, when Stateflow generates a stand-alone or Real-Time Workshop® target, it includes only those charts for which there are links. A model that includes links to a library model can be simulated only if all charts in the library model are free of parse and compile errors.

Machine

A *machine* is the collection of all Stateflow blocks defined by a Simulink model exclusive of chart instances (library links). If a model includes any library links, it also includes the state machines defined by the models from which the links originate.

Nonvirtual Block

Blocks that perform a calculation; such as a Gain block.

Notation

A *notation* defines a set of objects and the rules that govern the relationships between those objects. Stateflow notation provides a common language to communicate the design information conveyed by a Stateflow diagram.

Stateflow notation consists of:

- A set of graphical objects
- A set of nongraphical text-based objects
- Defined relationships between those objects

Parallelism

A system with *parallelism* can have two or more states that can be active at the same time. The activity of parallel states is essentially independent. Parallelism is represented with a parallel (AND) state decomposition.

Real-Time System

A system that uses actual hardware to implement algorithms, for example, digital signal processing or control applications.

Real-Time Workshop®

Real-Time Workshop is an automatic C language code generator for Simulink. It produces C code directly from Simulink block diagram models and automatically builds programs that can be run in real-time in a variety of environments.

Real-Time Workshop Target

An executable built from code generated by Real-Time Workshop

S-Function

A customized Simulink block written in C or M-Code. C-code S-Functions can be inlined in Real-Time Workshop. When using Simulink together with Stateflow for simulation, Stateflow generates an *S-Function* (MEX-file) for each Stateflow machine to support model simulation. This generated code is a simulation target and is called the S-Fun target within Stateflow.

Signal propagation

Process used by Simulink to determine attributes of signals and blocks, such as data types, labels, sample time, dimensionality, and so on, that are determined by connectivity

Signal source

The signal source is the block of origin for a signal. The signal source may or may not be the true source

Simulink

Simulink is a software package for modeling, simulating, and analyzing dynamic systems. It supports linear and nonlinear systems, modeled in continuous time, sampled time, or a hybrid of the two. Systems can also be multi-rate, i.e., have different parts that are sampled or updated at different rates.

It allows you to represent systems as block diagrams that you build using your mouse to connect blocks and your keyboard to edit block parameters. Stateflow is part of this environment. The Stateflow block is a masked Simulink model. Stateflow builds an S-Function that corresponds to each Stateflow machine. This S-Function is the agent Simulink interacts with for simulation and analysis.

The control behavior that Stateflow models complements the algorithmic behavior modeled in Simulink block diagrams. By incorporating Stateflow diagrams into Simulink models, you can add event-driven behavior to Simulink simulations. You create models that represent both data and control flow by combining Stateflow blocks with the standard Simulink blockset. These combined models are simulated using Simulink.

State

A *state* describes a mode of a reactive system. A reactive system has many possible states. States in a Stateflow diagram represent these modes. The activity or inactivity of the states dynamically changes based on events and conditions.

Every state has hierarchy. In a Stateflow diagram consisting of a single state, that state's parent is the Stateflow diagram itself. A state also has history that applies to its level of hierarchy in the Stateflow diagram. States can have actions that are executed in a sequence based upon action type. The action types are: entry, during, exit, or on *event_name* actions.

Name	Button Icon	Description
State		Use a state to depict a mode of the system.

Stateflow Block

The *Stateflow block* is a masked Simulink model and is equivalent to an empty, untitled Stateflow diagram. Use the Stateflow block to include a Stateflow diagram in a Simulink model.
The control behavior that Stateflow models complements the algorithmic behavior modeled in Simulink block diagrams. By incorporating Stateflow blocks into Simulink models, you can add complex event-driven behavior to Simulink simulations. You create models that represent both data and control flow by combining Stateflow blocks with the standard Simulink and toolbox block libraries. These combined models are simulated using Simulink.

Stateflow Debugger

Use the *Stateflow Debugger* to debug and animate your Stateflow diagrams. Each state in the Stateflow diagram simulation is evaluated for overall code coverage. This coverage analysis is done automatically when the target is compiled and built with the debug options. The Debugger can also be used to perform dynamic checking. The Debugger operates on the Stateflow machine.

Stateflow Diagram

Using Stateflow, you create Stateflow diagrams. A *Stateflow diagram* is also a graphical representation of a finite state machine where *states* and *transitions* form the basic building blocks of the system

Stateflow Explorer

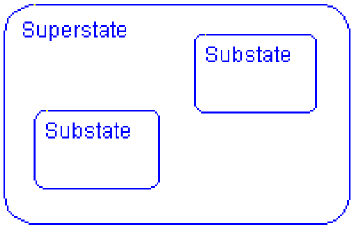
Use the *Stateflow Explorer* to add, remove, and modify data, event, and target objects.

Stateflow Finder

Use the *Finder* to display a list of objects based on search criteria you specify. You can directly access the properties dialog box of any object in the search output display by clicking on that object.

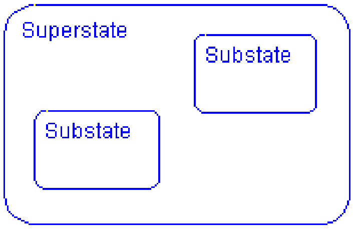
Substate

A state is a *substate* if it is contained by a superstate.



Superstate

A state is a *superstate* if it contains other states, called substates.



Target

An executable program built from code generated by Stateflow or Real-Time Workshop.

Top down Processing

Top down processing refers to the way in which Stateflow processes states. In particular, Stateflow processes superstates before states. Stateflow processes a state only if its superstate is activated first.

Transition

A *transition* describes the circumstances under which the system moves from one state to another. Either end of a transition can be attached to a source and a destination object. The *source* is where the transition begins and the *destination* is where the transition ends. It is often the occurrence of some event that causes a transition to take place.

Transition Path

A *transition path* is a Flowchart that starts and ends on a state

.

Transition Segment

A *transition segment* is a single directed edge on a Stateflow diagram. Transition segments are sometimes loosely referred to as transitions.

Tunable parameters

A *Tunable parameters* is a parameter that can be adjusted both in the model and in generated code.

True Source

The true source is the block which creates a signal. The true source is different from the signal source since the signal source may be a simple routing block such as a demux block.

Virtual Block

When creating models, you need to be aware that Simulink blocks fall into two basic categories: nonvirtual and virtual blocks. Nonvirtual blocks play an active role in the simulation of a system. If you add or remove a nonvirtual block, you change the model's behavior. Virtual blocks, by contrast, play no active role in the simulation. They simply help to organize a model graphically. Some Simulink blocks can be virtual in some circumstances and nonvirtual in others. Such blocks are called conditionally virtual blocks. The following table lists the virtual and conditionally virtual blocks in Simulink.

Virtual Blocks

Block Name	Condition Under Which Block Will Be Virtual
Bus Selector	Virtual if input bus is virtual
Demux	Always virtual
Enable	Virtual unless connected directly to an Outport block
From	Always virtual
Goto	Always virtual
Goto Tag Visibility	Always virtual
Ground	Always virtual
Inport	Virtual when the block resides within any subsystem block (conditional or not), and does not reside in the root (top-level) Simulink window.
Mux	Always virtual
Outport	Virtual when the block resides within any subsystem block (conditional or not), and does not reside in the root (top-level) Simulink window
Selector	Virtual except in matrix mode
Signal Specification	Always virtual
Subsystem	Virtual unless the block is conditionally executed and/or the block's Treat as Atomic Unit option is selected
Terminator	Always virtual
Trigger	Virtual if the Outport port is not present

Virtual Scrollbar

A *virtual scrollbar* enables you to set a value by scrolling through a list of choices. When you move the mouse over a menu item with a virtual scrollbar, the cursor changes to a line with a double arrowhead. Virtual scrollbars are either vertical or horizontal. The direction is indicated by the positioning of the arrowheads. Drag the mouse either horizontally or vertically to change the value.