

**Simulink®**

MathWorks® Advisory Board Control Algorithm  
Modeling Guidelines



**MATLAB® & SIMULINK®**

R2021b



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*MathWorks® Advisory Board Modeling Guidelines*

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# Introduction

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- “Model Advisor Checks for MAB Guidelines” on page 1-6

## Purpose of the Guidelines and Template

MathWorks Advisory Board (MAB) guidelines stipulate important basic rules for modeling in Simulink and Stateflow. The overall purpose of these modeling guidelines is to allow for a simple, common understanding by modelers and consumers of control system models.

The main objectives of these guidelines are:

- Readability
  - Improve graphical understandability
  - Improve readability of functional analysis
  - Prevent connection mistakes
  - Comments, etc.
- Simulation and verification
  - Mechanism to enable simulation
  - Testability
- Code Generation
  - Improve the efficiency of code generation (ROM, RAM efficiency)
  - Ensure the robustness of generated code

---

**Note** Model runtime errors and recommendations that cannot be implemented are outside of the scope of these rules.

---

Guidelines are documented by using a standard template. Use of this template is recommended when creating original guidelines.

---

**Note** This template specifies the minimum requirements that are needed to understand a guideline. New items can be added to the template as long as they do not duplicate existing information.

---

| Section Heading       | Format  | Section Description   |
|-----------------------|---|---|
| <b>Rule ID: Title</b> | <i>XX_nnnn</i> : Title of the guideline (unique, short) | A rule ID, which is used to identify the guideline, consists of two lower case letters and a four-digit number. The letter and number combination is separated by an underscore. For example, <b>xx_nnnn</b> . A rule ID is permanent and will not change.<br><br><b>Note</b> The two-letters in the rule ID identify the guideline author. |

| Section Heading               | Format   | Section Description  |
|-------------------------------|--|--|
| <b>Sub ID Recommendations</b> | NA-MAAB: x, y, z<br><br>JMAAB: x, y, z                               | Specifies guideline sub IDs that are recommended for use by the NA-MAAB (North American MathWorks Automotive Advisory Board) and JMAAB (Japan MathWorks Automotive Advisory Board) modeling standards organizations. Each organization is a region-specific consortium of automotive OEMs and suppliers; NA-MAAB represents North America and Europe. JMAAB represents Japan.  |
| <b>MATLAB Versions</b>        | All<br>RX, RY, RZ<br>RX and earlier<br>RX and later<br>RX through RY | MAB guidelines support all versions of MATLAB and Simulink products. When a rule applies only to a specific version(s), the version is identified in the MATLAB Version field by using one of these formats: <ul style="list-style-type: none"> <li>• All — All versions of MATLAB</li> <li>• RX, RY, RZ — A specific version of MATLAB</li> <li>• RX and earlier — Versions of MATLAB until version RX</li> <li>• RX and later — Versions of MATLAB from version RX to the current version</li> <li>• RX through RY — Versions of MATLAB between RX and RY</li> </ul> |

| Section Heading                | Format  | Section Description  |
|--------------------------------|---|--|
| <p><b>Rule &gt; Sub ID</b></p> | <p>Specifies the condition(s) of the rule by using Sub IDs. There can be multiple sub IDs per rule ID.</p> <p>The subsections for a Sub ID include:</p> <ul style="list-style-type: none"> <li>• <b>Custom Parameter</b></li> <li>• (Optional) <b>Exclusion</b></li> <li>• (Optional) <b>Example</b></li> </ul> | <p>Specifies the condition(s) of the rule. Sub IDs are designated as either:</p> <ul style="list-style-type: none"> <li>• <b>Selectable</b> — Consist of one lower-case letter (alphabetical order). The choice of whether to adopt a selectable sub ID is left to the user.</li> <li>• <b>Mutually Exclusive</b> — Consist of one lower case letter (alphabetical order) and a single-digit number. When choosing to accept or reject a mutually exclusive sub ID, only one option can be selected.</li> </ul> <p>For example, Sub IDs for guideline xy_0000 are:</p> <ul style="list-style-type: none"> <li>• xy_0000a — Represents a selectable (user’s choice) option</li> <li>• xy_0000b1</li> <li>xy_0000b2</li> <li>— Mutually Exclusive (if using, choose from xy_0000b1 or xy_0000b2)</li> </ul> <p>For rules that include custom parameters, the chosen value is specific for the project with regard to the item being described. Example of objects and values are provided in the description field. However, a project’s processes, condition of the control target, and skill levels of the engineers should be comprehensively evaluated when specifying a custom parameter.</p> |

| <b>Section Heading</b> | <b>Format</b>              | <b>Section Description</b>   |
|------------------------|----------------------------|--|
| <b>Rationale</b>       | Motivation for the Sub IDs | Provides reasoning for the use of the guideline with regard to readability, verification efficiency, efficiency of code after code generation, etc.  |
| <b>Verification</b>    | Verification methods       | Method(s) that verify compliance of the model with guideline conditions, such as: <ul style="list-style-type: none"><li>• Model Advisor check</li><li>• Manual verification method</li></ul> |
| <b>Last Change</b>     | R<year>                    | MATLAB revision in which the content of the guideline was last updated. For example, R2020a.   |
| <b>See Also</b>        | References                 | Additional information that can be helpful to better understand the guideline.   |

## Model Advisor Checks for MAB Guidelines

For information on using the Model Advisor, see “Run Model Advisor Checks”.

### Modeling Guidelines and Model Advisor Checks for MAB and JMAAB

This table identifies MathWorks Advisor Board (MAB) guidelines, the corresponding Japan MathWorks Automotive Advisor Board (JMAAB) guidelines, and Model Advisor check that you can use to verify compliance with these guidelines. Additional information in the tables includes:

- **MAB Modeling Guideline** — Links to the MathWorks Advisory Board (MAB) guideline.
- **Corresponding JMAAB Modeling Guideline** — Identifies the JMAAB modelling guideline that corresponds to the MAB guideline. To review the guideline, see *Control Algorithm Modeling Guidelines Using MATLAB, Simulink, and Stateflow* on the MathWorks website.
- **Model Advisor Check** — Provides links to the Model Advisor check that is used to verify compliance to the modeling guideline.

When applicable, this column clarifies why a guideline does not have a corresponding check:

- *No check* — Indicates that the guideline can be checked by using a Model Advisor check, however, the check does not currently exist.
- *Not checkable* — Indicates that it is not possible to verify compliance to this guideline by using a Model Advisor check.

| MAB Modeling Guideline<br>(Version 5.0)                        | Corresponding JMAAB<br>Modeling Guideline<br>(Version 5.1) | Model Advisor Check   |
|--|--|---|
| ar_0001: Usable characters for file names                      | ar_0001  | “Check file names” (Simulink Check)   |
| ar_0002: Usable characters for folder names                    | ar_0002  | “Check folder names” (Simulink Check)                                       |
| jc_0241: Length restriction for model file names               | jc_0241  | “Check length of model file name” (Simulink Check)                          |
| jc_0242: Length restriction for folder names                   | jc_0242  | “Check length of folder name at every level of model path” (Simulink Check) |
| jc_0201: Usable characters for subsystem names                 | jc_0201  | “Check Subsystem names” (Simulink Check)                                    |
| jc_0231: Usable characters for block names                     | jc_0231  | “Check character usage in block names” (Simulink Check)                     |
| jc_0211: Usable characters for Inport blocks and Outport block | jc_0211  | “Check port block names” (Simulink Check)                                   |
| jc_0243: Length restriction for subsystem names                | jc_0243  | “Check length of subsystem names” (Simulink Check)                          |
| jc_0247: Length restriction for block names                    | jc_0247  | “Check length of block names” (Simulink Check)                              |

| <b>MAB Modeling Guideline<br/>(Version 5.0)</b>          | <b>Corresponding JMAAB<br/>Modeling Guideline<br/>(Version 5.1)</b> | <b>Model Advisor Check</b>   |
|--|---|--|
| jc_0244: Length restriction for Inport and Outport names | jc_0244   | "Check length of Inport and Outport names" (Simulink Check)                    |
| jc_0222: Usable characters for signal and bus names      | jc_0222   | "Check usable characters for signal names and bus names" (Simulink Check)      |
| jc_0232: Usable characters for parameter names           | jc_0232   | "Check usable characters for parameter names" (Simulink Check)                 |
| jc_0245: Length restriction for signal and bus names     | jc_0245   | "Check length of signal and bus names" (Simulink Check)                        |
| jc_0246: Length restriction for parameter name           | jc_0246   | "Check length of parameter names" (Simulink Check)                             |
| jc_0795: Usable characters for Stateflow data names      | jc_0795   | "Check usable characters for Stateflow data names" (Simulink Check)            |
| jc_0796: Length restriction for Stateflow data names     | jc_0796   | "Check length of Stateflow data name" (Simulink Check)                         |
| jc_0791: Duplicate data name definitions                 | jc_0791   | "Check duplication of Simulink data names" (Simulink Check)                    |
| jc_0792: Unused Data                                     | jc_0792   | "Check unused data in Simulink Model" (Simulink Check)                         |
| jc_0700: Unused data in Stateflow block                  | jc_0700   | "Check for unused data in Stateflow Charts" (Simulink Check)                   |
| na_0019: Restricted variable names                       | No corresponding JMAAB guideline                                    | "Check usage of restricted variable names" (Simulink Check)                    |
| jc_0011: Optimization parameters for Boolean data types  | jc_0011   | "Check Implement logic signals as Boolean data (vs. double)" (Simulink Check)  |
| jc_0642: Integer rounding mode setting                   | jc_0642   | "Check Signed Integer Division Rounding mode" (Simulink Check)                 |
| jc_0806: Detecting incorrect calculation results         | jc_0806   | "Check diagnostic settings for incorrect calculation results" (Simulink Check) |
| jc_0021: Model diagnostic settings                       | No corresponding JMAAB guideline                                    | "Check model diagnostic parameters" (Simulink Check)                           |

| <b>MAB Modeling Guideline<br/>(Version 5.0)</b>                     | <b>Corresponding JMAAB<br/>Modeling Guideline<br/>(Version 5.1)</b> | <b>Model Advisor Check</b>  |
|---|---|---|
| na_0004: Simulink model appearance settings                         | na_0004   | "Check for Simulink diagrams using nonstandard display attributes" (Simulink Check) |
| db_0043: Model font and font size                                   | db_0043   | "Check Model font settings" (Simulink Check)  |
| jm_0002: Block resizing   | jm_0002   | <i>No check</i>   |
| db_0142: Position of block names                                    | db_0142   | "Check whether block names appear below blocks" (Simulink Check)                    |
| jc_0061: Display of block names                                     | jc_0061   | "Check the display attributes of block names" (Simulink Check)                      |
| db_0140: Display of block parameters                                | db_0140   | "Check for nondefault block attributes" (Simulink Check)                            |
| jc_0603: Model description  | jc_0603   | "Check Model Description" (Simulink Check)  |
| jc_0604: Using block shadow   | jc_0604   | "Check if blocks are shaded in the model" (Simulink Check)                          |
| db_0081: Unconnected signals and blocks                             | db_0081   | "Check for unconnected signal lines and blocks" (Simulink Check)                    |
| db_0032: Signal line connections                                    | db_0032   | "Check signal line connections" (Simulink Check)                                    |
| db_0141: Signal flow in Simulink models                             | db_0141   | "Check signal flow in model<br>Check position of signal labels" (Simulink Check)    |
| jc_0110: Direction of block   | jc_0110   | "Check block orientation" (Simulink Check)  |
| jc_0171: Clarification of connections between structural subsystems | jc_0171   | "Check connections between structural subsystems" (Simulink Check)                  |
| jc_0602: Consistency in model element names                         | jc_0602   | "Check for consistency in model element names" (Simulink Check)                     |
| jc_0281: Trigger signal names                                       | jc_0281   | "Check trigger signal names" (Simulink Check)                                       |
| db_0143: Usable block types in model hierarchy                      | db_0143   | "Check for mixing basic blocks and subsystems" (Simulink Check)                     |
| db_0144: Use of subsystems  | db_0144   | <i>Not checkable</i>  |



| <b>MAB Modeling Guideline<br/>(Version 5.0)</b>                                 | <b>Corresponding JMAAB<br/>Modeling Guideline<br/>(Version 5.1)</b> | <b>Model Advisor Check</b>  |
|---|---|---|
| jc_0653: Delay block layout in feedback loops                                   | jc_0653   | "Check for avoiding algebraic loops between subsystems"<br>(Simulink Check)         |
| hd_0001: Prohibited Simulink sinks  | No corresponding JMAAB guideline                                    | "Check for prohibited sink blocks" (Simulink Check)                                 |
| na_0010: Usage of vector and bus signals  | na_0010   | "Check usage of vector and bus signals" (Simulink Check)                            |
| jc_0008: Definition of signal names   | jc_0008   | "Check signal line labels"<br>(Simulink Check)                                      |
| jc_0009: Signal name propagation  | jc_0009   | "Check for propagated signal labels" (Simulink Check)                               |
| db_0097: Position of labels for signals and buses                               | db_0097   | "Check signal flow in model<br>Check position of signal labels"<br>(Simulink Check) |
| na_0008: Display of labels on signals   | No corresponding JMAAB guideline                                    | "Check signal line labels"<br>(Simulink Check)                                      |
| na_0009: Entry versus propagation of signal labels                              | No corresponding JMAAB guideline                                    | "Check for propagated signal labels" (Simulink Check)                               |
| db_0110: Block parameters   | db_0110   | "Check usage of tunable parameters in blocks" (Simulink Check)                      |
| db_0112: Usage of index   | db_0112   | "Check Indexing Mode"<br>(Simulink Check)   |
| jc_0645: Parameter definition for calibration                                   | jc_0645   | "Check if tunable block parameters are defined as named constants" (Simulink Check) |
| jc_0641: Sample time setting  | jc_0641   | "Check for sample time setting"<br>(Simulink Check)                                 |
| jc_0643: Fixed-point setting  | jc_0643   | "Check usage of fixed-point data type with non-zero bias"<br>(Simulink Check)       |
| jc_0644: Type setting   | jc_0644   | "Check type setting by data objects" (Simulink Check)                               |
| db_0146: Block layout in conditional subsystems                                 | db_0146   | "Check position of conditional blocks and iterator blocks"<br>(Simulink Check)      |
| jc_0640: Initial value settings for Outputport blocks in conditional subsystems | jc_0640   | "Check undefined initial output for conditional subsystems"<br>(Simulink Check)     |

| <b>MAB Modeling Guideline<br/>(Version 5.0)</b>  | <b>Corresponding JMAAB<br/>Modeling Guideline<br/>(Version 5.1)</b> | <b>Model Advisor Check</b>   |
|--|---|--|
| jc_0659: Usage restrictions of signal lines input to Merge blocks                            | jc_0659   | "Check usage of Merge block" (Simulink Check)                                  |
| na_0003: Usage of If blocks  | na_0003   | "Check logical expressions in If blocks" (Simulink Check)                      |
| jc_0656: Usage of Conditional Control blocks   | jc_0656   | "Check default/else case in Switch Case blocks and If blocks" (Simulink Check) |
| jc_0657: Retention of output value based on conditional control flow blocks and Merge blocks | jc_0657   | <i>Not checkable</i>   |
| na_0002: Appropriate usage of basic logical and numerical operations                         | na_0002   | "Check fundamental logical and numerical operations" (Simulink Check)          |
| jc_0121: Usage of add and subtraction blocks   | jc_0121   | "Check usage of Sum blocks" (Simulink Check)                                   |
| jc_0610: Operator order for multiplication and division block                                | jc_0610   | "Check operator order of Product blocks" (Simulink Check)                      |
| jc_0611: Input sign for multiplication and division blocks                                   | jc_0611   | "Check signs of input signals in product blocks" (Simulink Check)              |
| jc_0794: Division in Simulink  | jc_0794   | "Check for division by zero in Simulink" (Simulink Check)                      |
| jc_0805: Numerical operation block inputs  | jc_0805   | <i>No check</i>  |
| jc_0622: Usage of Fcn blocks   | jc_0622   | "Check for parentheses in Fcn block expressions" (Simulink Check)              |
| jc_0621: Usage of Logical Operator blocks  | jc_0621   | "Check icon shape of Logical Operator blocks" (Simulink Check)                 |
| jc_0131: Usage of Relational Operator blocks   | jc_0131   | "Check usage of Relational Operator blocks" (Simulink Check)                   |
| jc_0800: Comparing floating-point types in Simulink  | jc_0800   | "Comparing floating point types in Simulink" (Simulink Check)                  |
| jc_0626: Usage of Lookup Table blocks  | jc_0626   | "Check usage of Lookup Tables" (Simulink Check)                                |

| <b>MAB Modeling Guideline<br/>(Version 5.0)</b>                               | <b>Corresponding JMAAB<br/>Modeling Guideline<br/>(Version 5.1)</b> | <b>Model Advisor Check</b>  |
|---|---|---|
| jc_0623: Usage of continuous-time Delay blocks and discrete-time Delay blocks | jc_0623   | "Check usage of Memory and Unit Delay blocks" (Simulink Check)              |
| jc_0624: Usage of Tapped Delay blocks/Delay blocks                            | jc_0624   | "Check for cascaded Unit Delay blocks" (Simulink Check)                     |
| jc_0627: Usage of Discrete-Time Integrator blocks                             | jc_0627   | "Check usage of Discrete-Time Integrator block" (Simulink Check)            |
| jc_0628: Usage of Saturation blocks   | jc_0628   | "Check usage of the Saturation blocks" (Simulink Check)                     |
| jc_0651: Implementing a type conversion                                       | jc_0651   | "Check output data type of operation blocks" (Simulink Check)               |
| db_0042: Usage of Inport and Outport blocks                                   | db_0042   | "Check position of Inport and Outport blocks" (Simulink Check)              |
| jc_0081: Inport and Outport block icon display                                | jc_0081   | "Check display for port blocks" (Simulink Check)                            |
| na_0011: Scope of Goto and From blocks  | na_0011   | "Check scope of From and Goto blocks" (Simulink Check)                      |
| jc_0161: Definition of Data Store Memory blocks                               | jc_0161   | "Check for usage of Data Store Memory blocks" (Simulink Check)              |
| jc_0141: Usage of the Switch blocks   | jc_0141   | "Check usage of Switch blocks" (Simulink Check)                             |
| jc_0650: Block input/output data type with switching function                 | jc_0650   | "Check input and output datatype for Switch blocks" (Simulink Check)        |
| jc_0630: Usage of Multiport Switch blocks                                     | jc_0630   | "Check settings for data ports in Multiport Switch blocks" (Simulink Check) |
| na_0020: Number of inputs to variant subsystems                               | na_0020   | "Check for missing ports in Variant Subsystems" (Simulink Check)            |
| na_0036: Default variant  | na_0036   | "Check use of default variants" (Simulink Check)                            |
| na_0037: Use of single variable for variant condition                         | na_0037   | "Check use of single variable variant conditionals" (Simulink Check)        |

| <b>MAB Modeling Guideline<br/>(Version 5.0)</b>                          | <b>Corresponding JMAAB<br/>Modeling Guideline<br/>(Version 5.1)</b> | <b>Model Advisor Check</b>   |
|--|---|--|
| db_0122: Stateflow and Simulink interface signals and parameters         | db_0122   | "Check for Strong Data Typing with Simulink I/O" (Simulink Check)            |
| db_0123: Stateflow port names  | No corresponding JMAAB guideline                                    | "Check for names of Stateflow ports and associated signals" (Simulink Check) |
| db_0125: Stateflow local data  | db_0125   | "Check definition of Stateflow data" (Simulink Check)                        |
| db_0126: Defining Stateflow events                                       | db_0126   | "Check definition of Stateflow events" (Simulink Check)                      |
| jc_0701: Usable number for first index                                   | jc_0701   | "Check usable number for first index" (Simulink Check)                       |
| jc_0712: Execution timing for default transition path                    | jc_0712   | "Check execution timing for default transition path" (Simulink Check)        |
| jc_0722: Local data definition in parallel states                        | jc_0722   | "Check scope of data in parallel states" (Simulink Check)                    |
| jc_0797: Unconnected transitions / states / connective junctions         | jc_0797   | "Check for unconnected objects in Stateflow Charts" (Simulink Check)         |
| db_0137: States in state machines  | db_0137   | "Check for state in state machines" (Simulink Check)                         |
| jc_0721: Usage of parallel states  | jc_0721   | "Check usage of parallel states" (Simulink Check)                            |
| db_0129: Stateflow transition appearance                                 | db_0129   | "Check for Stateflow transition appearance" (Simulink Check)                 |
| jc_0531: Default transition  | jc_0531   | "Check default transition placement in Stateflow charts" (Simulink Check)    |
| jc_0723: Prohibited direct transition from external state to child state | jc_0723   | "Check usage of transitions to external states" (Simulink Check)             |
| jc_0751: Backtracking prevention in state transition                     | jc_0751   | "Check for unexpected backtracking in state transitions" (Simulink Check)    |
| jc_0760: Starting point of internal transition                           | jc_0760   | "Check starting point of internal transition in Stateflow" (Simulink Check)  |
| jc_0763: Usage of multiple internal transitions                          | jc_0763   | "Check usage of internal transitions in Stateflow states" (Simulink Check)   |

| <b>MAB Modeling Guideline<br/>(Version 5.0)</b>                          | <b>Corresponding JMAAB<br/>Modeling Guideline<br/>(Version 5.1)</b> | <b>Model Advisor Check</b>   |
|--|---|--|
| jc_0762: Prohibition of state action and flow chart combination          | jc_0762   | "Check prohibited combination of state action and flow chart" (Simulink Check)           |
| db_0132: Transitions in flow charts                                      | db_0132   | "Check transitions in Stateflow Flow charts" (Simulink Check)                            |
| jc_0773: Unconditional transition of a flow chart                        | jc_0773   | "Check usage of unconditional transitions in flow charts" (Simulink Check)               |
| jc_0775: Terminating junctions in flow charts                            | jc_0775   | "Check terminal junctions in Stateflow" (Simulink Check)                                 |
| jc_0738: Usage of Stateflow comments                                     | jc_0738   | "Check usage of Stateflow comments" (Simulink Check)                                     |
| jc_0790: Action language of Chart block                                  | jc_0790   | "Check Stateflow chart action language" (Simulink Check)                                 |
| jc_0702: Use of named Stateflow parameters and constants                 | jc_0702   | "Check usage of numeric literals in Stateflow" (Simulink Check)                          |
| jm_0011: Pointers in Stateflow   | jm_0011   | "Check for pointers in Stateflow charts" (Simulink Check)                                |
| jc_0491: Reuse of Stateflow data   | jc_0491   | <i>Not checkable</i>   |
| jm_0012: Usage restrictions of events and broadcasting events            | jm_0012   | "Check for usage of events and broadcasting events in Stateflow charts" (Simulink Check) |
| jc_0733: Order of state action types                                     | jc_0733   | "Check order of state action types" (Simulink Check)                                     |
| jc_0734: Number of state action types                                    | jc_0734   | "Check repetition of Action types" (Simulink Check)                                      |
| jc_0740: Limitation on use of exit state action                          | jc_0740   | "Check if state action type 'exit' is used in the model" (Simulink Check)                |
| jc_0741: Timing to update data used in state chart transition conditions | jc_0741   | "Check updates to variables used in state transition conditions" (Simulink Check)        |
| jc_0772: Execution order and transition conditions of transition lines   | jc_0772   | "Check usage of transition conditions in Stateflow transitions" (Simulink Check)         |
| jc_0753: Condition actions and transition actions in Stateflow           | jc_0753   | "Check condition actions and transition actions in Stateflow" (Simulink Check)           |
| jc_0711: Division in Stateflow   | jc_0711   | <i>Not checkable</i>   |

| <b>MAB Modeling Guideline<br/>(Version 5.0)</b>                                   | <b>Corresponding JMAAB<br/>Modeling Guideline<br/>(Version 5.1)</b> | <b>Model Advisor Check</b>   |
|---|---|--|
| db_0127: Limitation on MATLAB commands in Stateflow blocks                        | db_0127   | "Check for MATLAB expressions in Stateflow charts" (Simulink Check)              |
| jc_0481: Use of hard equality comparisons for floating point numbers in Stateflow | jc_0481   | "Check usage of floating-point expressions in Stateflow charts" (Simulink Check) |
| na_0001: Standard usage of Stateflow operators                                    | na_0001   | "Check Stateflow operators" (Simulink Check)                                     |
| jc_0655: Prohibition of logical value comparison in Stateflow                     | jc_0655   | "Check prohibited comparison operation of logical type signals" (Simulink Check) |
| jc_0451: Use of unary minus on unsigned integers                                  | jc_0451   | "Check usage of unary minus operations in Stateflow charts" (Simulink Check)     |
| jc_0802: Prohibited use of implicit type casting in Stateflow                     | jc_0802   | "Check for implicit type casting in Stateflow" (Simulink Check)                  |
| jc_0803: Passing values to library functions                                      | jc_0803   | <i>Not checkable</i>   |
| jc_0732: Distinction between state names, data names, and event names             | jc_0732   | "Check uniqueness of Stateflow State and Data names" (Simulink Check)            |
| jc_0730: Unique state name in Stateflow blocks                                    | jc_0730   | "Check uniqueness of State names" (Simulink Check)                               |
| jc_0731: State name format  | jc_0731   | "Check usage of State names" (Simulink Check)                                    |
| jc_0501: Format of entries in a State block                                       | jc_0501   | "Check entry formatting in State blocks in Stateflow charts" (Simulink Check)    |
| jc_0736: Uniform indentations in Stateflow blocks                                 | jc_0736   | "Check indentation of code in Stateflow states" (Simulink Check)                 |
| jc_0739: Describing text inside states  | jc_0739   | "Check for usage of text inside states" (Simulink Check)                         |
| jc_0770: Position of transition label   | jc_0770   | "Check placement of Label String in Transitions" (Simulink Check)                |
| jc_0771: Comment position in transition labels                                    | jc_0771   | "Check position of comments in transition labels" (Simulink Check)               |

| <b>MAB Modeling Guideline<br/>(Version 5.0)</b>                     | <b>Corresponding JMAAB<br/>Modeling Guideline<br/>(Version 5.1)</b> | <b>Model Advisor Check</b>   |
|---|---|--|
| jc_0752: Condition action in transition label                       | jc_0752   | "Check usage of parentheses in Stateflow transitions" (Simulink Check)             |
| jc_0774: Comments for through transition                            | jc_0774   | "Check for comments in unconditional transitions" (Simulink Check)                 |
| jc_0511: Return values from a graphical function                    | jc_0511   | "Check return value assignments in Stateflow graphical functions" (Simulink Check) |
| jc_0804: Prohibited use of recursive calls with graphical functions | jc_0804   | "Check usage of graphical functions in Stateflow" (Simulink Check)                 |
| na_0042: Usage of Simulink functions                                | na_0042   | "Check usage of Simulink function in Stateflow" (Simulink Check)                   |
| na_0039: Limitation on Simulink functions in Chart blocks           | na_0039   | "Check use of Simulink in Stateflow charts" (Simulink Check)                       |
| na_0018: Number of nested if/else and case statement                | No corresponding JMAAB guideline                                    | "Check nested conditions in MATLAB Functions" (Simulink Check)                     |
| na_0025: MATLAB Function header                                     | No corresponding JMAAB guideline                                    | <i>No check</i>  |
| na_0024: Shared data in MATLAB functions                            | na_0024   | "Check MATLAB code for global variables" (Simulink Check)                          |
| na_0031: Definition of default enumerated value                     | na_0031   | "Check usage of enumerated values" (Simulink Check)                                |
| na_0034: MATLAB Function block input/output settings                | na_0034   | "Check input and output settings of MATLAB Functions" (Simulink Check)             |
| na_0016: Source lines of MATLAB Functions                           | No corresponding JMAAB guideline                                    | "Check lines of code in MATLAB Functions" (Simulink Check)                         |
| na_0017: Number of called function levels                           | No corresponding JMAAB guideline                                    | "Check the number of function calls in MATLAB Function blocks" (Simulink Check)    |
| na_0021: Strings in MATLAB functions                                | na_0021   | "Check usage of character vector inside MATLAB Function block" (Simulink Check)    |
| na_0022: Recommended patterns for Switch/Case statements            | No corresponding JMAAB guideline                                    | "Check usage of recommended patterns for Switch/Case statements" (Simulink Check)  |

| <b>MAB Modeling Guideline<br/>(Version 5.0)</b>             | <b>Corresponding JMAAB<br/>Modeling Guideline<br/>(Version 5.1)</b> | <b>Model Advisor Check</b>  |
|---|---|---|
| jc_0801: Prohibited use of the /*<br>and */ comment symbols | jc_0801   | "Check for use of C-style<br>comment symbols" (Simulink<br>Check) |

**See Also**

- "Run Model Advisor Checks and Review Results"



# Naming Conventions

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- “General Conventions” on page 2-2
- “Content Conventions” on page 2-11

## **General Conventions**

# ar\_0001: Usable characters for file names

## Sub ID Recommendations

- NA-MAAB — a, b, c, d, e, f, g
- JMAAB — a, b, c, d, e, f, g

## MATLAB Versions

All

## Rule

### Sub ID a

Only these character types shall be used in file names:

- Single-byte alphanumeric characters (a-z, A-Z, 0-9)
- Single-byte underscore ( \_ )

Line breaks, single-byte spaces, double-byte characters, and control characters shall not be used. File types that are checked for model and MATLAB files shall be set in the project settings.

### Custom Parameter

File (extension)

### Example — Incorrect

MAB Model.slx — Single-byte spaces are used

JMAAB 設定.m or NA-MAABModel.p — Double-byte characters are used.

JMAAB(Model).mdl — Symbol characters are used.

### Sub ID b

The file name shall not use numbers at the beginning.

### Custom Parameter

File (extension)

### Example — Incorrect

001\_JMAABModel.slx

### Sub ID c

The file name shall not use underscores at the beginning.

### Custom Parameter

File (extension)

#### Example — Incorrect

`_JMAABModel.slx`

### Sub ID d

The file name shall not use an underscore at the end.

### Custom Parameter

File (extension)

#### Example — Incorrect

`MABModel_.slx`

### Sub ID e

The file name shall not use consecutive underscores.

### Custom Parameter

File (extension)

#### Example — Incorrect

`JMAAB__Model.slx`

### Sub ID f

The file name shall not consist solely of a single reserved MATLAB word.

### Custom Parameter

File (extension)

#### Example — Incorrect

`ans.slx, double.slx`

### Sub ID g

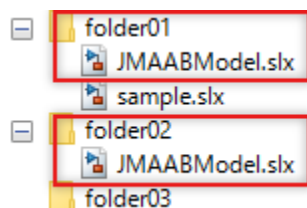
File names on the MATLAB path shall not be identical.

### Custom Parameter

File (extension)

#### Example — Incorrect

Files with the same name are saved to the folder that goes through the MATLAB path.



## Rationale

Sub IDs a, b, c, f:

- Readability is impaired.
- Deviation from the rule can cause unexpected issues.

Sub IDs d, e

- Readability is impaired.

Sub ID g:

- If there are multiple files with the same name, the one higher on the path is loaded. As a result, unnecessary files might be included.
- Readability is impaired.
- Deviation from the rule can cause unexpected issues.

## Verification

Model Advisor check: “Check file names” (Simulink Check)

## Last Changed

R2020a

## See Also

- JMAAB guideline ar\_0001, which is available in *Control Algorithm Modeling Guidelines Using MATLAB, Simulink, and Stateflow* on the MathWorks website.
- “Reserved Keywords” (Embedded Coder)
- “Reserved Identifiers and Code Replacement” (Embedded Coder)

**Introduced in R2020a**

## ar\_0002: Usable characters for folder names

### Sub ID Recommendations

- NA-MAAB — a, b, c, d, e, f
- JMAAB — a, b, c, d, e, f

### MATLAB Versions

All

### Rule

#### Sub ID a

Only these character types shall be used in folder names:

- Single-byte alphanumeric characters (a - z, A - Z, 0 - 9)
- Single-byte underscore (\_)

Line breaks, single-byte spaces, double-byte characters, and control characters shall not be used.

#### Custom Parameter

Not Applicable

#### Example — Incorrect



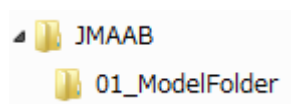
#### Sub ID b

The folder name shall not use numbers at the beginning.

#### Custom Parameter

Not Applicable

#### Example — Incorrect

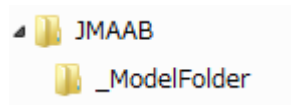


**Sub ID c**

The folder name shall not use underscores at the beginning.

**Custom Parameter**

Not Applicable

**Example — Incorrect****Sub ID d**

The folder name shall not use underscores at the end.

**Custom Parameter**

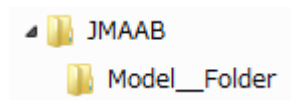
Not Applicable

**Example — Incorrect****Sub ID e**

The folder name shall not use consecutive underscores.

**Custom Parameter**

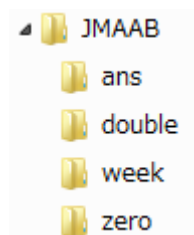
Not Applicable

**Example — Incorrect****Sub ID f**

The folder name shall not consist solely of a single reserved MATLAB word.

**Custom Parameter**

Not Applicable

**Example — Incorrect**

### **Rationale**

Sub IDs a, b, c, d, e, f:

- Readability is impaired.
- Deviation from the rule can cause unexpected issues.

### **Verification**

Model Advisor check: “Check folder names” (Simulink Check)

### **Last Changed**

R2020a

### **See Also**

- JMAAB guideline ar\_0002, which is available in *Control Algorithm Modeling Guidelines Using MATLAB, Simulink, and Stateflow* on the MathWorks website.
- “Reserved Keywords” (Embedded Coder)
- “Reserved Identifiers and Code Replacement” (Embedded Coder)

### **Introduced in R2020a**



# jc\_0241: Length restriction for model file names

## Sub ID Recommendations

- NA-MAAB — a
- JMAAB — a

## MATLAB Versions

All

## Rule

### Sub ID a

Model file name length shall be a maximum of 63 characters (not including dots and extension).

### Custom Parameter

Maximum model file name length

## Rationale

Sub ID a:

- Possible that a long file name cannot be referred to in the model reference.

## Verification

Model Advisor check: “Check length of model file name” (Simulink Check)

## Last Changed

R2020a

## See Also

- JMAAB guideline jc\_0241, which is available in *Control Algorithm Modeling Guidelines Using MATLAB, Simulink, and Stateflow* on the MathWorks website.

## Introduced in R2020a

## jc\_0242: Length restriction for folder names

### Sub ID Recommendations

- NA-MAAB — a
- JMAAB — a

### MATLAB Versions

All

### Rule

#### Sub ID a

Folder name length shall be a maximum of 63 characters.

#### Custom Parameter

Maximum folder name

### Rationale

Sub ID a:

- Possible that the full path name cannot be display in the user interface.

### Verification

Model Advisor check: “Check length of folder name at every level of model path” (Simulink Check)

### Last Changed

R2020a

### See Also

- JMAAB guideline jc\_0242, which is available in *Control Algorithm Modeling Guidelines Using MATLAB, Simulink, and Stateflow* on the MathWorks website.

### Introduced in R2020a

# **Content Conventions**

## jc\_0201: Usable characters for subsystem names

### Sub ID Recommendations

- NA-MAAB — a, b, c, d, e, f
- JMAAB — a, b, c, d, e, f

### MATLAB Versions

All

### Rule

#### Sub ID a

Only these character types shall be used in structural subsystem names:

- Single-byte alphanumeric characters (a - z, A - Z, 0 - 9)
- Single-byte underscore (\_)

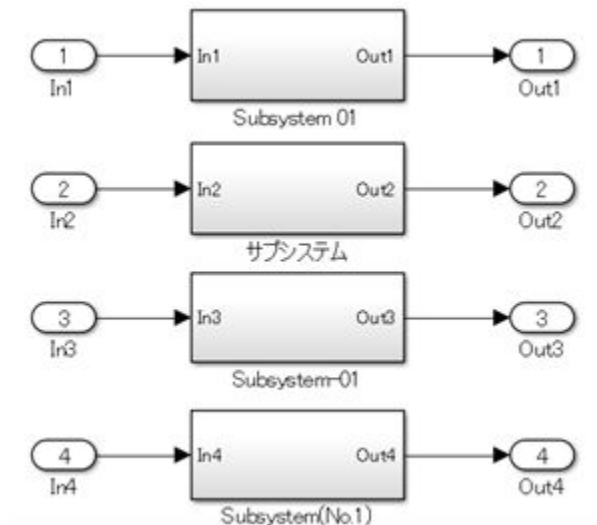
Line breaks, single-byte spaces, double-byte characters, and control characters shall not be used.

#### Custom Parameter

Not Applicable

#### Example — Incorrect

Single-byte spaces, double-byte, and symbol characters are used.

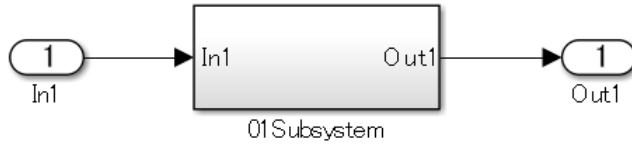


#### Sub ID b

A structural subsystem name shall not use numbers at the beginning.

**Custom Parameter**

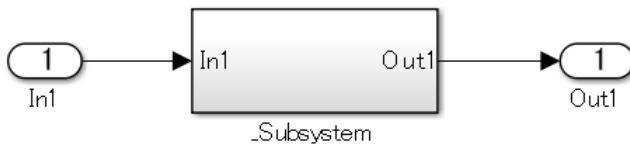
Not Applicable

**Example — Incorrect****Sub ID c**

A structural subsystem name shall not use an underscore at the beginning.

**Custom Parameter**

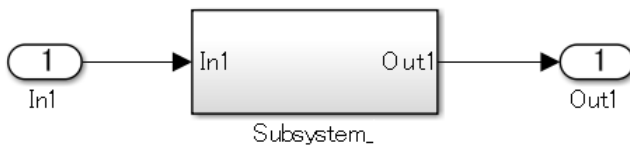
Not Applicable

**Example — Incorrect****Sub ID d**

A structural subsystem name shall not use an underscore at the end.

**Custom Parameter**

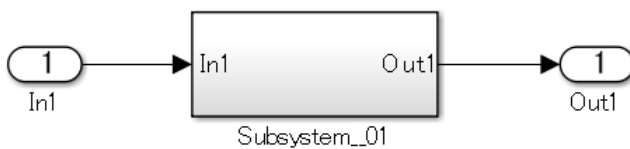
Not Applicable

**Example — Incorrect****Sub ID e**

A structural subsystem name shall not use consecutive underscores.

**Custom Parameter**

Not Applicable

**Example — Incorrect**

### Sub ID f

A structural subsystem shall not consist solely of a single reserved MATLAB word.

#### Custom Parameter

Not Applicable

#### Example — Incorrect



### Rationale

Sub IDs a, b, f:

- Cannot generate code using the configured structural subsystem name.

Sub IDs c, d, e:

- May not be able to generate code using the configured structural subsystem name.

### Verification

Model Advisor check: “Check Subsystem names” (Simulink Check)

### Last Changed

R2020a

### See Also

- JMAAB guideline jc\_0201, which is available in *Control Algorithm Modeling Guidelines Using MATLAB, Simulink, and Stateflow* on the MathWorks website.
- “Types of Subsystems”

**Introduced in R2020a**

# jc\_0231: Usable characters for block names

## Sub ID Recommendations

- NA-MAAB — a, b, c, d, e, f
- JMAAB — a, b, c, d, e, f

## MATLAB Versions

All

## Rule

### Sub ID a

Only these character types shall be used for basic block names:

- Single-byte alphanumeric characters (a - z, A - Z, 0 - 9)
- Single-byte underscore (\_)

Line breaks and single-byte spaces shall not be permitted when adding a new block name. However, they shall be permitted when used initially as a block name that is saved in the Simulink library.

Double-byte characters and control characters shall not be used.

### Exception

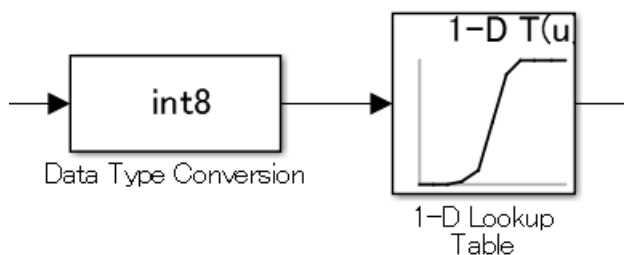
Inport and Outport blocks

### Custom Parameter

Not Applicable

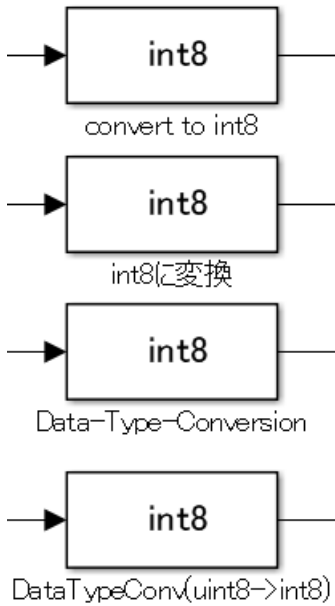
### Example — Correct

Block names are registered in the Simulink library.



### Example — Incorrect

Single-byte spaces, double-byte characters, and symbol characters are used.



**Sub ID b**

Basic block names shall not use numbers at the beginning.

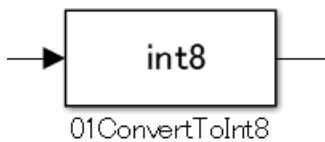
**Exception**

Inport and Outport blocks

**Custom Parameter**

Not Applicable

**Example — Incorrect**



**Sub ID c**

Basic block names shall not use underscores at the beginning.

**Exception**

Inport and Outport blocks

**Custom Parameter**

Not Applicable

**Example — Incorrect**





**Sub ID d**

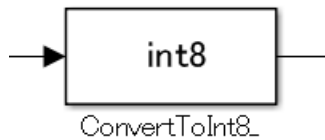
Basic block names shall not use underscores at the end.

**Exception**

Inport and Outport blocks

**Custom Parameter**

Not Applicable

**Example — Incorrect****Sub ID e**

Basic block names shall not use consecutive underscores.

**Exception**

Inport and Outport blocks

**Custom Parameter**

Not Applicable

**Example — Incorrect****Sub ID f**

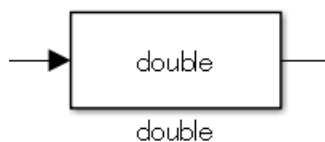
Basic block names shall not consist solely of a single reserved MATLAB word.

**Exception**

Inport and Outport blocks

**Custom Parameter**

Not Applicable

**Example — Incorrect**

### Rationale

Sub IDs a, b:

- Deviation from the rule can make it difficult to maintain the integrity of the model and code.

Sub IDs c, e:

- Readability is impaired.

Sub IDs d:

- Readability is impaired.
- Underscores can be used to separate words. However, they are typically used as word breaks and can cause misunderstanding in the description.

Sub IDs f:

- Readability is impaired.
- Deviation from the rule can cause unexpected issues.

### Verification

Model Advisor check: “Check character usage in block names” (Simulink Check)

### Last Changed

R2020a

### See Also

- JMAAB guideline jc\_0231, which is available in *Control Algorithm Modeling Guidelines Using MATLAB, Simulink, and Stateflow* on the MathWorks website.
- “Reserved Keywords” (Embedded Coder)
- “Reserved Identifiers and Code Replacement” (Embedded Coder)

### Introduced in R2020a

# jc\_0211: Usable characters for Inport blocks and Outport block

## Sub ID Recommendations

- NA-MAAB — a, b, c, d, e, f
- JMAAB — a, b, c, d, e, f

## MATLAB Versions

All

## Rule

### Sub ID a

Only these character types shall be used in Inport and Outport block names:

- Single-byte alphanumeric characters (a - z, A - Z, 0 - 9)
- Single-byte underscore (\_)

Line breaks, single-byte spaces, double-byte characters, and control characters shall not be used.

### Custom Parameter

Not Applicable

### Example — Incorrect

  
Inport signal

  
Inport(信号)

  
Inport-signal2

  
Signal(inport)

### Sub ID b

[Inport] and [Outport] block names shall not use numbers at the beginning.

**Custom Parameter**

Not Applicable

**Example — Incorrect**



**Sub ID c**

[Inport] and [Outport] block names shall not use underscores at the beginning.

**Custom Parameter**

Not Applicable

**Example — Incorrect**



**Sub ID d**

[Inport] and [Outport] block names shall not use underscores at the end.

**Custom Parameter**

Not Applicable

**Example — Incorrect**



**Sub ID e**

[Inport] and [Outport] block names shall not use consecutive underscores.

**Custom Parameter**

Not Applicable

**Example — Incorrect**



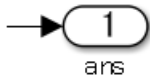
**Sub ID f**

[Inport] and [Outport] block names shall not consist solely of a single reserved MATLAB word.

## Custom Parameter

Not Applicable

### Example — Incorrect



## Rationale

Sub IDs a, b:

- Deviation from the rule can make it difficult to maintain the integrity of the model and code.

Sub IDs c, e:

- Readability is impaired.

Sub IDs d:

- Readability is impaired.
- Underscores can be used to separate words. However, they are typically used as word breaks and can cause misunderstanding in the description.

Sub IDs f:

- Readability is impaired.
- Deviation from the rule can cause unexpected issues.

## Verification

Model Advisor check: “Check port block names” (Simulink Check)

## Last Changed

R2020a

## See Also

- JMAAB guideline jc\_0211, which is available in *Control Algorithm Modeling Guidelines Using MATLAB, Simulink, and Stateflow* on the MathWorks website.
- “Reserved Keywords” (Embedded Coder)
- “Reserved Identifiers and Code Replacement” (Embedded Coder)

## Introduced in R2020a

# jc\_0243: Length restriction for subsystem names

## Sub ID Recommendations

- NA-MAAB — a
- JMAAB — a

## MATLAB Versions

All

## Rule

### Sub ID a

Structural subsystem name length shall be a maximum of 63 characters.

### Custom Parameter

Maximum subsystem name length

## Rationale

Sub ID a:

- Code generation may not be possible.

## Verification

Model Advisor check: “Check length of subsystem names” (Simulink Check)

## Last Changed

R2020a

## See Also

- JMAAB guideline jc\_0243, which is available in *Control Algorithm Modeling Guidelines Using MATLAB, Simulink, and Stateflow* on the MathWorks website.
- “Model Configuration Parameters”
- “Types of Subsystems”

## Introduced in R2020a

# jc\_0247: Length restriction for block names

## Sub ID Recommendations

- NA-MAAB — a
- JMAAB — a

## MATLAB Versions

All

## Rule

### Sub ID a

Basic block name length shall be a maximum of 63 characters.

### Exception

Inport and Outport blocks

### Custom Parameter

Maximum block name length

## Rationale

Sub ID a:

- Code generation may not be possible.

## Verification

Model Advisor check: “Check length of block names” (Simulink Check)

## Last Changed

R2020a

## See Also

- JMAAB guideline jc\_0247, which is available in *Control Algorithm Modeling Guidelines Using MATLAB, Simulink, and Stateflow* on the MathWorks website.

## Introduced in R2020a

## jc\_0244: Length restriction for Inport and Outport names

### Sub ID Recommendations

- NA-MAAB — a
- JMAAB — a

### MATLAB Versions

All

### Rule

#### Sub ID a

Inport and Outport block name length shall be a maximum of 63 characters.

#### Custom Parameter

Maximum Inport block name length

Maximum Outport block name length

### Rationale

Sub ID a:

- Code generation may not be possible.

### Verification

Model Advisor check: “Check length of Inport and Outport names” (Simulink Check)

### Last Changed

R2020a

### See Also

- JMAAB guideline jc\_0244, which is available in *Control Algorithm Modeling Guidelines Using MATLAB, Simulink, and Stateflow* on the MathWorks website.

### Introduced in R2020a



# jc\_0222: Usable characters for signal and bus names

## Sub ID Recommendations

- NA-MAAB — a, b, c, d, e, f
- JMAAB — a, b, c, d, e, f

## MATLAB Versions

All

## Rule

### Sub ID a

Only these character types shall be used in signal and bus names:

- Single-byte alphanumeric characters (a - z, A - Z, 0 - 9)
- Single-byte underscore ( \_ )

Line breaks, single-byte spaces, double-byte characters, and control characters shall not be used.

### Custom Parameter

Not Applicable

### Sub ID b

Signal and bus names shall not use numbers at the beginning.

### Custom Parameter

Not Applicable

### Sub ID c

The signal or bus name shall not use underscores at the beginning.

### Custom Parameter

Not Applicable

### Sub ID d

Signal and bus names shall not use underscores at the end.

### Custom Parameter

Not Applicable

### Sub ID e

Signal and bus names shall not use consecutive underscores.

#### Custom Parameter

Not Applicable

### Sub ID f

Signal and bus names shall not consist solely of a single reserved MATLAB word.

#### Custom Parameter

Not Applicable

## Rationale

Sub IDs a, b:

- Deviation from the rule can make it difficult to maintain the integrity of the model and code.

Sub IDs c, e:

- Readability is impaired.

Sub IDs d:

- Readability is impaired.
- Underscores can be used to separate words. However, they are typically used as word breaks and can cause misunderstanding in the description.

Sub IDs f:

- Readability is impaired.
- Deviation from the rule can cause unexpected issues.

## Verification

Model Advisor check: “Check usable characters for signal names and bus names” (Simulink Check)

## Last Changed

R2020a

## See Also

- JMAAB guideline jc\_0222, which is available in *Control Algorithm Modeling Guidelines Using MATLAB, Simulink, and Stateflow* on the MathWorks website.
- “Reserved Keywords” (Embedded Coder)
- “Reserved Identifiers and Code Replacement” (Embedded Coder)
- “Signal Basics”

- “Explore Simulink Bus Capabilities”

**Introduced in R2020a**

## jc\_0232: Usable characters for parameter names

### Sub ID Recommendations

- NA-MAAB — d, e
- JMAAB — a, b, c, d, e, f

### MATLAB Versions

All

### Rule

#### Sub ID a

Only these character types shall be used in parameter names:

- Single-byte alphanumeric characters (a - z, A - Z, 0 - 9)
- Single-byte underscore (\_)

Line break, single-byte space, double-byte characters, and control characters shall not be used.

#### Custom Parameter

Not Applicable

#### Sub ID b

The parameter name shall not use numbers at the beginning.

#### Custom Parameter

Not Applicable

#### Sub ID c

The parameter name shall not use underscores at the beginning.

#### Custom Parameter

Not Applicable

#### Sub ID d

The parameter name shall not use underscores at the end.

#### Custom Parameter

Not Applicable

#### Sub ID e

The parameter name shall not use consecutive underscores.

**Custom Parameter**

Not Applicable

**Sub ID f**

The parameter name shall not consist solely of a single reserved MATLAB word.

**Custom Parameter**

Not Applicable

**Rationale**

Sub IDs a, b:

- Deviation from the rule can make it difficult to maintain the integrity of the model and code.

Sub IDs c, e:

- Readability is impaired.

Sub ID d:

- Readability is impaired.
- Underscores can be used to separate words. However, they are typically used as word breaks and can cause misunderstanding in the description.

Sub ID f:

- Readability is impaired. Deviation from the rule can cause unexpected issues.

**Verification**

Model Advisor check: "Check usable characters for parameter names" (Simulink Check)

**Last Changed**

R2020a

**See Also**

- JMAAB guideline jc\_0232, which is available in *Control Algorithm Modeling Guidelines Using MATLAB, Simulink, and Stateflow* on the MathWorks website.
- "Reserved Keywords" (Embedded Coder)
- "Reserved Identifiers and Code Replacement" (Embedded Coder)

**Introduced in R2020a**

## jc\_0245: Length restriction for signal and bus names

### Sub ID Recommendations

- NA-MAAB — a
- JMAAB — a

### MATLAB Versions

All

### Rule

#### Sub ID a

Signal and bus name length shall be a maximum of 63 characters.

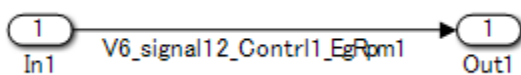
#### Custom Parameter

Maximum signal name length

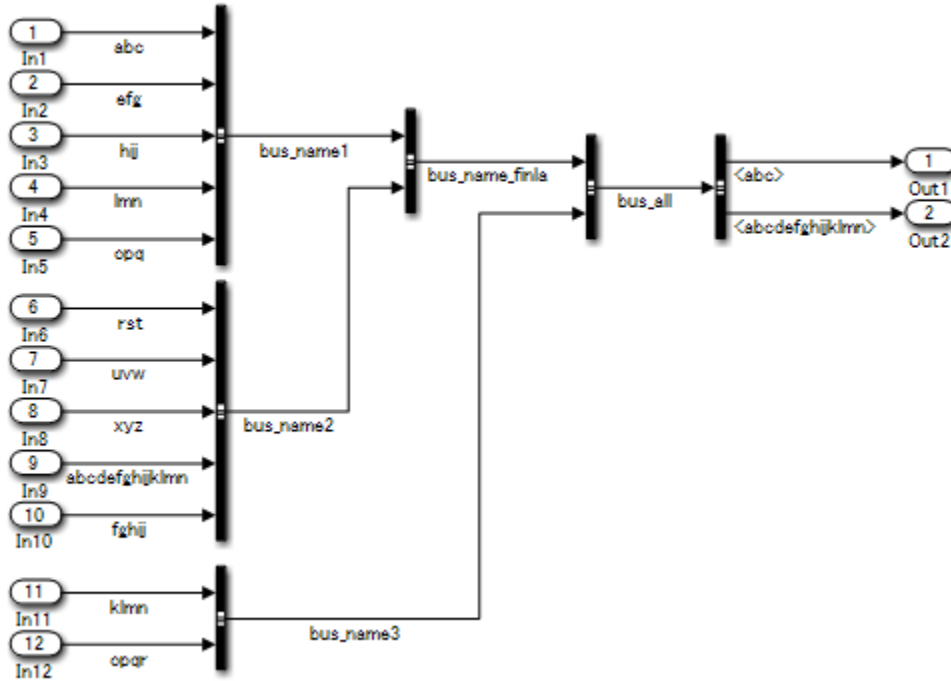
Maximum bus name length

#### Example — Correct

Signal name length is less than 63 characters.



The length of the hierarchical signal name (full path) `bus_all.bus_name_finla.bus_name2.abcdefghijklmn` is less than or equal to 63 characters.



## Rationale

Sub ID a:

- Code generation may not be possible.

## Verification

Model Advisor check: “Check length of signal and bus names” (Simulink Check)

## Last Changed

R2020a

## See Also

- JMAAB guideline jc\_0245, which is available in *Control Algorithm Modeling Guidelines Using MATLAB, Simulink, and Stateflow* on the MathWorks website.
- “Model Configuration Parameters”
- “Signal Basics”
- “Explore Simulink Bus Capabilities”

**Introduced in R2020a**

## jc\_0246: Length restriction for parameter name

### Sub ID Recommendations

- NA-MAAB — a
- JMAAB — a

### MATLAB Versions

All

### Rule

#### Sub ID a

Parameter name length shall be a maximum of 63 characters.

#### Custom Parameter

Maximum parameter name length

### Rationale

Sub ID a:

- Code generation may not be possible.

### Verification

Model Advisor check: “Check length of parameter names” (Simulink Check)

### Last Changed

R2020a

### See Also

- JMAAB guideline jc\_0246, which is available in *Control Algorithm Modeling Guidelines Using MATLAB, Simulink, and Stateflow* on the MathWorks website.

### Introduced in R2020a



# jc\_0795: Usable characters for Stateflow data names

## Sub ID Recommendations

- NA-MAAB — a, b, c, d
- JMAAB — a, b, c, d

## MATLAB Versions

All

### Rule

#### Sub ID a

Stateflow data {name} shall not use underscores at the beginning.

#### Custom Parameter

Not Applicable

#### Sub ID b

Stateflow data {name} shall not use underscores at the end.

#### Custom Parameter

Not Applicable

#### Sub ID c

Stateflow data {name} shall not use consecutive underscores.

#### Custom Parameter

Not Applicable

#### Sub ID d

Stateflow data {name} shall not consist solely of a single reserved MATLAB word.

#### Custom Parameter

Not Applicable

### Rationale

Sub IDs a, b, c, d:

- Readability is impaired.
- Deviation from the rule may result in unintended code behavior.

### **Verification**

Model Advisor check: “Check usable characters for Stateflow data names” (Simulink Check)

### **Last Changed**

R2020a

### **See Also**

- JMAAB guideline jc\_0795, which is available in *Control Algorithm Modeling Guidelines Using MATLAB, Simulink, and Stateflow* on the MathWorks website.
- “Add Stateflow Data” (Stateflow)
- “Set Data Properties” (Stateflow)

### **Introduced in R2020a**

# jc\_0796: Length restriction for Stateflow data names

## Sub ID Recommendations

- NA-MAAB — a, b, c, d
- JMAAB — a, b, c, d

## MATLAB Versions

All

## Rule

### Sub ID a

Stateflow data {name} shall be a maximum of 63 characters.

### Custom Parameter

Stateflow data name character limit

## Rationale

Sub ID a:

- Readability is impaired.
- Deviation from the rule can result in unintended code behavior

## Verification

Model Advisor check: “Check length of Stateflow data name” (Simulink Check)

## Last Changed

R2020a

## See Also

- JMAAB guideline jc\_0796, which is available in *Control Algorithm Modeling Guidelines Using MATLAB, Simulink, and Stateflow* on the MathWorks website.
- “Add Stateflow Data” (Stateflow)
- “Set Data Properties” (Stateflow)

## Introduced in R2020a

## jc\_0791: Duplicate data name definitions

### Sub ID Recommendations

- NA-MAAB — a, b, c
- JMAAB — a, b, c

### MATLAB Versions

All

### Rule

#### Sub ID a

Data name definitions shall not be duplicated in the base workspace and model workspace.

#### Custom Parameter

Not Applicable

#### Sub ID b

Data names shall not be duplicated in the base workspace and data dictionary (sldd).

#### Custom Parameter

Types of data dictionary

#### Sub ID c

Data name definitions shall not be duplicated in the model workspace and data dictionary (sldd).

#### Custom Parameter

Types of data dictionary

### Rationale

Sub IDs a, b, c:

- Duplicated data name can cause unintended model behavior.

### Verification

Model Advisor check: “Check duplication of Simulink data names” (Simulink Check)

### Last Changed

R2020a

## See Also

- JMAAB guideline jc\_0791, which is available in *Control Algorithm Modeling Guidelines Using MATLAB, Simulink, and Stateflow* on the MathWorks website.
- “Set Data Properties” (Stateflow)
- “Add Stateflow Data” (Stateflow)
- “Model Workspaces and Data Dictionaries”

## Introduced in R2020a

## jc\_0792: Unused Data

### Sub ID Recommendations

- NA-MAAB — a, b
- JMAAB — a, b

### MATLAB Versions

All

### Rule

#### Sub ID a

The data dictionary (sldd) shall define only the data that is used in the Simulink or Stateflow Coder™ model.

#### Custom Parameter

Types of data dictionary

#### Sub ID b

The model workspace shall define only the data that is used in the Simulink or Stateflow model.

#### Custom Parameter

Not Applicable

### Rationale

Sub IDs a, b:

- Unused data can affect maintainability and operability.

### Verification

Model Advisor check: “Check unused data in Simulink Model” (Simulink Check)

### Last Changed

R2020a

### See Also

- JMAAB guideline jc\_0792, which is available in *Control Algorithm Modeling Guidelines Using MATLAB, Simulink, and Stateflow* on the MathWorks website.

- “Model Workspaces and Data Dictionaries”

**Introduced in R2020a**

## jc\_0700: Unused data in Stateflow block

### Sub ID Recommendations

- NA-MAAB — a
- JMAAB — a

### MATLAB Versions

All

### Rule

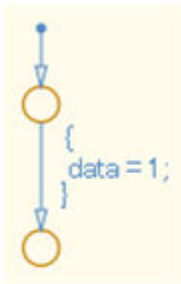
#### Sub ID a

Configuration parameter **Unused data, events, messages, and functions** shall be set to Warning or Error to prevent unused Stateflow data, events, and messages in the Stateflow block.

#### Custom Parameter

Not Applicable

#### Example — Correct



| Name | Scope | Port | Resolve                  | Signa | DataType | Size |
|------|-------|------|--------------------------|-------|----------|------|
| data | Local |      | <input type="checkbox"/> |       | uint8    | -1   |

#### Example — Incorrect

Unused data is defined.



| Name  | Scope | Port | Resolve                  | Signa | DataType | Size |
|-------|-------|------|--------------------------|-------|----------|------|
| data  | Local |      | <input type="checkbox"/> |       | uint8    | -1   |
| data1 | Local |      | <input type="checkbox"/> |       | uint8    | -1   |



## Rationale

Sub ID a:

- Unused data and events in the Stateflow block can affect maintainability and reusability.
- Affects code as a declarative statement concerning unused data is inserted into the generated code.

## Verification

Model Advisor check: “Check for unused data in Stateflow Charts” (Simulink Check)

## Last Changed

R2020a

## See Also

- JMAAB guideline jc\_0700, which is available in *Control Algorithm Modeling Guidelines Using MATLAB, Simulink, and Stateflow* on the MathWorks website.
- “Data, Events, and Messages” (Stateflow)
- “View Differences Between Stateflow Messages, Events, and Data” (Stateflow)
- “Manage Symbols in the Stateflow Editor” (Stateflow)

## Introduced in R2020a

## na\_0019: Restricted variable names

### Sub ID Recommendations

- NA-MAAB — a, b
- JMAAB — Not supported

### MATLAB Versions

All

### Rule

#### Sub ID a

Reserved C variable names shall not be used as variable names in MATLAB code. For example, avoid using `const`, `TRUE`, `FALSE`, `infinity`, `nil`, `double`, `single`, or `enum` in MATLAB code.

#### Custom Parameter

Not Applicable

#### Sub ID b

Variable names that conflict with MATLAB functions, such as `conv`, shall not be used.

#### Custom Parameter

Not Applicable

### Rationale

Sub IDs a, b:

- Improves readability of the code
- Code generation may not be possible.

### Verification

Model Advisor check: “Check usage of restricted variable names” (Simulink Check)

### Last Changed

R2020a

### See Also

- “Reserved Keywords” (Embedded Coder)

- “Reserved Identifiers and Code Replacement” (Embedded Coder)
- “Program a MATLAB Function in a Chart” (Stateflow)
- “Implementing MATLAB Functions Using Blocks”

**Introduced in R2020a**



# Simulink

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- “Configuration Parameters” on page 3-2
- “Diagram Appearance” on page 3-11
- “Signal” on page 3-63
- “Conditional Subsystem Relations” on page 3-98
- “Operation Blocks” on page 3-120
- “Other Blocks” on page 3-170

## **Configuration Parameters**

# jc\_0011: Optimization parameters for Boolean data types

## Sub ID Recommendations

- NA-MAAB — a
- JMAAB — a

## MATLAB Versions

All

## Rule

### Sub ID a

Configuration parameter **Implement logic signals as Boolean data (vs. double)** shall be selected so that optimization parameters are activated for logic signals.

### Custom Parameter

Not Applicable

## Rationale

Sub ID a:

- Using Boolean data can reduce RAM capacity when using C code.

## Verification

Model Advisor check: “Check Implement logic signals as Boolean data (vs. double)” (Simulink Check)

## Last Changed

R2020a

## See Also

- JMAAB guideline jc\_0011, which is available in *Control Algorithm Modeling Guidelines Using MATLAB, Simulink, and Stateflow* on the MathWorks website.
- “Signal Basics”

## Introduced in R2020a

## jc\_0642: Integer rounding mode setting

### Sub ID Recommendations

- NA-MAAB — a
- JMAAB — a

### MATLAB Versions

All

### Rule

#### Sub ID a

When block parameter **Integer rounding mode** is set to `Simplest`, configuration parameter **Production hardware signed integer division rounds to** shall be set to `Floor` or `Zero`.

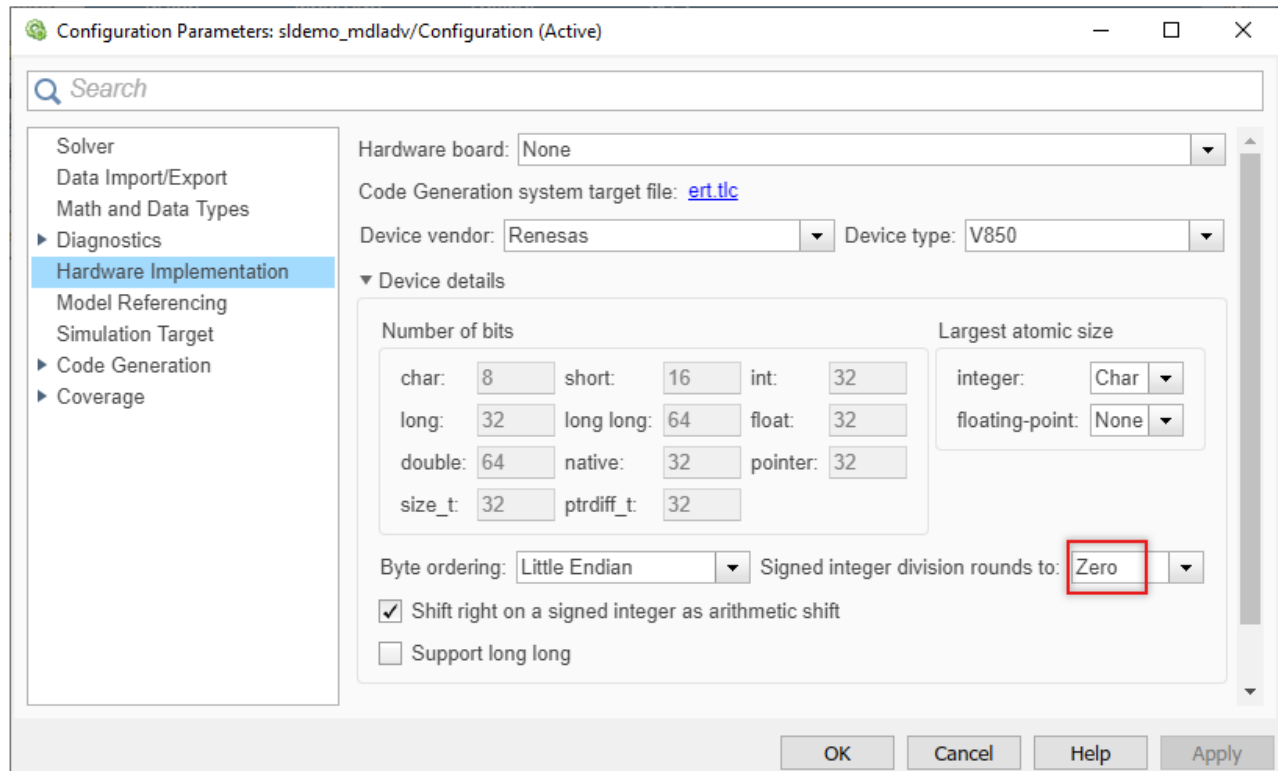
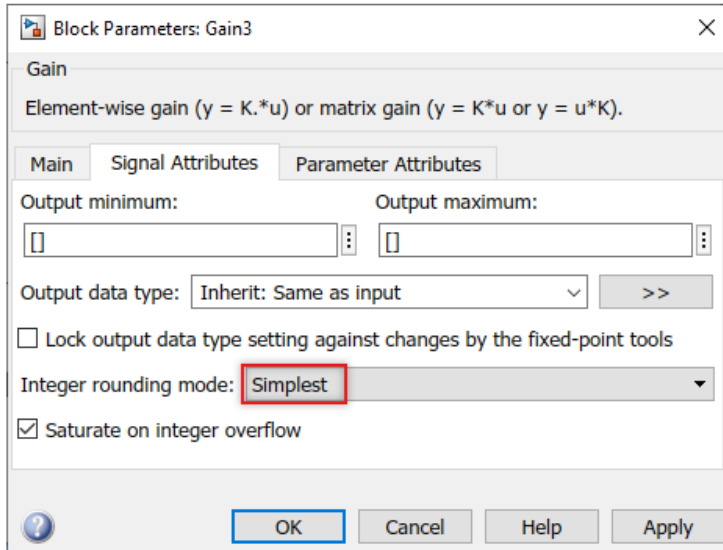
#### Custom Parameter

Not Applicable

#### Example — Correct

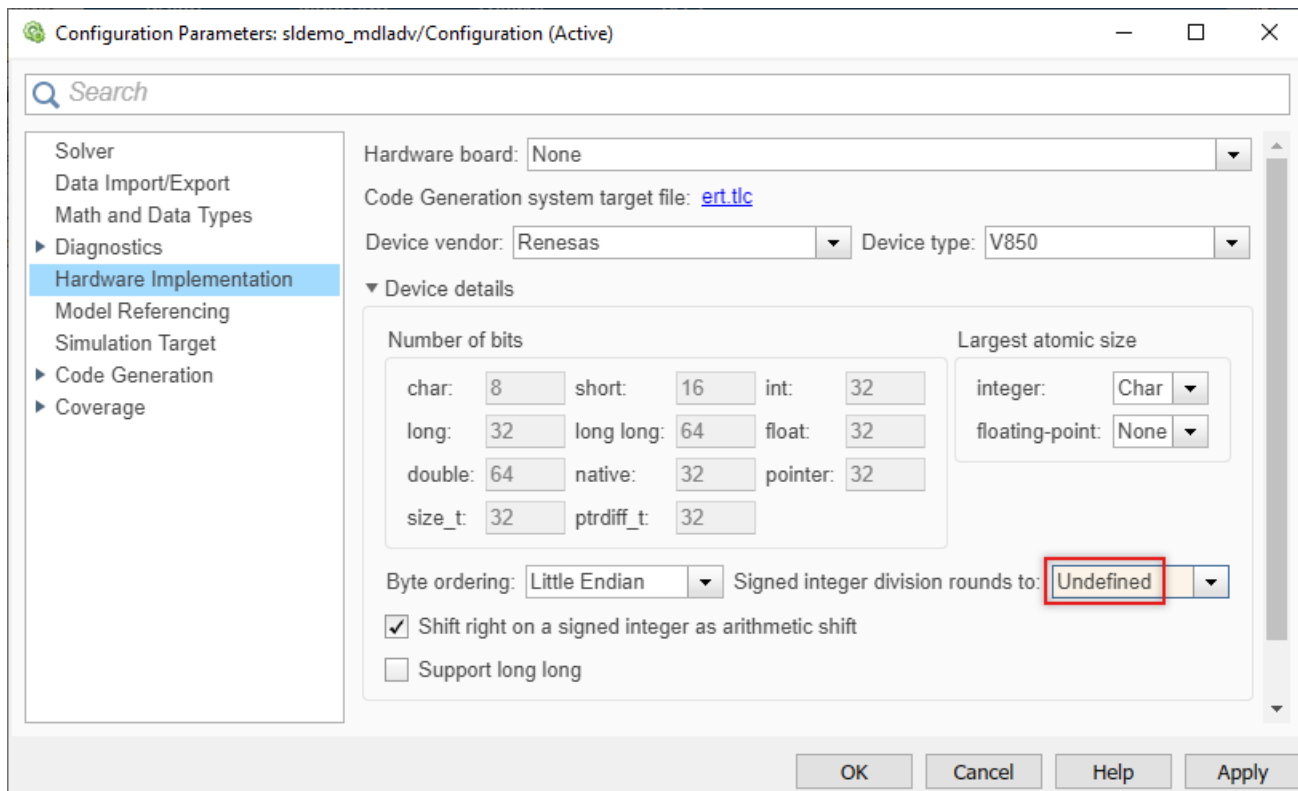
Block parameter **Integer rounding mode** is set to `Simplest` and configuration parameter **Production hardware signed integer division rounds to** is set to `Zero`.





### Example — Incorrect

Configuration parameter **Production hardware signed integer division rounds to** is set to Undefined when block parameter **Integer rounding mode** is set to Simplest.



## Rationale

Sub ID a:

- Prevents unintended rounding of divided signed integers.

## Verification

Model Advisor check: “Check Signed Integer Division Rounding mode” (Simulink Check)

## Last Changed

R2020a

## See Also

- Sub ID a, see MISRA AC SLSF 008B
- JMAAB guideline jc\_0642, which is available in *Control Algorithm Modeling Guidelines Using MATLAB, Simulink, and Stateflow* on the MathWorks website.
- “Signed integer division rounds to”

**Introduced in R2020a**

# jc\_0806: Detecting incorrect calculation results

## Sub ID Recommendations

- NA-MAAB — a, b, c
- JMAAB — a, b, c

## MATLAB Versions

All

## Rule

### Sub ID a

Configuration parameter **Division by singular matrix** shall be set to Error.

#### Custom Parameter

Not Applicable

### Sub ID b

Configuration parameter **Inf or NaN block output** shall be set to Error.

#### Custom Parameter

Not Applicable

### Sub ID c

(R2014b and later) These configuration parameters shall be set to Error:

- **Wrap on overflow**
- **Saturate on overflow**

(R2010b to R2014a) Configuration parameter **Detect overflow** shall be set to Error.

#### Custom Parameter

Not Applicable

## Rationale

Sub IDs a, b, c:

- Allows detection of operations with invalid values.

## Verification

Model Advisor check: “Check diagnostic settings for incorrect calculation results” (Simulink Check)

## **Last Changed**

R2020a

## **See Also**

- JMAAB guideline jc\_0806, which is available in *Control Algorithm Modeling Guidelines Using MATLAB, Simulink, and Stateflow* on the MathWorks website.

## **Introduced in R2020a**

# jc\_0021: Model diagnostic settings

## Sub ID Recommendations

- NA-MAAB — a
- JMAAB — Not supported

## MATLAB Versions

All

## Rule

### Sub ID a

These configuration parameters shall be set to warning or error:

- **Algebraic loop**
- **Minimize algebraic loop**
- **Multitask rate transition**
- **Inf or NaN block output**
- **Duplicate data store names**
- **Unconnected block input ports**
- **Unconnected block output ports**
- **Unconnected line**
- **Unspecified bus object at root Output block**
- **Element name mismatch**
- (R2017a and earlier) **Mux blocks used to create bus signals**
- (R2012a and earlier) **Invalid function-call connection**

### Custom Parameter

Not Applicable

## Rationale

Sub ID a:

- Improves model workflow.
- Code generation may not be possible

## Verification

Model Advisor check “Check model diagnostic parameters” (Simulink Check)

**Last Changed**

R2020a

**Introduced in R2020a**

## **Diagram Appearance**

## na\_0004: Simulink model appearance settings

### Sub ID Recommendations

- NA-MAAB — No recommendations
- JMAAB — a

### MATLAB Versions

All

### Rule

#### Sub ID a

Simulink model appearance settings shall conform with the project settings.

#### Custom Parameter

Display option

#### Example — View Options

On the Simulink toolstrip, these parameters are available in the **Modeling** tab, under **Environment**.

| Parameter     | Setting                                 |
|---------------|---|
| Model Browser | Deselect <b>Model Browser</b> .         |
| Status Bar    | Select <b>Status Bar</b> .              |
| Toolstrip     | Select <b>Toolstrip</b> .               |
| Zoom          | Select <b>Zoom (Normal View 100%)</b> . |

#### Example — Block Display Options

On the Simulink toolstrip, these parameters are available in the **Debug** tab, under **Information Overlays**.

| Parameter                | Setting                                   |
|--------------------------|---|
| Library Links            | Select <b>Hide All Links</b> .            |
| Linearization Indicators | Select <b>Linearization Indicators</b> .  |
| Ref. Model I/O Mismatch  | Deselect <b>Ref. Model I/O Mismatch</b> . |
| Ref. Model Version       | Deselect <b>Ref. Model Version</b> .      |
| Sample Time Colors       | Deselect <b>Colors</b> .                  |
| Execution Order          | Deselect <b>Execution Order</b> .         |

#### Example — Block Color Options

On the Simulink toolstrip, these parameters are available in the **Format** tab.



| Parameter        | Setting   |
|------------------|---|
| Background color | Select <b>white</b> option from the <b>Background</b> list. |
| Foreground color | Select <b>black</b> option from the <b>Foreground</b> list. |

#### Example — Storage Class Indicators

To access the parameter below, On the Simulink toolstrip, open Simulink Coder from Apps, select **C Code** tab and choose **Code Interface**.

| Parameter               | Setting                                   |
|-------------------------|---|
| Storage Class Indicator | Deselect <b>Storage Class Indicator</b> . |

#### Example — Signal Display Options

On the Simulink toolstrip, these parameters are available in the **Debug** tab, under **Information Overlays**.

| Parameter                     | Setting                               |
|-------------------------------|---------------------------------------|
| Base Data Types               | Deselect <b>Base Data Types</b> .     |
| Alias Data Types              | Deselect <b>Alias Data Types</b> .    |
| Signal Dimensions             | Deselect <b>Signal Dimensions</b> .   |
| Testpoint                     | Select <b>Test Point</b> .            |
| Logging and Viewer indicators | Select <b>Logging &amp; Viewers</b> . |
| Nonscalar Signals             | Select <b>Nonscalar Signals</b> .     |

## Rationale

Sub ID a:

- Standard model appearance improves readability.

## Verification

Model Advisor check: “Check for Simulink diagrams using nonstandard display attributes” (Simulink Check)

## Last Changed

R2020a

## See Also

- JMAAB guideline: na\_0004, which is available in *Control Algorithm Modeling Guidelines Using MATLAB, Simulink, and Stateflow* on the MathWorks website.
- MISRA AC SLSF 023A
- “Mapping from Simulink Editor to the Simulink Toolstrip”

**Introduced in R2020a**

# db\_0043: Model font and font size

## Sub ID Recommendations

- NA-MAAB — a, b, c, d
- JMAAB — a, b, c, d

## MATLAB Versions

All

### Rule

#### Sub ID a

Block name *font* and *font style* shall conform with the project settings.

Signal name *font* and *font style* shall conform with the project settings.

#### Custom Parameter

Font

Font style

#### Sub ID b

Block name *font size* shall conform with the project settings.

Signal name *font size* shall conform with the project settings

#### Custom Parameter

Font size

#### Sub ID c

State labels and box name *font* and *font style* shall conform with the project settings.

Transition labels and comment *font* and *font style* shall conform with the project settings.

#### Custom Parameter

Font

Font style

#### Sub ID d

State labels and box name *font size* shall conform with the project settings.

Transition labels and comment *font size* shall conform with the project settings.

**Custom Parameter**

Font size

**Rationale**

Sub IDs a, c:

- Standard fonts improve readability.

Sub IDs b, d:

- Standard font size improves readability.

**Verification**

Model Advisor check: “Check Model font settings” (Simulink Check)

**Last Changed**

R2020a

**See Also**

- JMAAB guideline db\_0043, which is available in *Control Algorithm Modeling Guidelines Using MATLAB, Simulink, and Stateflow* on the MathWorks website.

**Introduced in R2020a**

# jm\_0002: Block resizing

## Sub ID Recommendations

- NA-MAAB — a
- JMAAB — a

## MATLAB Versions

All

## Rule

### Sub ID a

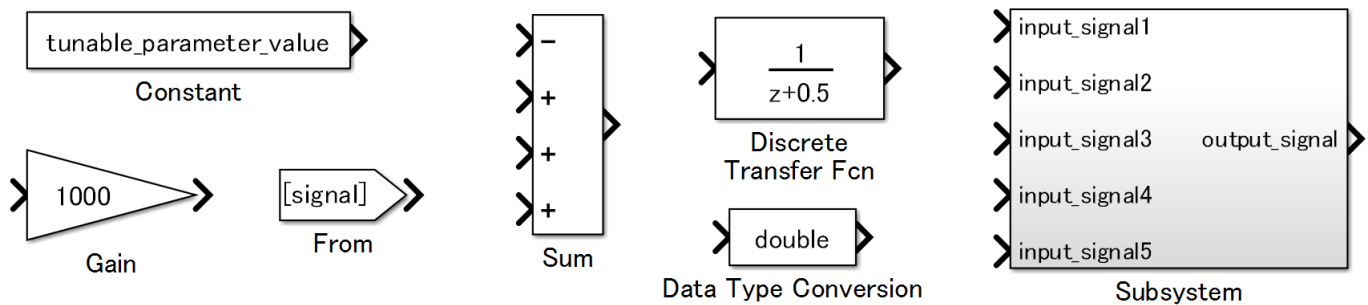
Blocks shall be sized so that the block icon is visible and recognizable.

### Custom Parameter

Not Applicable

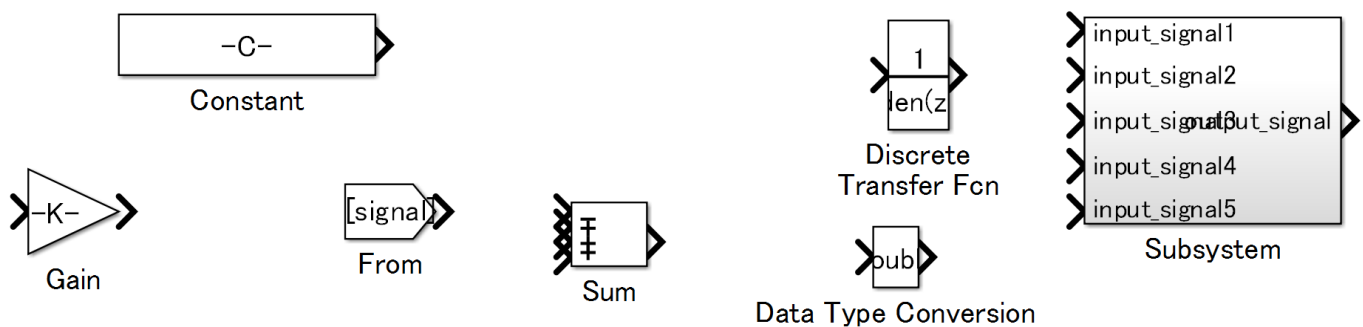
### Example — Correct

The block icon is visible and recognizable.



### Example — Incorrect

The block is too small so the icon is neither visible nor recognizable.



## Rationale

Sub ID a:

- When a block is too small, the text and symbol displayed by the icon can be difficult to see, which impairs readability.

## Verification

Adherence to this modeling guideline cannot be verified by using a Model Advisor check.

## Last Changed

R2020a

## See Also

- JMAAB guideline jm\_0002, which is available in *Control Algorithm Modeling Guidelines Using MATLAB, Simulink, and Stateflow* on the MathWorks website.
- “Format a Model”

**Introduced in R2020a**

## db\_0142: Position of block names

### Sub ID Recommendations

- NA-MAAB — a
- JMAAB — a

### MATLAB Versions

All

### Rule

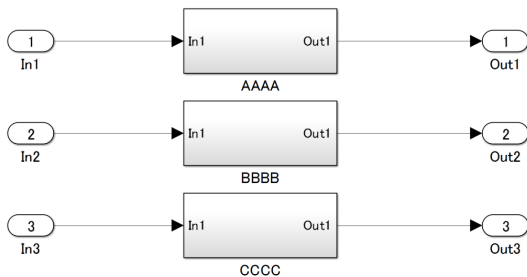
#### Sub ID a

The block name shall be positioned below the block.

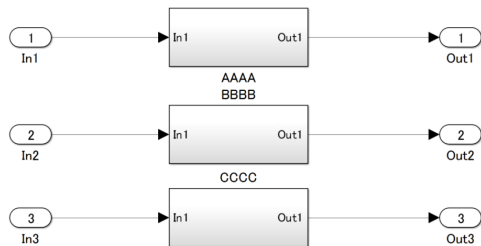
#### Custom Parameter

Not Applicable

#### Example — Correct



#### Example — Incorrect



### Rationale

Sub ID a:

- Consistent placement of the block name improves model readability because it is easier to determine which name corresponds to the block.

## **Verification**

Model Advisor check: “Check whether block names appear below blocks” (Simulink Check)

## **Last Changed**

R2020a

## **See Also**

- JMAAB guideline db\_0142, which is available in *Control Algorithm Modeling Guidelines Using MATLAB, Simulink, and Stateflow* on the MathWorks website.

**Introduced in R2020a**



# jc\_0061: Display of block names

## Sub ID Recommendations

- NA-MAAB — a
- JMAAB — a

## MATLAB Versions

All

## Rule

### Sub ID a

Block names shall be hidden for blocks that meet the following criteria:

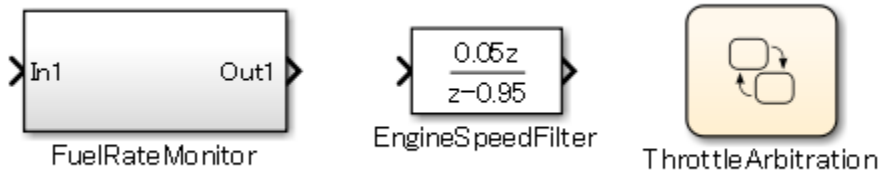
- Block type is evident from its visual appearance
- Uses the default block name (including instances where only a number has been added at the end)

For blocks that do not meet the criteria, their name shall be displayed.

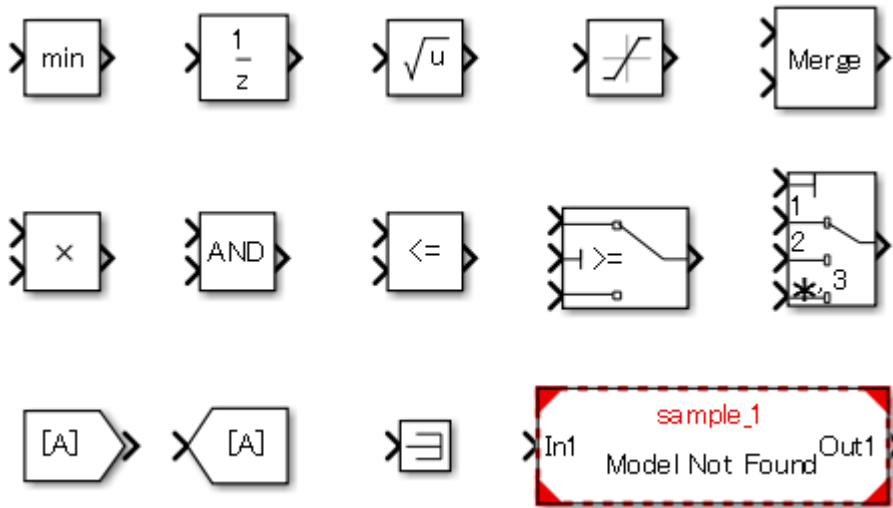
### Custom Parameter

Blocks with a clear type due their appearance

### Example — Displayed block names



**Example — Hidden block names**



**Rationale**

Sub ID a:

- Improves model readability.

**Verification**

Model Advisor check: “Check the display attributes of block names” (Simulink Check)

**Last Changed**

R2020a

**See Also**

- JMAAB guideline jc\_0061, which is available in *Control Algorithm Modeling Guidelines Using MATLAB, Simulink, and Stateflow* on the MathWorks website.
- MISRA AC SLSF 026A

**Introduced in R2020a**

# db\_0140: Display of block parameters

## Sub ID Recommendations

- NA-MAAB — No recommendations
- JMAAB — a

## MATLAB Versions

All

## Rule

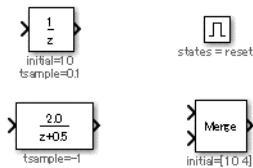
### Sub ID a

Block annotation shall display block parameters that are defined by the project.

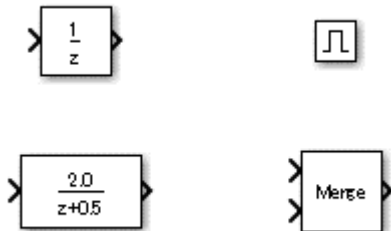
### Custom Parameter

Block parameters

### Example — Correct



### Example — Incorrect



## Rationale

Sub ID a:

- Readability improves when block parameters are displayed.

## Verification

Model Advisor check: “Check for nondefault block attributes” (Simulink Check)

## Last Changed

R2020a

## See Also

- MISRA AC SLSF 026E
- JMAAB guideline db\_0140, which is available in *Control Algorithm Modeling Guidelines Using MATLAB, Simulink, and Stateflow* on the MathWorks website.
- “Set Block Annotation Properties”

## Introduced in R2020a

# jc\_0603: Model description

## Sub ID Recommendations

- NA-MAAB — No recommendations
- JMAAB — a, b

## MATLAB Versions

All

## Rule

### Sub ID a

The model layer shall include a description of the layer.

Layers that require a description are defined (by function and layer type) in the project.

### Custom Parameter

Description object (block type, etc.)

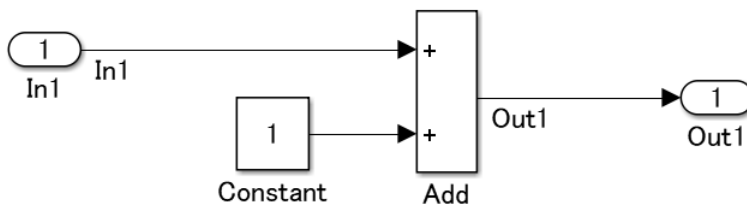
Layer being described

### Example — Correct

Model layer includes description [Requirement].

#### 【Requirement】

Performs an increment process on the input signal In1



### Sub ID b

The format of the layer description shall be consistent in the model.

### Custom Parameter

Model description format

## Rationale

Sub ID a:

- When a description is not included, the readability of the control specifications is reduced. Usability, maintainability, and portability also decreases.

Sub ID b:

- Readability is impaired when the description format is not consistent.

## Verification

Model Advisor check: “Check Model Description” (Simulink Check)

## Last Changed

R2020a

## See Also

- Sub ID a and b, see MISRA AC SLSF 022
- JMAAB guideline jc\_0603, which is available in *Control Algorithm Modeling Guidelines Using MATLAB, Simulink, and Stateflow* on the MathWorks website.

**Introduced in R2020a**

# jc\_0604: Using block shadow

## Sub ID Recommendations

- NA-MAAB — a
- JMAAB — a

## MATLAB Versions

All

## Rule

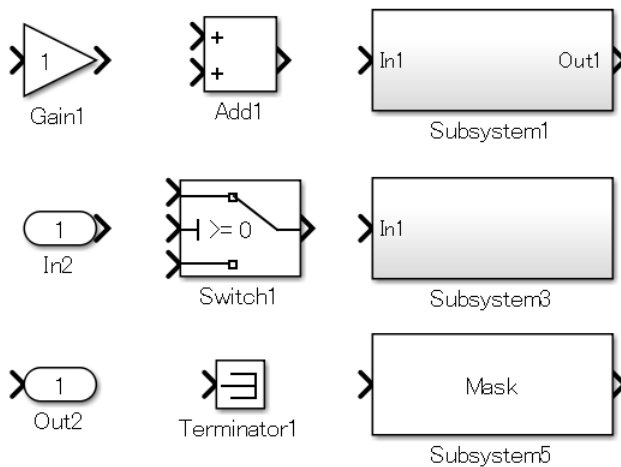
### Sub ID a

Block format property **Shadow** (DropShadow) shall not be selected.

### Custom Parameter

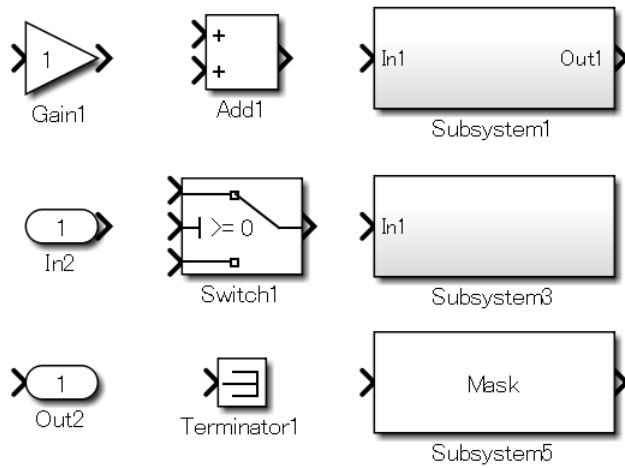
Not Applicable

### Example — Correct



### Example — Incorrect

Blocks have a drop shadow.



## Rationale

Sub ID a:

- Difficult to determine if a port exists because it is hidden by the shading, which impairs readability.

## Verification

Model Advisor check: “Check if blocks are shaded in the model” (Simulink Check)

## Last Changed

R2020a

## See Also

- JMAAB guideline jc\_0604, which is available in *Control Algorithm Modeling Guidelines Using MATLAB, Simulink, and Stateflow* on the MathWorks website.
- “Common Block Properties”
- “Set Block Parameter Values”

**Introduced in R2020a**



## db\_0081: Unconnected signals and blocks

### Sub ID Recommendations

- NA-MAAB — a, b
- JMAAB — a, b

### MATLAB Versions

All

### Rule

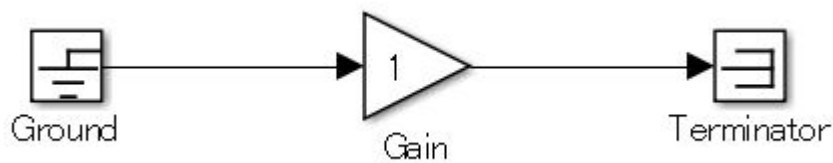
#### Sub ID a

The model shall not have signal lines that are not connected.

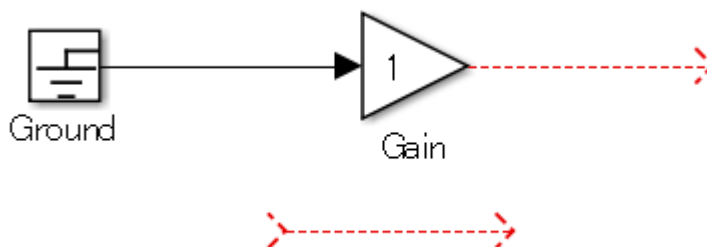
#### Custom Parameter

Not Applicable

#### Example — Correct



#### Example — Incorrect

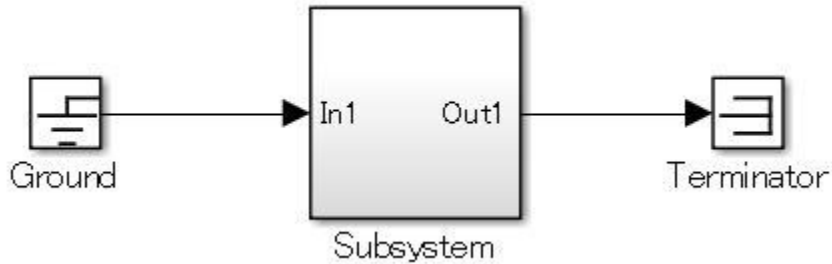
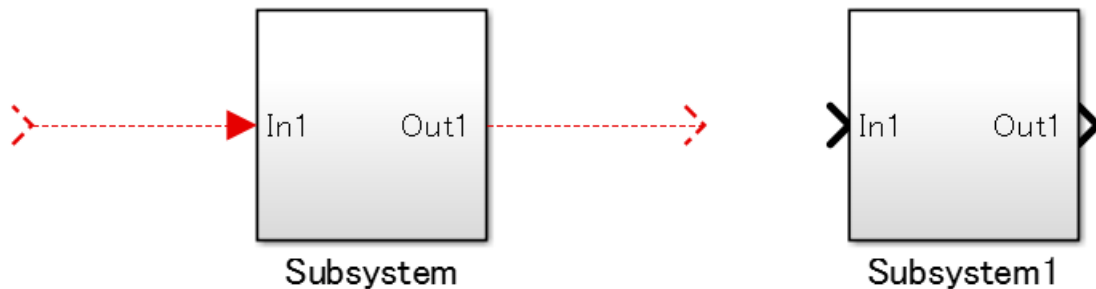


#### Sub ID b

The model shall not have subsystems or basic blocks that are not connected.

#### Custom Parameter

Not Applicable

**Example — Correct****Example — Incorrect****Rationale**

Sub IDs a, b:

- Unconnected lines can have adverse effects, such as simulation errors or failure to generate code.

**Verification**

Model Advisor check: “Check for unconnected signal lines and blocks” (Simulink Check)

**Last Changed**

R2020a

**See Also**

- JMAAB guideline db\_0081, which is available in *Control Algorithm Modeling Guidelines Using MATLAB, Simulink, and Stateflow* on the MathWorks website.
- “Signal Basics”
- “Types of Subsystems”

**Introduced in R2020a**

# db\_0032: Signal line connections

## Sub ID Recommendations

- NA-MAAB — a1/a2, b, c, e
- JMAAB — a1/a2, b, c, d, e

## MATLAB Versions

All

## Rule

### Sub ID a1

Vertical and horizontal signal lines shall not cross over one another.

#### Custom Parameter

Not Applicable

### Sub ID a2

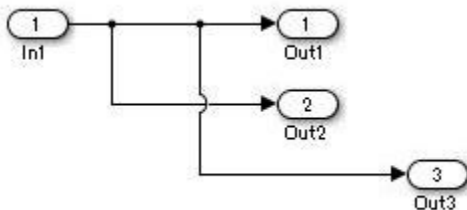
(R2014a and later) When vertical and horizontal signal lines must cross, Simulink editor preference **Line crossing style** shall be set to **Line hop**.

#### Custom Parameter

Not Applicable

#### Example — Correct

The vertical line hops over the horizontal line.



### Sub ID b

Signal lines shall not overlap with other signal lines.

#### Custom Parameter

Not Applicable

**Sub ID c**

Signal lines shall not cross over blocks.

**Custom Parameter**

Not Applicable

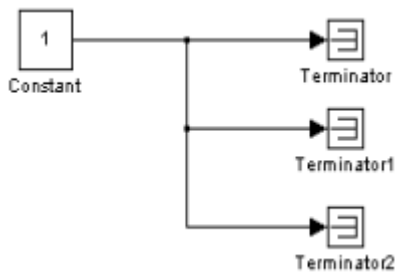
**Sub ID d**

Signal lines shall not split into more than two sub lines at a single branching point.

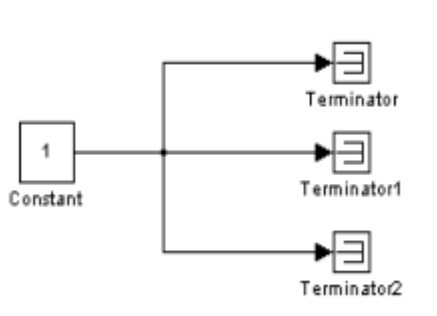
**Custom Parameter**

Not Applicable

**Example — Correct**



**Example — Incorrect**



**Sub ID e**

Signal lines shall be resized vertically or horizontally as required for the model layout.

**Custom Parameter**

Not Applicable

**Rationale**

Sub IDs a1, c:

- Difficult to understand the relationships between blocks when signal lines cross.

Sub ID a2:

- In R2014a and later, the difference between crossing and branching is clarified.

Sub ID b:

- Difficult to understand the relationships between blocks when signal lines overlap.

Sub ID d:

- Difficult to understand the relationships between blocks.

Sub ID e:

- Consistent application of signal lines improves readability.

## Verification

Model Advisor check: “Check signal line connections” (Simulink Check)

## Last Changed

R2020a

## See Also

- JMAAB guideline db\_0032, which is available in *Control Algorithm Modeling Guidelines Using MATLAB, Simulink, and Stateflow* on the MathWorks website.
- “Signal Basics”

**Introduced in R2020a**

# db\_0141: Signal flow in Simulink models

## Sub ID Recommendations

- NA-MAAB — No recommendations
- JMAAB — a, b, c

## MATLAB Versions

All

## Rule

### Sub ID a

Signals shall flow from left to right.

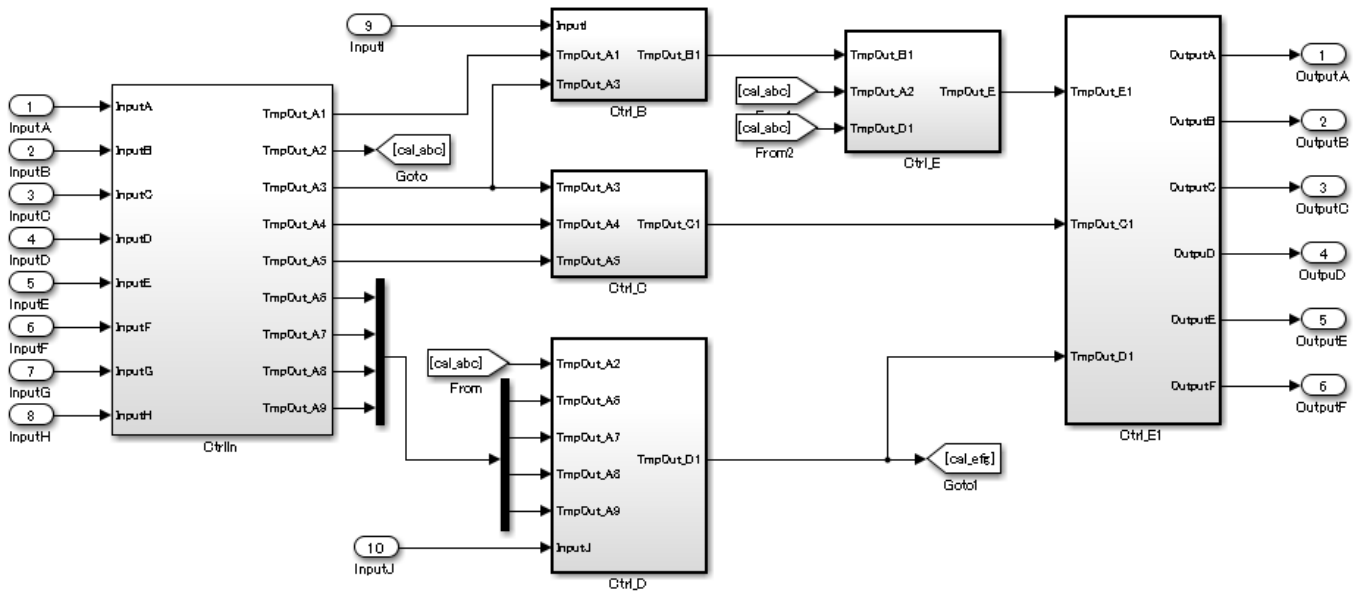
### Exception

Feedback loops can flow from right to left.

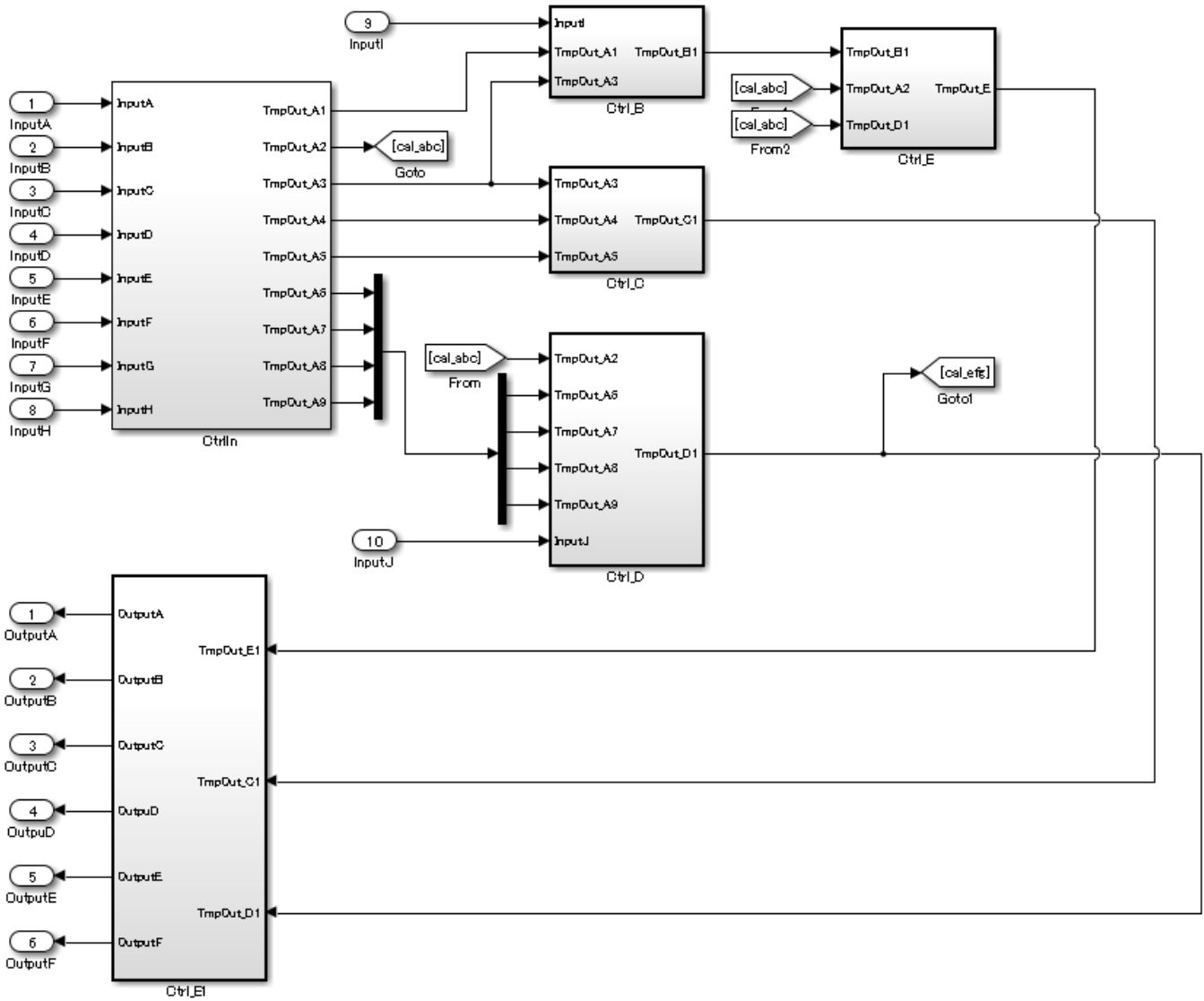
### Custom Parameter

Not Applicable

### Example — Correct



**Example – Incorrect**



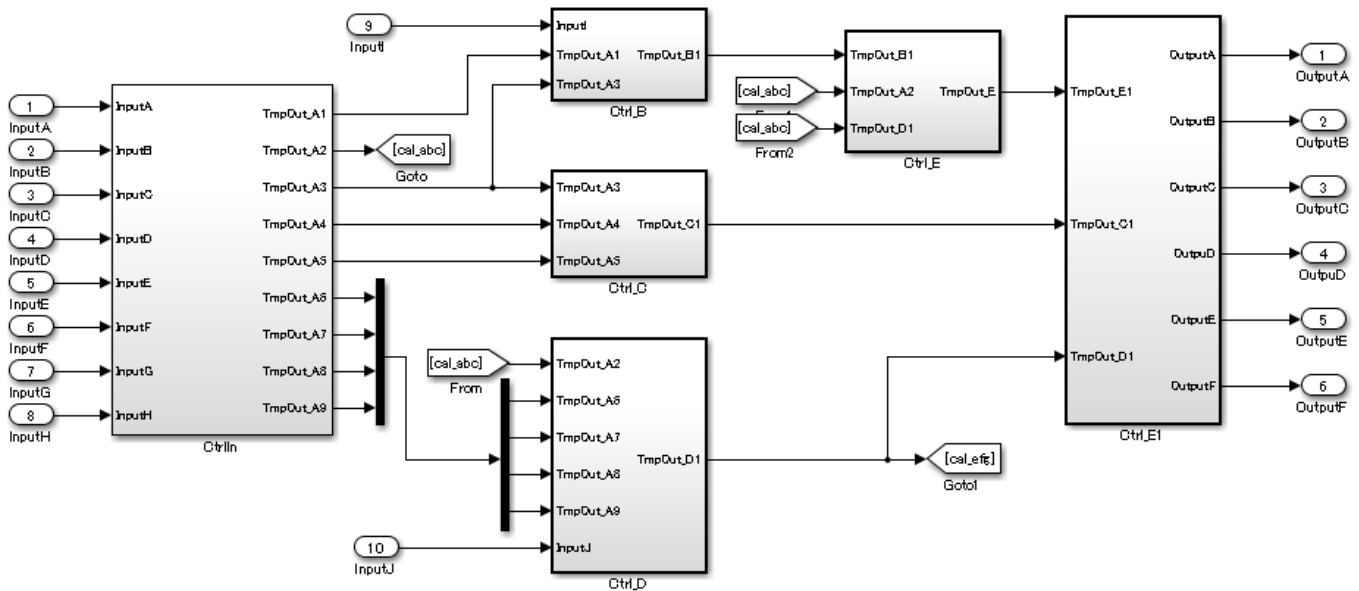
**Sub ID b**

Parallel blocks or subsystems shall be arranged from top to bottom.

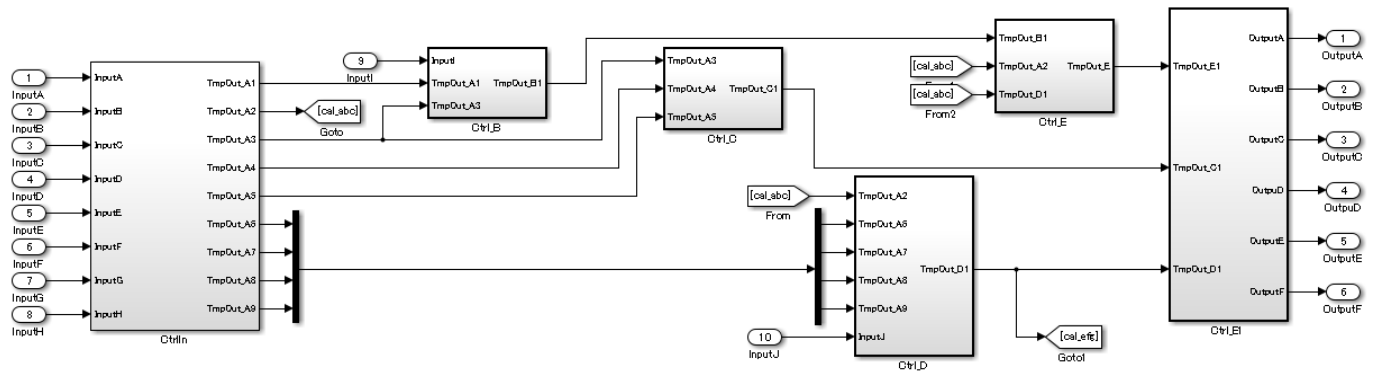
**Custom Parameter**

Not Applicable

**Example – Correct**



**Example – Incorrect**



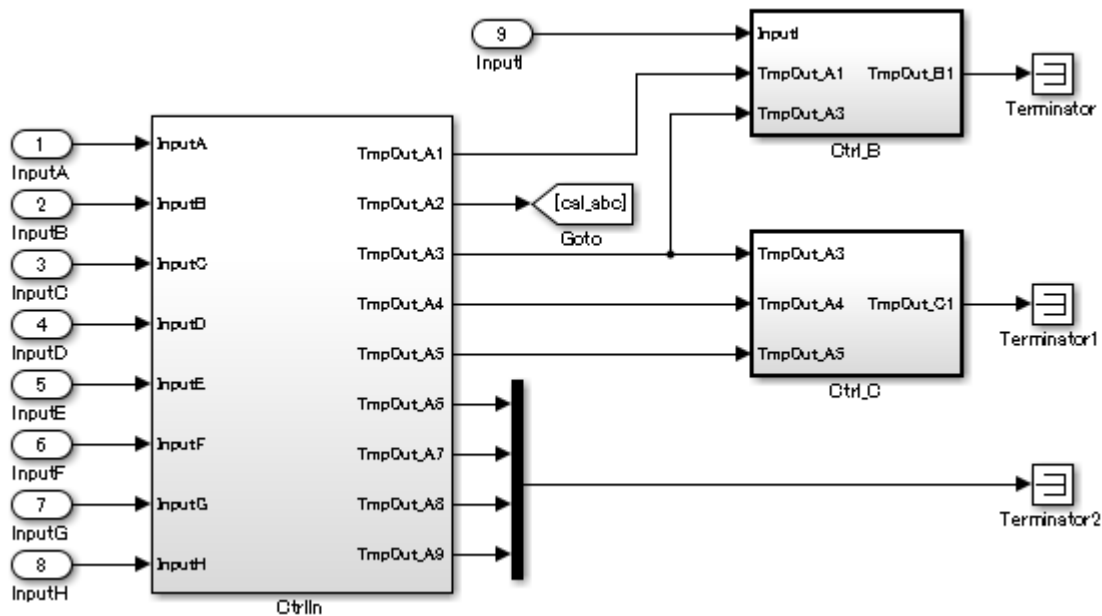
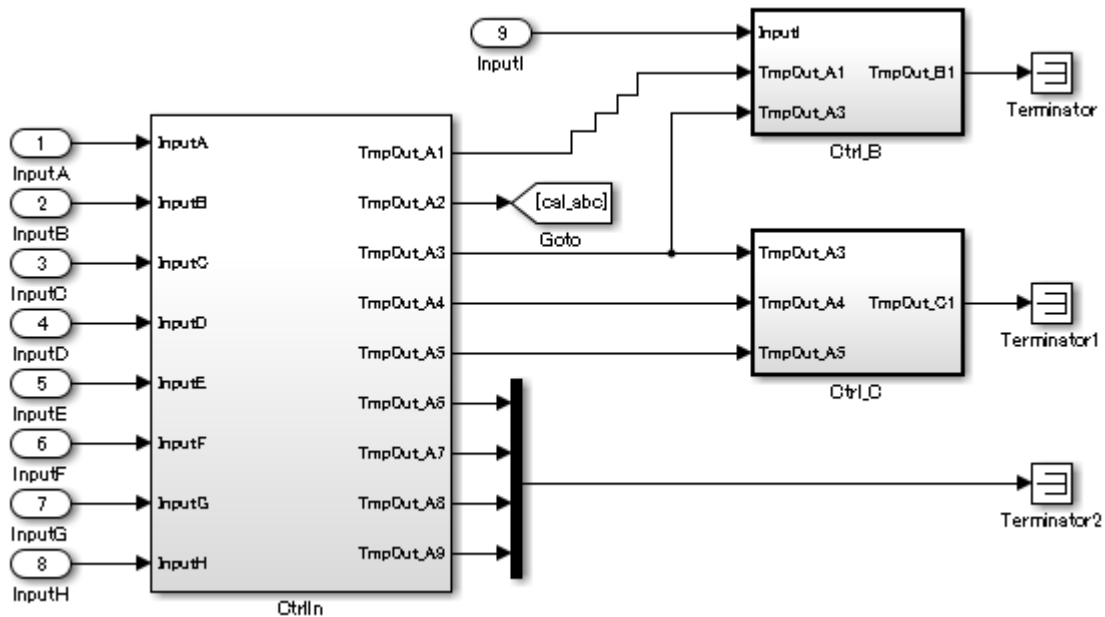
**Sub ID c**

Signal lines shall not bend multiple times unnecessarily.

**Custom Parameter**

Not Applicable



**Example – Correct****Example – Incorrect****Rationale**

Sub IDs a, b, c:

- Deviation from the rules can impair readability.

## Verification

Model Advisor check: “Check signal flow in model Check position of signal labels” (Simulink Check)

## Last Changed

R2020a

## See Also

- JMAAB guideline db\_0141, which is available in *Control Algorithm Modeling Guidelines Using MATLAB, Simulink, and Stateflow* on the MathWorks website.
- “Signal Basics”
- “Types of Subsystems”

**Introduced in R2020a**

# jc\_0110: Direction of block

## Sub ID Recommendations

- NA-MAAB — No recommendations
- JMAAB — a

## MATLAB Versions

All

## Rule

### Sub ID a

Blocks shall be arranged so the output is to the right.

### Exception

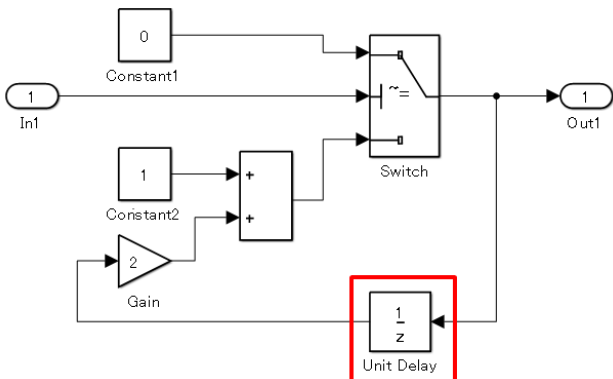
When a Delay is used in a feedback loop, the output can be to the left.

### Custom Parameter

Not Applicable

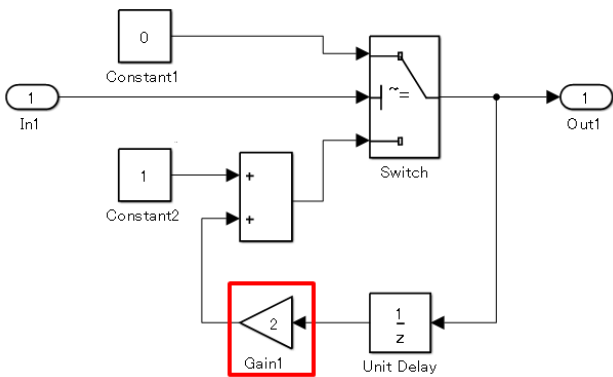
### Example — Correct

The model is arranged so that the output is to the right. The output of the Delay block is to the left.



### Example — Incorrect

The block is arranged so the output is to the left.



## Rationale

Sub ID a:

- Signal flow can be difficult to understand if the direction of the signals is not consistent.

## Verification

Model Advisor check: "Check block orientation" (Simulink Check)

## Last Changed

R2020a

## See Also

- JMAAB guideline jc\_0110, which is available in *Control Algorithm Modeling Guidelines Using MATLAB, Simulink, and Stateflow* on the MathWorks website.

**Introduced in R2020a**

# jc\_0171: Clarification of connections between structural subsystems

## Sub ID Recommendations

- NA-MAAB — No recommendations
- JMAAB — a, b

## MATLAB Versions

All

## Rule

### Sub ID a

A minimum of one signal line shall connect two structural subsystems.

When a two-way signal connection exists between two structural subsystems (A and B), each direction shall be connected to at least one signal line.

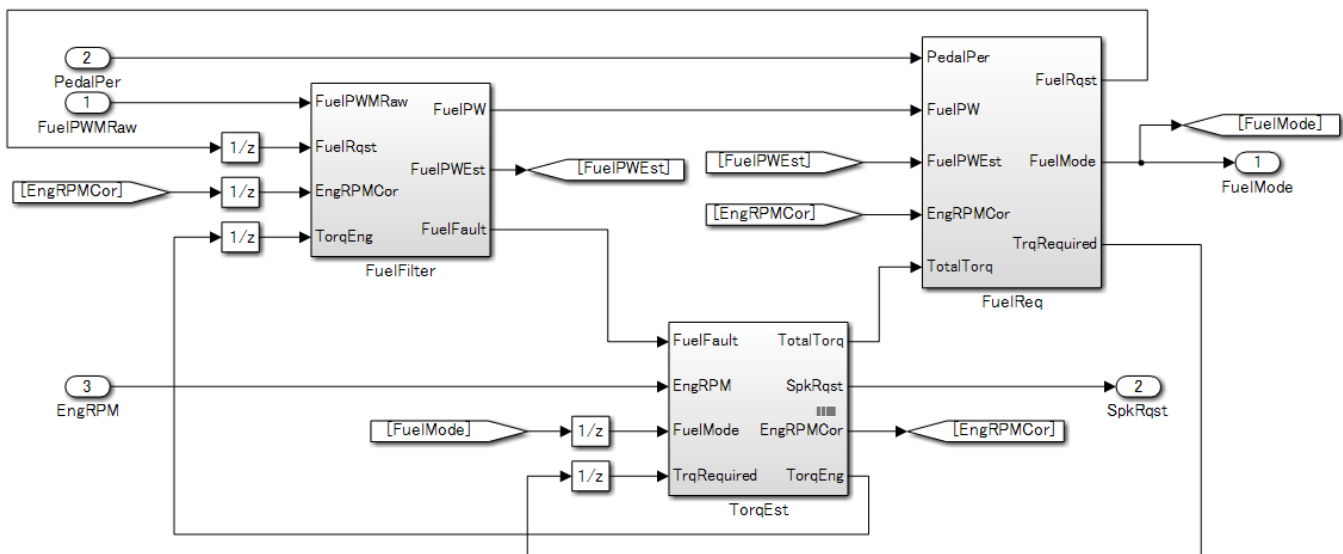
### Exception

Using Goto and From blocks to create buses or connect signals to a Merge block.

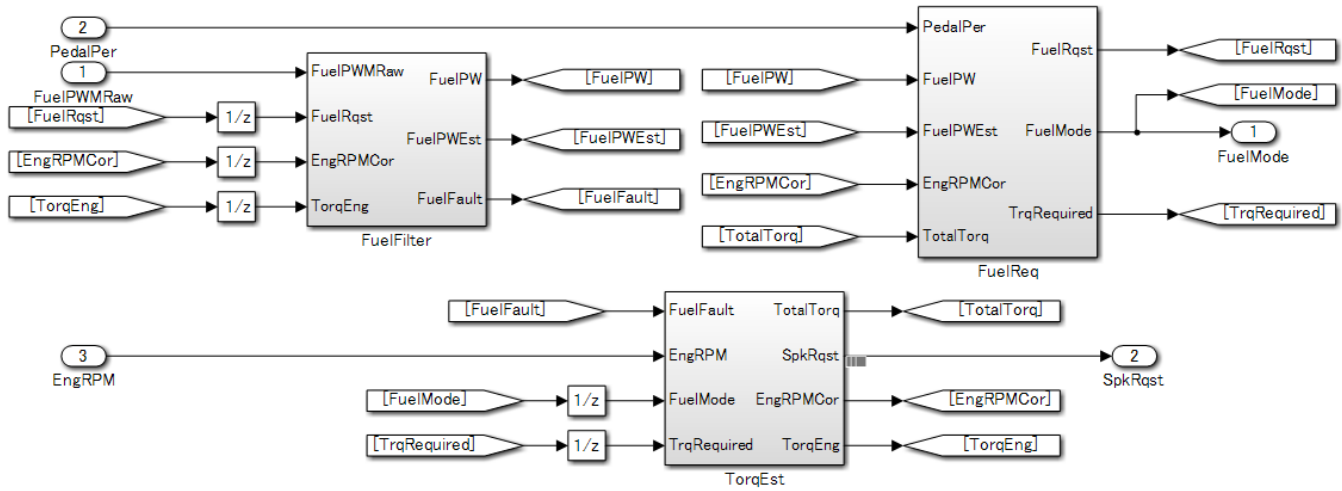
### Custom Parameter

Not Applicable

### Example — Correct



**Example – Incorrect**



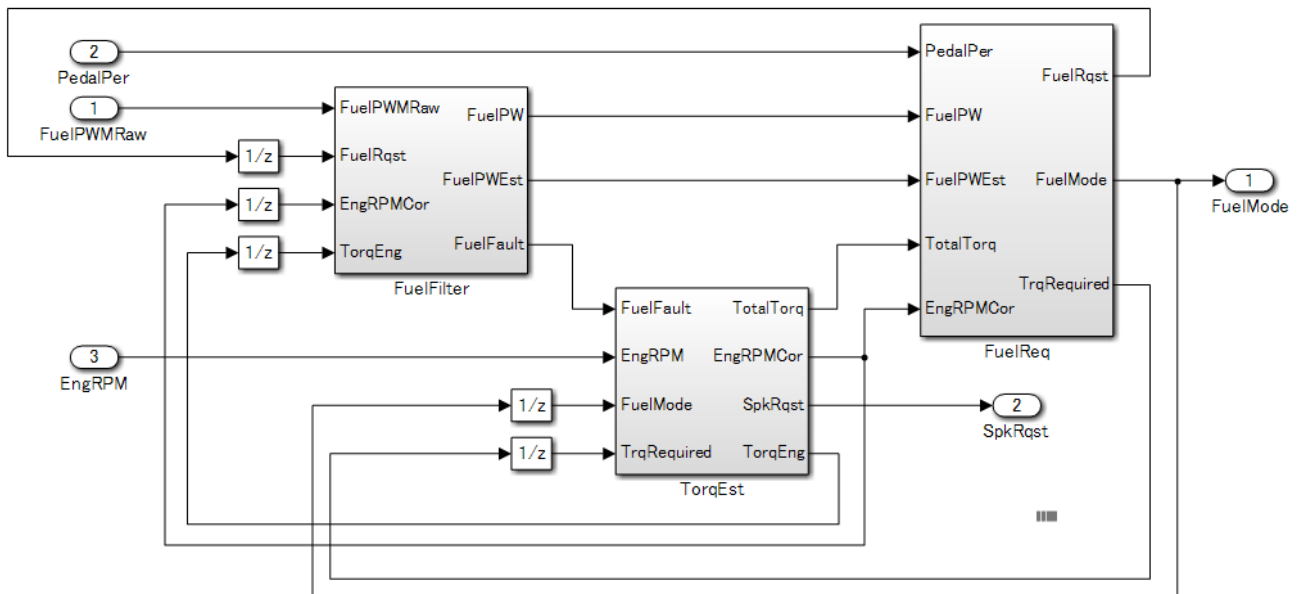
**Sub ID b**

Signals that are not used within a structural subsystem shall be input to a structural subsystem. These signals shall not be output to other structural subsystems or basic blocks.

**Custom Parameter**

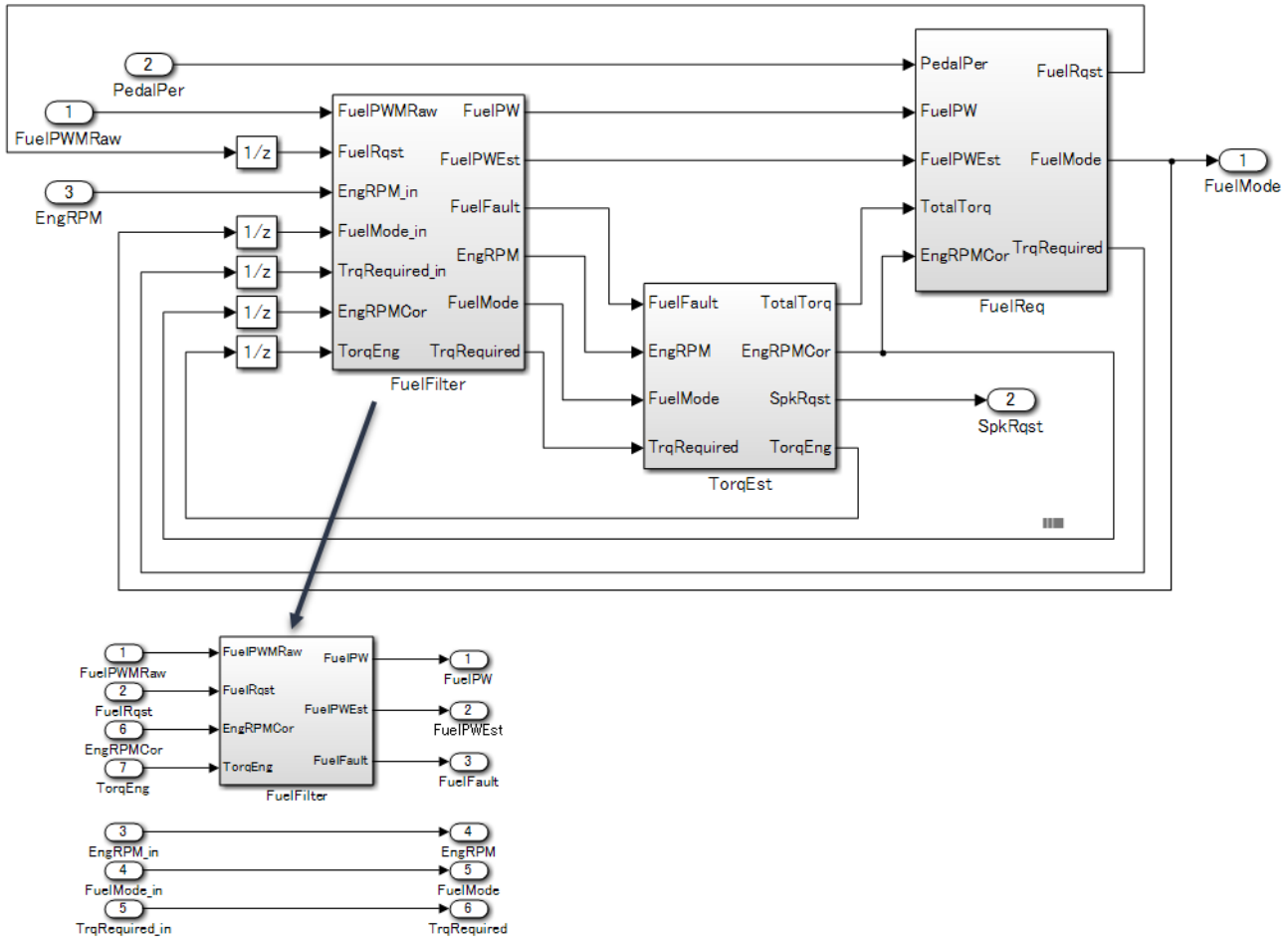
Not Applicable

**Example – Correct**



**Example — Incorrect**

Signals that are not used in the subsystem are connected to avoid crossing of signal lines.



**Rationale**

Sub ID a:

- Clarifies structural subsystem connections and execution order.

Sub ID b:

- Eliminating unnecessary connections clarifies the relationship between connections.
- Deviation from the rule can cause to confusion due to unused input/output signals.

**Verification**

Model Advisor check: “Check connections between structural subsystems” (Simulink Check)

## **Last Changed**

R2020a

## **See Also**

- JMAAB guideline jc\_0171, which is available in *Control Algorithm Modeling Guidelines Using MATLAB, Simulink, and Stateflow* on the MathWorks website.
- “Signal Basics”
- “Types of Subsystems”

## **Introduced in R2020a**



# jc\_0602: Consistency in model element names

## Sub ID Recommendations

- NA-MAAB — No recommendations
- JMAAB — a

## MATLAB Versions

All

## Rule

### Sub ID a

These names shall match when they are directly connected by using signal lines.

- Inport block name
- Outport block name
- Structural subsystem input port label name
- Structural subsystem output port label name
- From block tag name
- Goto block tag name
- Signal line signal name

### Exceptions

A signal line that connects to one of the following subsystem types can have a name that differs from that of the subsystem port label:

- Subsystems linked to a library
- Reusable subsystems

When a combination of Inport, Outport, and other blocks have the same name, use a suffix or prefix for the Inport and Outport blocks. Any prefix or suffix can be used for ports, but they must be consistent. For example, the Inport block uses “in” and Outport block uses “out”.

---

**Note** Inport and Outport blocks must have different names and signal names.

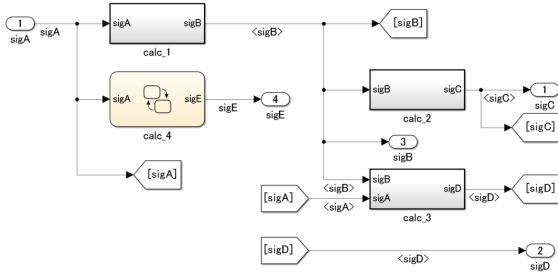
---

### Custom Parameter

Not Applicable

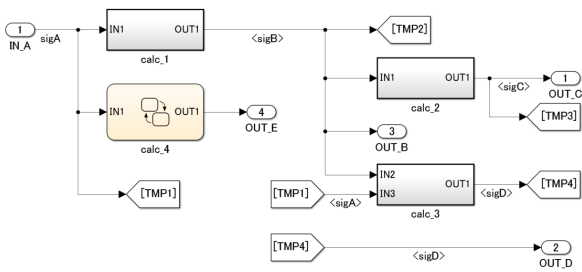
### Example — Correct

Names of model elements that connect directly to signal lines are consistent.



**Example — Incorrect**

Inconsistent names for model elements that connect directly to signal lines.



**Rationale**

Sub ID a:

- Prevent misconnected signal lines.
- Readability is impaired.
- Deviation from the rule can make it difficult to maintain the integrity of the model and code.

**Verification**

Model Advisor check: “Check for consistency in model element names” (Simulink Check)

**Last Changed**

R2020a

**See Also**

- JMAAB guideline jc\_0602, which is available in *Control Algorithm Modeling Guidelines Using MATLAB, Simulink, and Stateflow* on the MathWorks website.
- “Manage Signal Lines”
- “Types of Subsystems”

**Introduced in R2020a**

# jc\_0281: Trigger signal names

## Sub ID Recommendations

- NA-MAAB — No recommendations
- JMAAB — a1/a2/a3/a4, b1/b2/b3/b4

## MATLAB Versions

All

## Rule

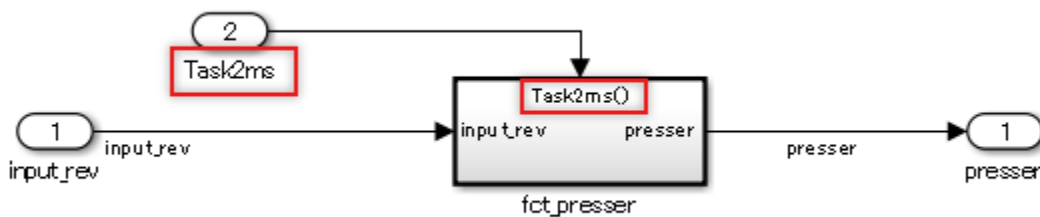
### Sub ID a1

The name of the conditional input block at the destination shall include the name of the block at the origin of the trigger signal

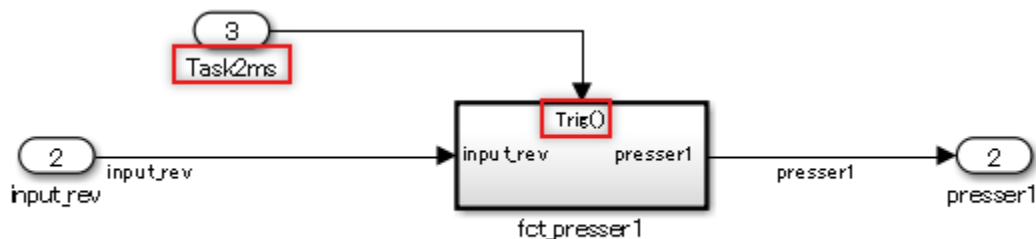
### Custom Parameter

Not Applicable

### Example — Correct



### Example — Incorrect



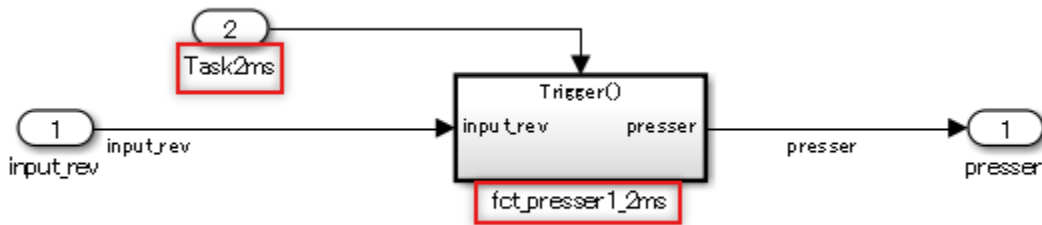
**Sub ID a2**

The name of the conditional subsystem at the destination shall include the name of the block at the origin of the trigger signal.

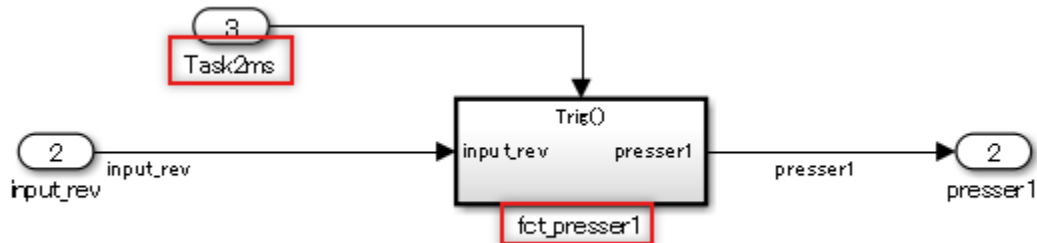
**Custom Parameter**

Not Applicable

**Example — Correct**



**Example — Incorrect**



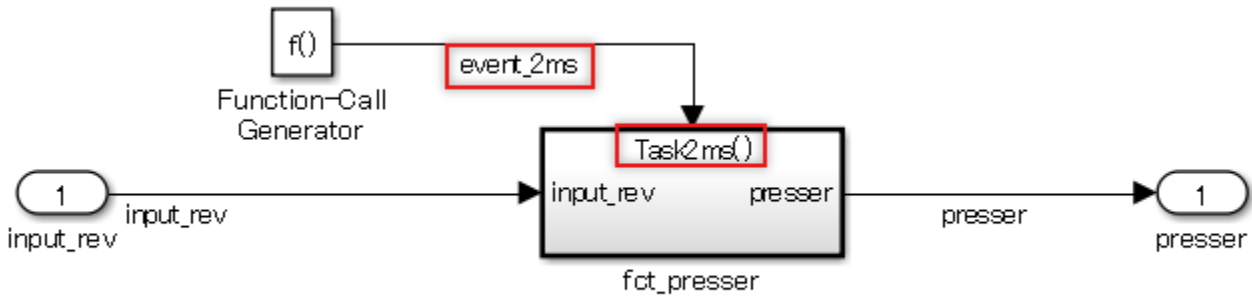
**Sub ID a3**

The name of the conditional input block at the destination shall include the name of the trigger signal.

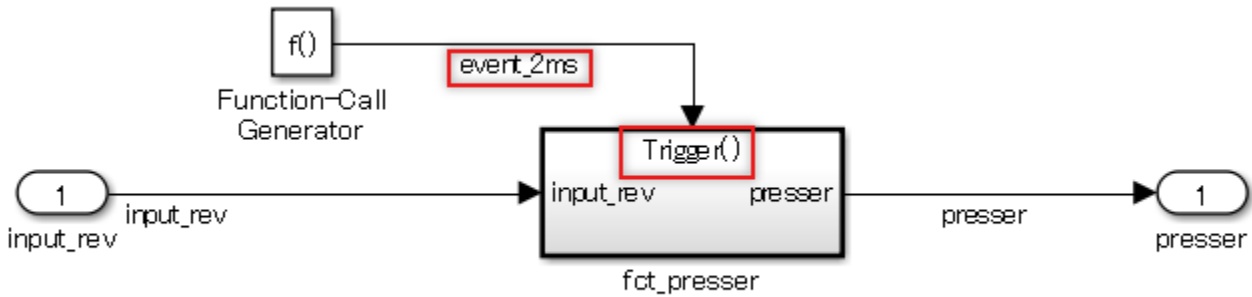
**Custom Parameter**

Not Applicable

**Example – Correct**



**Example – Incorrect**



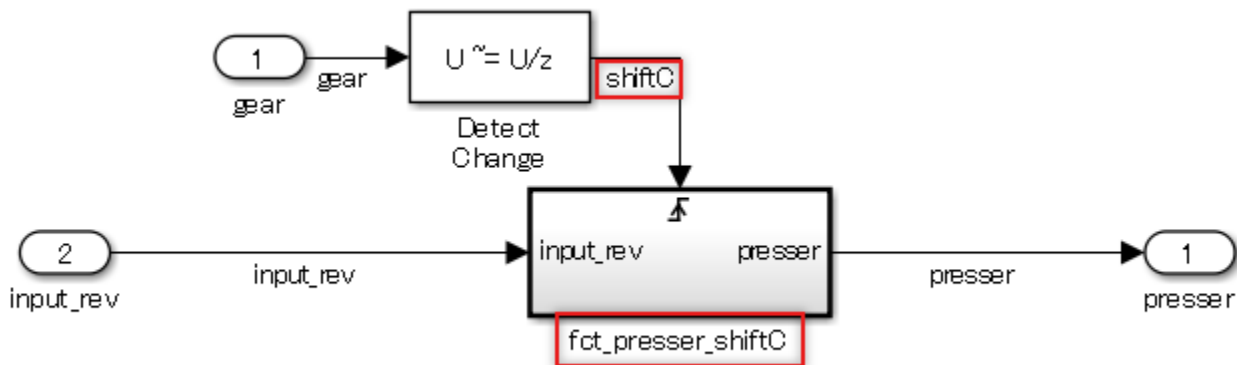
**Sub ID a4**

The name of the conditional subsystem at the destination shall include the name of the trigger signal.

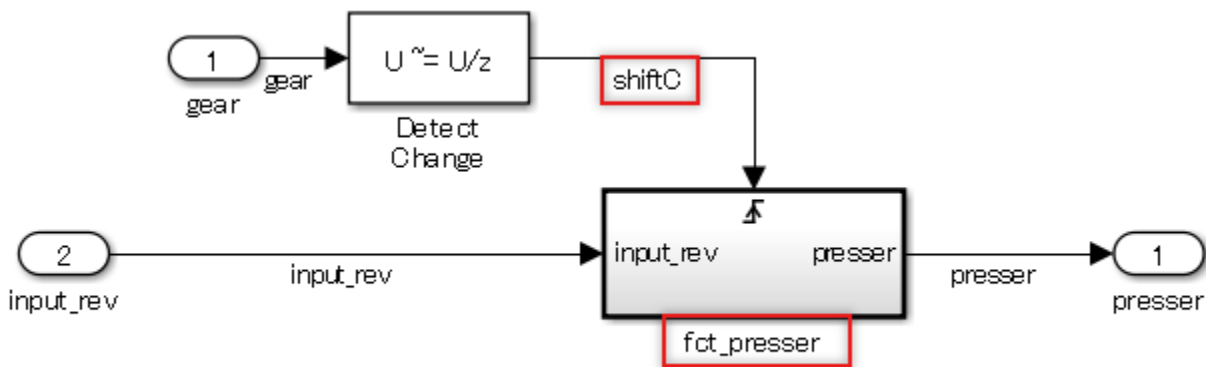
**Custom Parameter**

Not Applicable

**Example – Correct**



**Example – Incorrect**



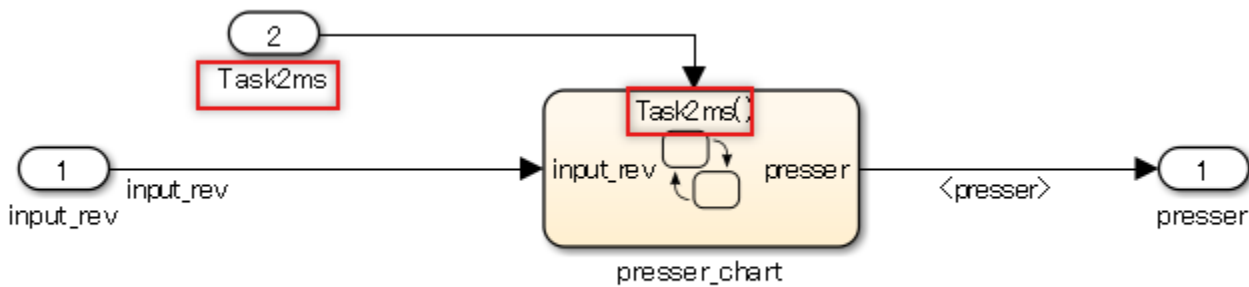
**Sub ID b1**

The name of the Stateflow block event at the destination shall include the name of the block at the origin of the trigger signal.

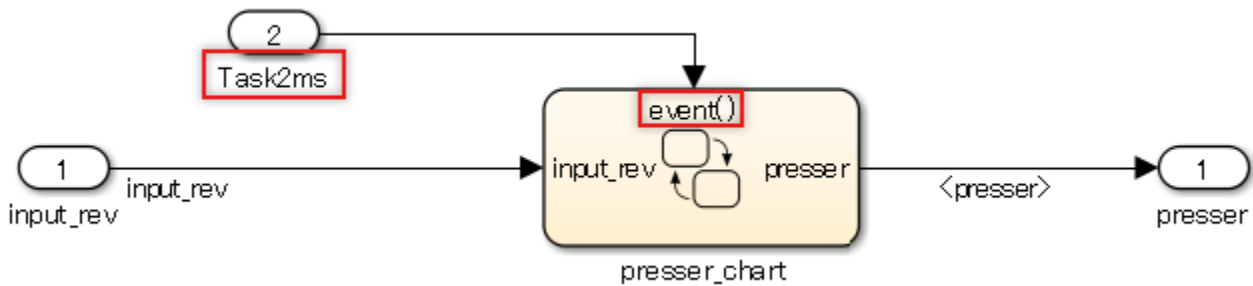
**Custom Parameter**

Not Applicable

**Example – Correct**



**Example – Incorrect**

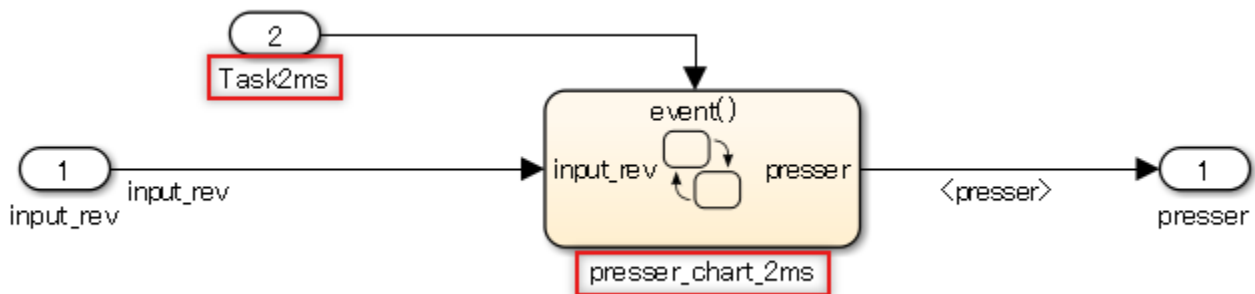
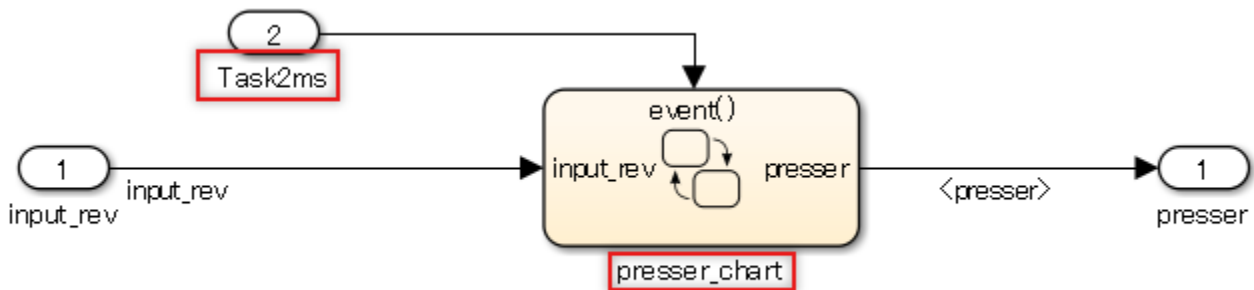


**Sub ID b2**

The name of Stateflow Chart at the destination shall include the name of the block at the origin of the trigger signal.

**Custom Parameter**

Not Applicable

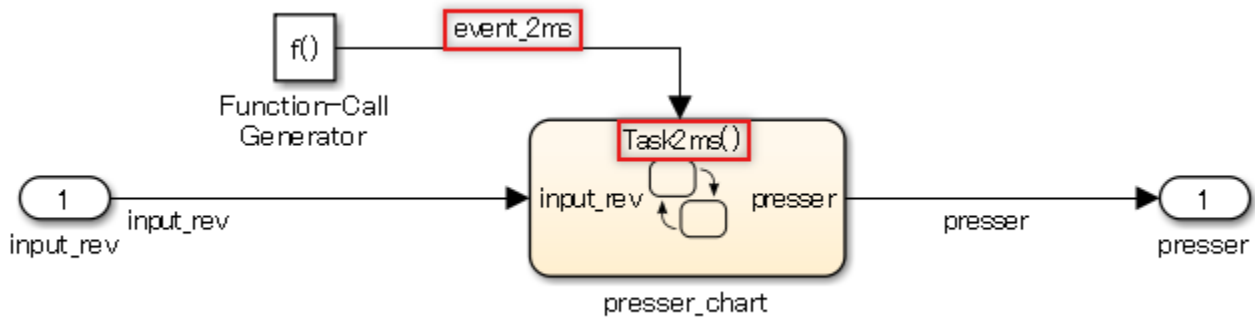
**Example — Correct****Example — Incorrect****Sub ID b3**

The name of the Stateflow block event at the destination shall include the name of the trigger signal.

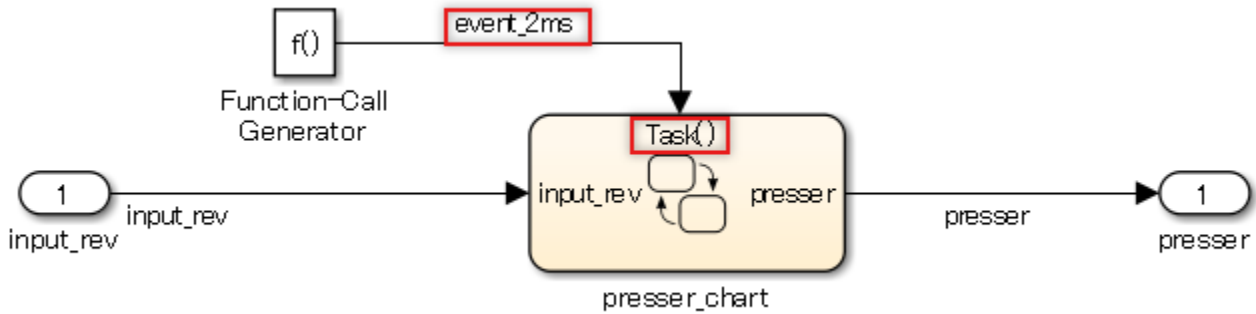
**Custom Parameter**

Not Applicable

**Example – Correct**



**Example – Incorrect**



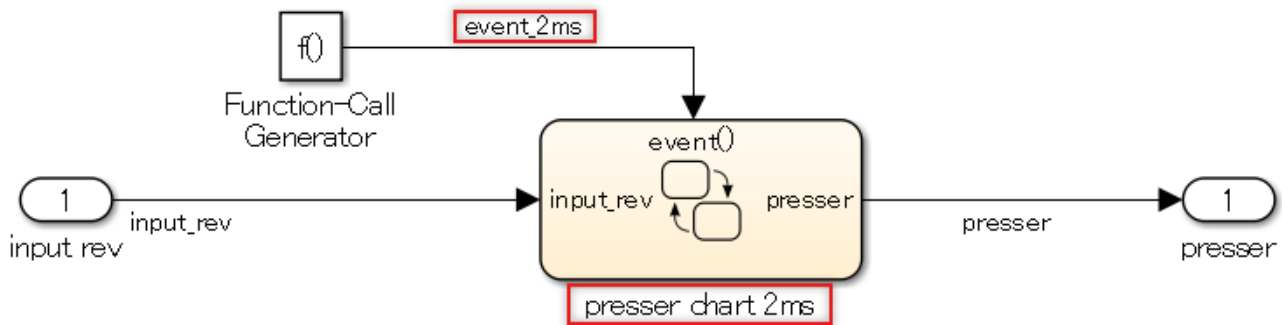
**Sub ID b4**

The name of the trigger signal and the Stateflow Chart name at the destination must include the same name. The name of the Chart block at the destination shall include the name of the trigger signal.

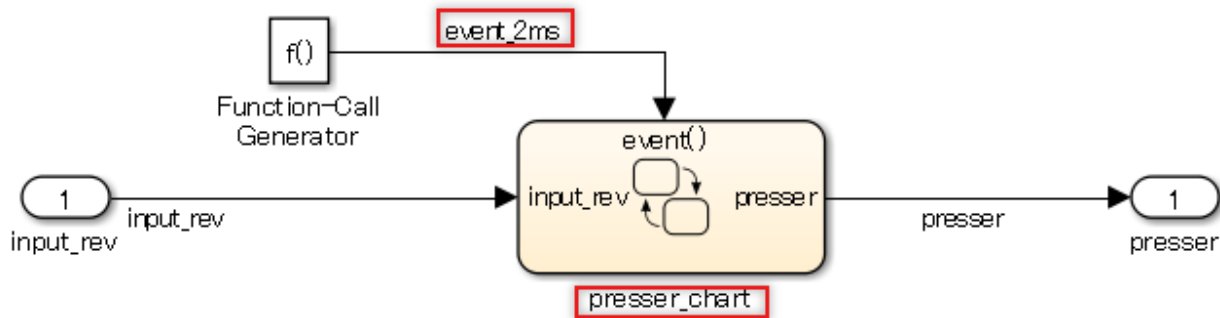
**Custom Parameter**

Not Applicable

**Example – Correct**





**Example — Incorrect****Rationale**

Sub ID a1, a2, a3, a4, b1, b2, b3, b4:

- Reduces connection mistakes.
- Increases understanding of the relationship between the origin of the trigger signal and the destination.

**Verification**

Model Advisor check: “Check trigger signal names” (Simulink Check)

**Last Changed**

R2020a

**See Also**

- Sub ID a1, a2, a3, a4, see MISRA AC SLSF 026C
- JMAAB guideline jc\_0281, which is available in *Control Algorithm Modeling Guidelines Using MATLAB, Simulink, and Stateflow* on the MathWorks website.
- “Signal Basics”
- “Use Events to Execute Charts” (Stateflow)
- “Types of Subsystems”

**Introduced in R2020a**

## **db\_0143: Usable block types in model hierarchy**

### **Sub ID Recommendations**

- NA-MAAB — a
- JMAAB — a

### **MATLAB Versions**

All

### **Rule**

#### **Sub ID a**

Model levels shall use only the block types that are defined for the layer type. Clearly defined layer types restrict the number of blocks that can be used.

Block restrictions:

- (R2011a and earlier) Enable block cannot be used at the root level of the model.
- Action ports are not permitted at the root level of a model.

Layer restrictions:

- Data flow layers that are used for basic blocks only.
- Other than data flow layers, layers can include blocks that are used for structural subsystems and all other layers.

Blocks that can be used for all layers include:

- Inport
- Outport
- Mux
- Demux
- Bus Selector
- Bus Creator
- Selector
- Ground
- Terminator
- From
- Goto
- Merge
- Unit Delay

- Rate Transition
- Data Type Conversion
- Data Store Memory
- If
- Switch Case
- Function-Call Generator
- Function-Call Split
- Inport Shadow

**Custom Parameter**

Layer type

Block type

**Rationale**

Sub ID a:

- Readability is impaired when subsystems and basic blocks are used in the same layer.

**Verification**

Model Advisor check: “Check for mixing basic blocks and subsystems” (Simulink Check)

**Last Changed**

R2020a

**See Also**

- JMAAB guideline db\_0143, which is available in *Control Algorithm Modeling Guidelines Using MATLAB, Simulink, and Stateflow* on the MathWorks website.

**Introduced in R2020a**

## db\_0144: Use of subsystems

### Sub ID Recommendations

- NA-MAAB — a, b
- JMAAB — a, b

### MATLAB Versions

All

### Rule

#### Sub ID a

Blocks in a Simulink diagram shall be grouped together into subsystems based on functional decomposition of the algorithm, or portion thereof, represented in the diagram. Blocks can also be grouped together based on behavioral variants or timing.

Avoid grouping blocks into subsystems primarily for the purpose of saving space in the diagram. Each subsystem in the diagram should represent a unit of functionality that is required to accomplish the purpose of the model or submodel.

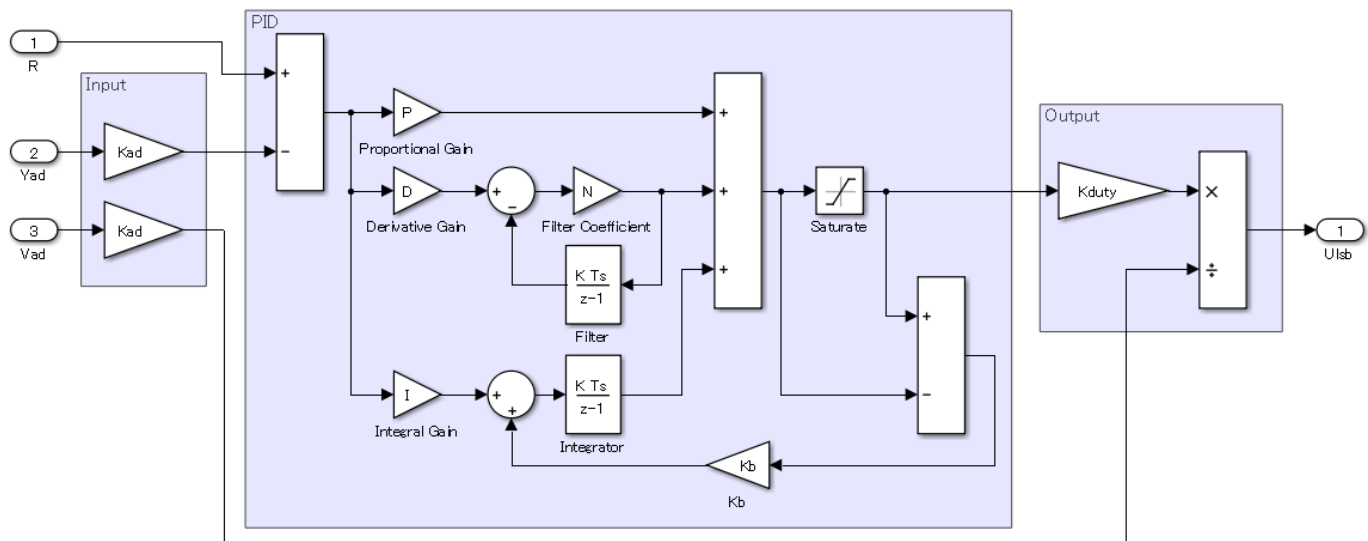
When implementing a subsystem to alleviate readability issues, use a virtual subsystem.

#### Custom Parameter

Not Applicable

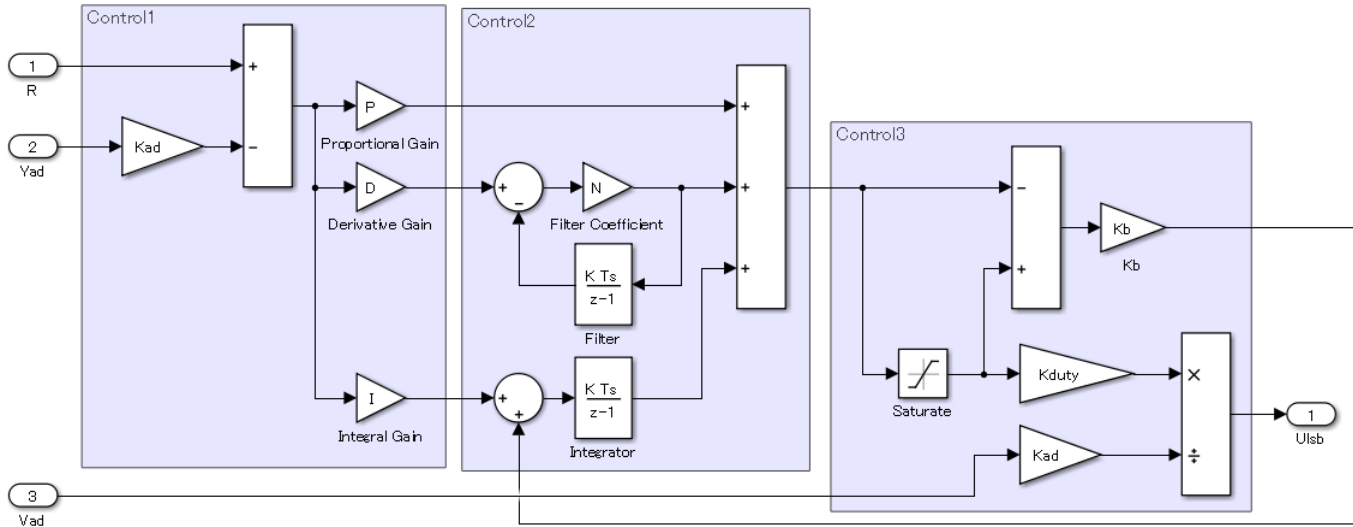
#### Example — Correct

Subsystems are divided by functional unit.



**Example — Incorrect**

Subsystems are not divided by functional unit.

**Sub ID b**

A virtual subsystem shall be used when processing order and code generation does not need to be taken into consideration.

**Custom Parameter**

Not Applicable

**Rationale**

Sub ID a:

- Avoid grouping blocks into subsystems primarily for the purpose of saving space in the diagram.
- It can be difficult to reuse the subsystem.

Sub ID b:

- As atomic subsystems are considered a single process that influences processing order and code optimization, they can be misinterpreted when used other than as intended.

**Verification**

Adherence to this modeling guideline cannot be verified by using a Model Advisor check.

**Last Changed**

R2020a

**See Also**

- JMAAB guideline db\_0144, which is available in *Control Algorithm Modeling Guidelines Using MATLAB, Simulink, and Stateflow* on the MathWorks website.
- “Types of Subsystems”
- Subsystem, Atomic Subsystem, CodeReuse Subsystem

**Introduced in R2020a**

# jc\_0653: Delay block layout in feedback loops

## Sub ID Recommendations

- NA-MAAB — a
- JMAAB — a

## MATLAB Versions

All

## Rule

### Sub ID a

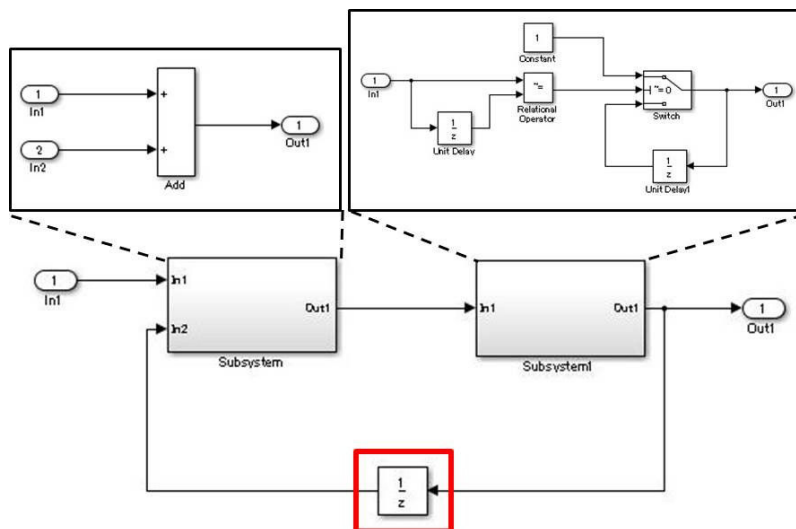
Delay block in feedback loops across subsystems shall reside in the hierarchy that describes the feedback loop.

### Custom Parameter

Not Applicable

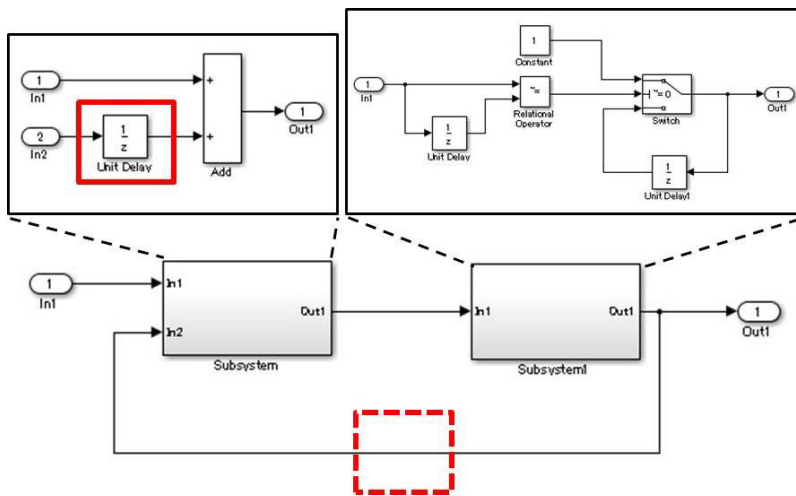
### Example — Correct

Delay block resides in the hierarchy that describes the feedback loop.



### Example — Incorrect

Delay block resides in a subsystem that is nested within the hierarchy which describes the feedback loop.



## Rationale

Sub ID a:

- Prevents double placement of the Delay block.
- Clarifying the extent of diversion improves reusability.
- Improves testability; it is difficult to test a subsystem that contains a Delay block on its own because past values cannot be entered directly.

## Verification

Model Advisor check: “Check for avoiding algebraic loops between subsystems” (Simulink Check)

## Last Changed

R2020a

## See Also

- JMAAB guideline jc\_0653, which is available in *Control Algorithm Modeling Guidelines Using MATLAB, Simulink, and Stateflow* on the MathWorks website.

**Introduced in R2020a**



# hd\_0001: Prohibited Simulink sinks

## Sub ID Recommendations

- NA-MAAB — a
- JMAAB — Not supported

## MATLAB Versions

All

## Rule

### Sub ID a

Control algorithm models shall be designed from discrete blocks.

Scope and Display blocks can be used in the model diagram.

These sink blocks shall not be used:

- To File
- To Workspace
- Stop Simulation

Consider using signal logging and the Viewers and Generators Manager for data logging and viewing requirements. (R2019b and later) To log and manage the signal, click the **Simulation** tab and, under the **Prepare** gallery, select the appropriate tool.

### Custom Parameter

Not Applicable

## Rationale

Sub ID a

- Improves readability and model simulation.
- Code generation may not be possible.

## Verification

Model Advisor check: “Check for prohibited sink blocks” (Simulink Check)

## Last Changed

R2020a

## **See Also**

- “Viewers and Generators Manager”

**Introduced in R2020a**

# Signal

## na\_0010: Usage of vector and bus signals

### Sub ID Recommendations

- NA-MAAB — No recommendations
- JMAAB — a, b, c, d

### MATLAB Versions

All

### Rule

#### Sub ID a

Mux and Demux blocks shall be used when generating and decomposing vectors.

#### Custom Parameter

Not Applicable

#### Sub ID b

Mux block inputs shall be scalars and vectors.

#### Custom Parameter

Not Applicable

#### Sub ID c

Bus Creator and Bus Selector blocks shall be used when generating and decomposing buses.

#### Custom Parameter

Not Applicable

#### Sub ID d

Buses shall connect to blocks that support buses.

#### Custom Parameter

Not Applicable

### Rationale

Sub IDs a, b, c, d:

- Prevents issues that are caused by combining vector and bus signals.

## Verification

Model Advisor check: “Check usage of vector and bus signals” (Simulink Check)

## Last Changed

R2021a

## See Also

- JMAAB guideline na\_0010, which is available in *Control Algorithm Modeling Guidelines Using MATLAB, Simulink, and Stateflow* on the MathWorks website.
- “Signal Basics”
- “Signal Types”
- “Data Types for Buses”
- “Bus-Capable Blocks”

## Introduced in R2020a

## jc\_0008: Definition of signal names

### Sub ID Recommendations

- NA-MAAB — No recommendations
- JMAAB — a

### MATLAB Versions

All

### Rule

#### Sub ID a

Signal names shall be defined for signal lines that output from important blocks. The signal name shall be provided once, at the origin of the signal line.

A label shall be used to display defined signal names.

---

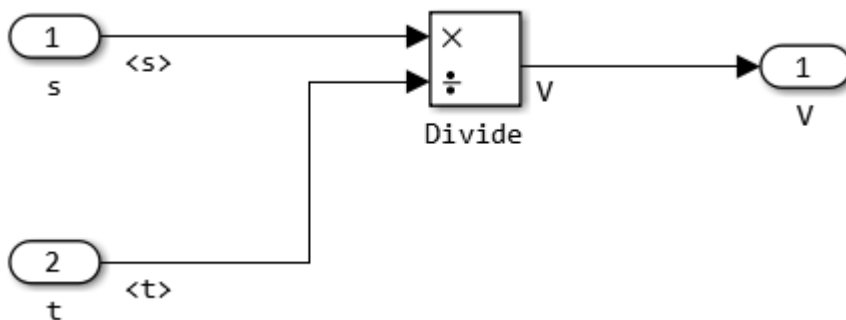
**Note** An important block is defined by the system input and output of meaningful results, not by its type.

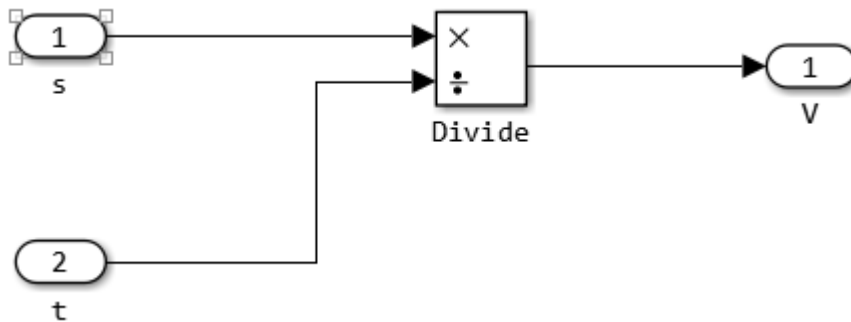
---

#### Custom Parameter

Definition of an important block

#### Example — Correct



**Example — Incorrect****Rationale**

Sub ID a:

- Defining the signal name and displaying the label for the output of meaningful results from important blocks improves the readability of the model.

**Verification**

Model Advisor check: “Check signal line labels” (Simulink Check)

**Last Changed**

R2020a

**See Also**

- JMAAB guideline jc\_0008, which is available in *Control Algorithm Modeling Guidelines Using MATLAB, Simulink, and Stateflow* on the MathWorks website.
- “Signal Basics”
- “Types of Subsystems”

**Introduced in R2020a**

## jc\_0009: Signal name propagation

### Sub ID Recommendations

- NA-MAAB — No recommendations
- JMAAB — a, b

### MATLAB Versions

All

### Rule

#### Sub ID a

When defining the signal name for a signal that extends across a hierarchy, signal property **Show propagated signals** shall be selected so that propagated signal names are displayed.

However, when one of the following conditions is met, do not select **Show propagated signals**:

- In a subsystem with a library
- In subsystems where reusable functions are set
- A signal name is not set at the outport signal of the Bus Creator block

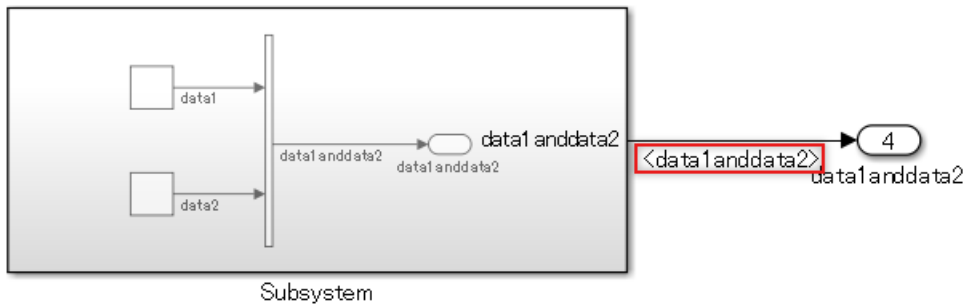
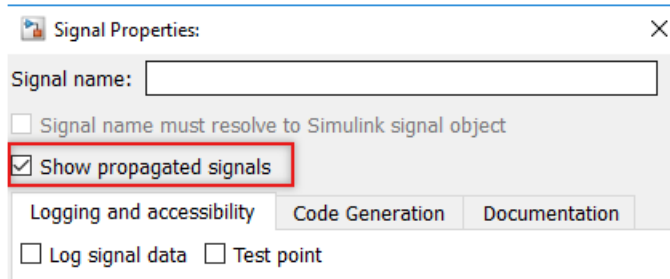
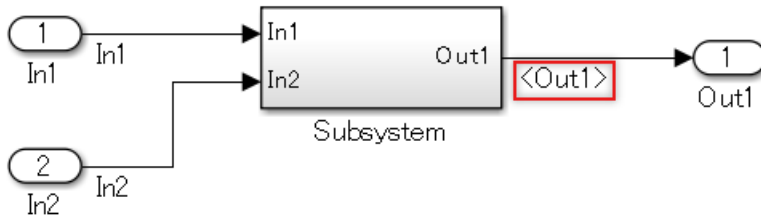
#### Custom Parameter

Not Applicable

#### Example — Correct

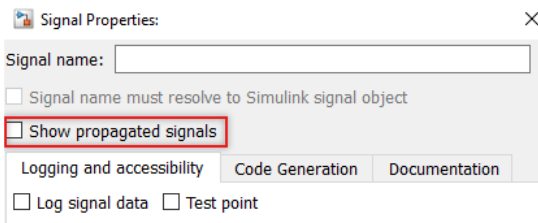
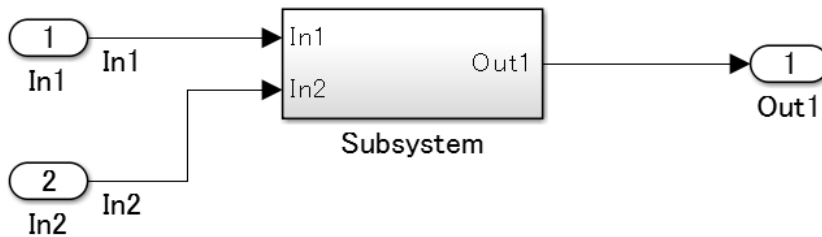
Propagated signal names are displayed.



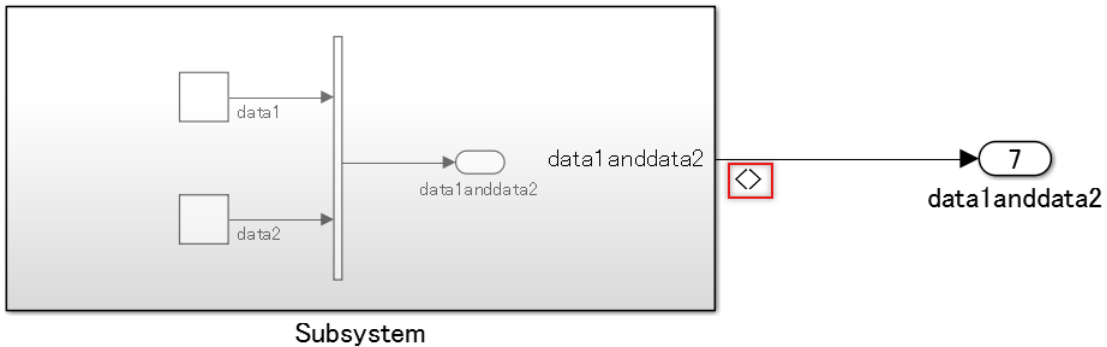


**Example – Incorrect**

**Show propagated signals** is not selected, therefore signal names are not displayed.



Signals that connect to Bus Creator and Outport blocks do not have names, but **Show propagated signals** is selected for signals that connect to Subsystem and Outport blocks.



Signals that connect to Bus Creator and Outport blocks have names, but signals that connect to Subsystem and Outport blocks also have names.



**Sub ID b**

Signal property **Show propagated signals** shall be selected for these blocks so that propagated signal names of the signal output are displayed:

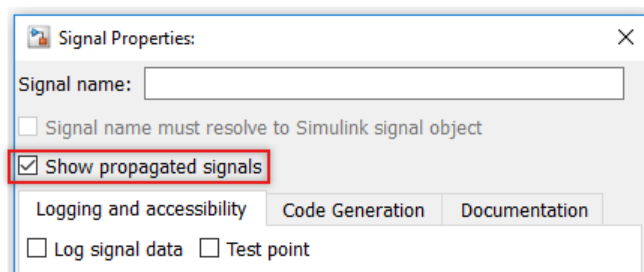
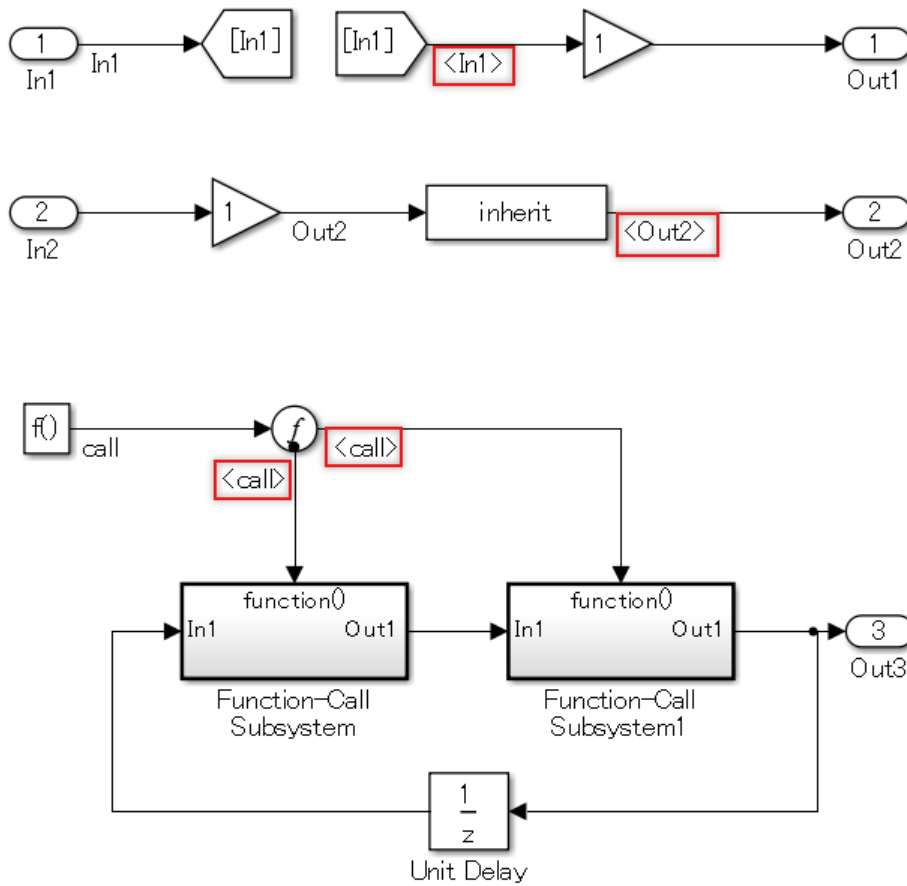
- From
- Signal Specification
- Function-Call Split[

**Custom Parameter**

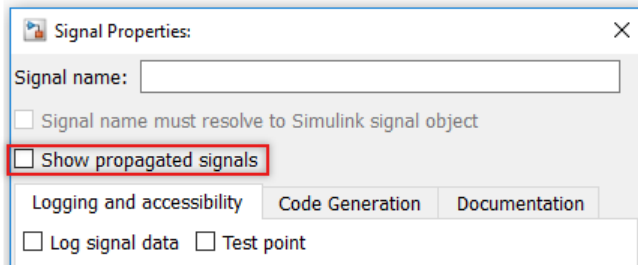
Not Applicable

**Example — Correct**

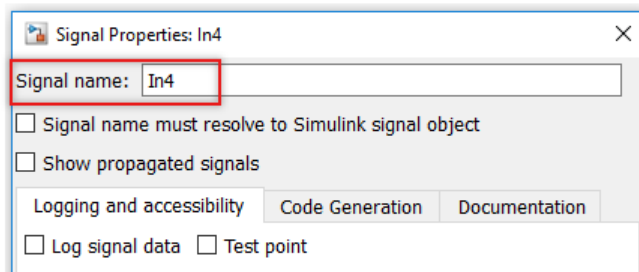
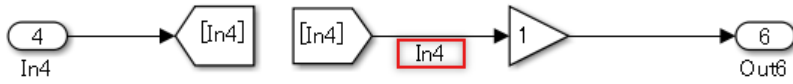
Propagated signal names are displayed.



Signals that connect to Inport and Goto blocks do not have names, therefore **Show propagated signals** does not need to be selected.

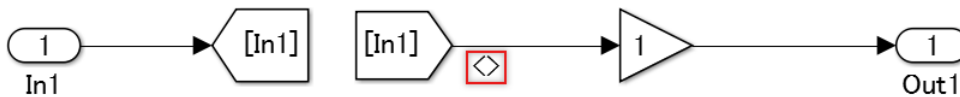


Signals that connect to Inport and Goto blocks do not have names, therefore signals that connect to From and Gain blocks can be left unnamed.

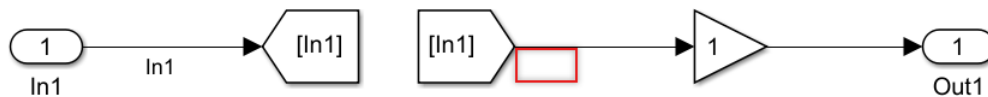


**Example – Incorrect**

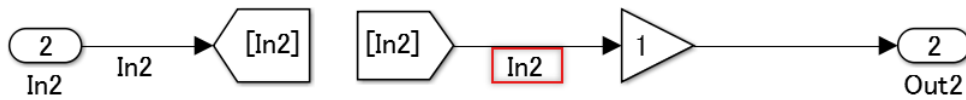
Signals that connect to Inport and Goto blocks do not have names, but **Show propagated signals** is selected for signals that connect to From and Gain blocks.



Regardless of whether signals are propagated, **Show propagated signals** is not selected



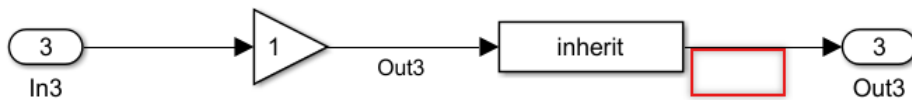
Signals that connect to Inport and Goto blocks have names, but signals that connect to From and Gain blocks are named.



Signals that connect to Gain and Signal Specification blocks do not have names, but **Show propagated signals** is selected for signals that connect to Signal Specification and Output blocks.



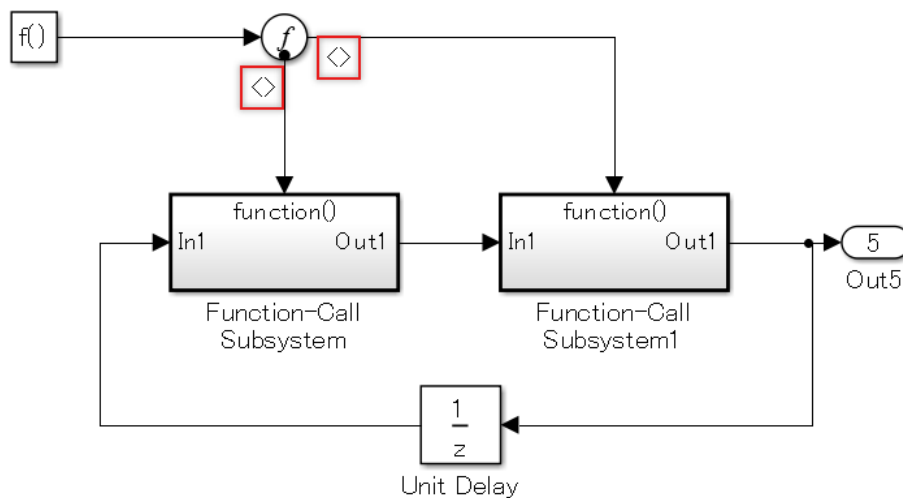
Regardless of whether signals are propagated, **Show propagated signals** is not selected.



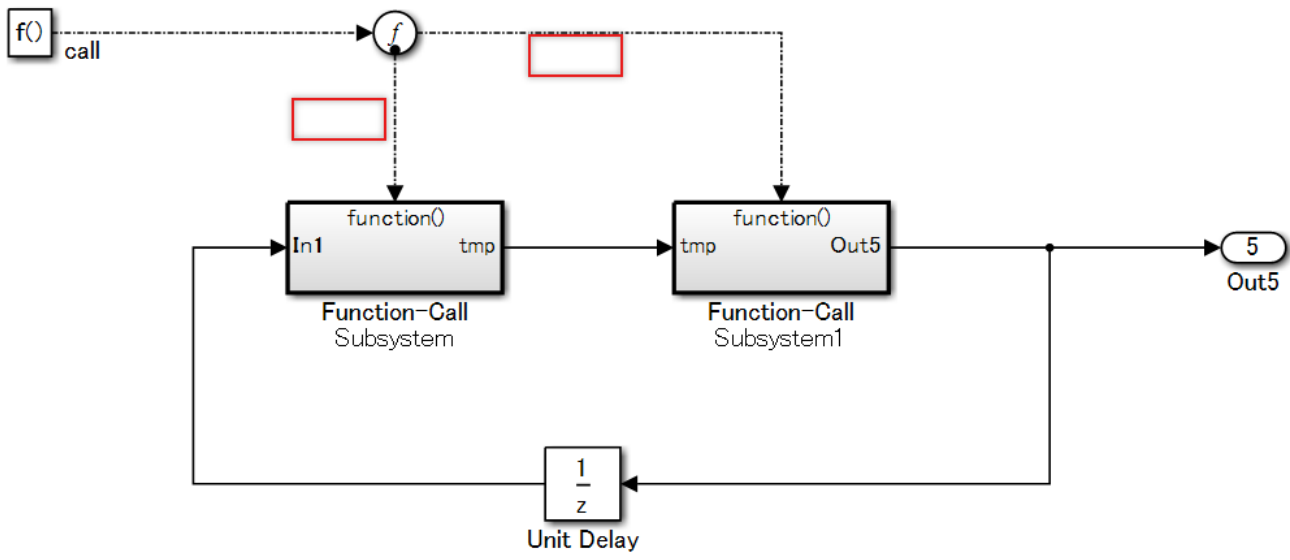
Signals that connect to Gain and Signal Specification blocks have names, but signals that connect to Signal Specification and Output blocks also have names.



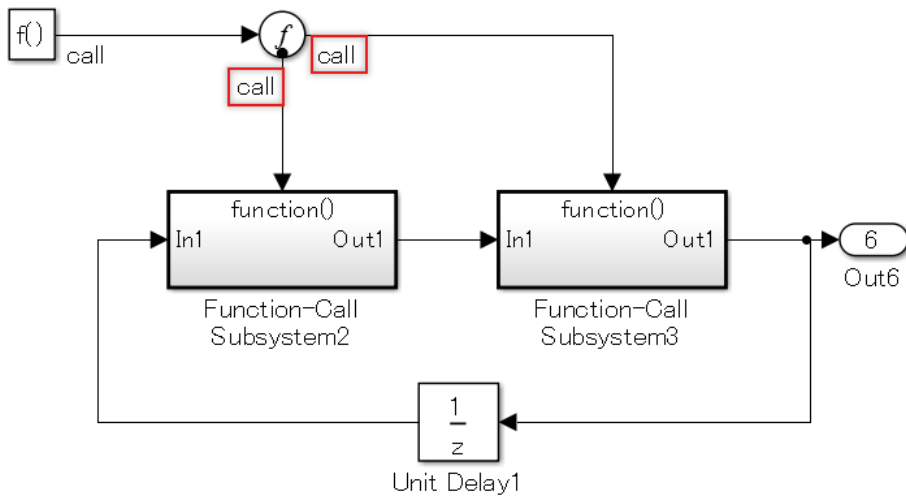
Signals that connect to Function-Call Generator and Function-Call Split blocks do not have names, but **Show propagated signals** is selected for signals that connect to Function-Call Split and Function-Call Subsystem blocks.



Regardless of whether signals are propagated, **Show propagated signals** is not selected.



Signals that connect to Function-Call Generator and Function-Call Split blocks have names and signals that connect to Function-Call Split and Function-Call Subsystem blocks are also named.



**Rationale**

Sub IDs a, b:

- Prevents signal line connection mistakes.
- Prevents signal line name mistakes.

**Verification**

Model Advisor check: “Check for propagated signal labels” (Simulink Check)

## **Last Changed**

R2020a

## **See Also**

- JMAAB guideline jc\_0009, which is available in *Control Algorithm Modeling Guidelines Using MATLAB, Simulink, and Stateflow* on the MathWorks website.
- “Signal Basics”
- “Types of Subsystems”

## **Introduced in R2020a**

## db\_0097: Position of labels for signals and buses

### Sub ID Recommendations

- NA-MAAB — a, b, c
- JMAAB — a, b, c

### MATLAB Versions

All

### Rule

#### Sub ID a

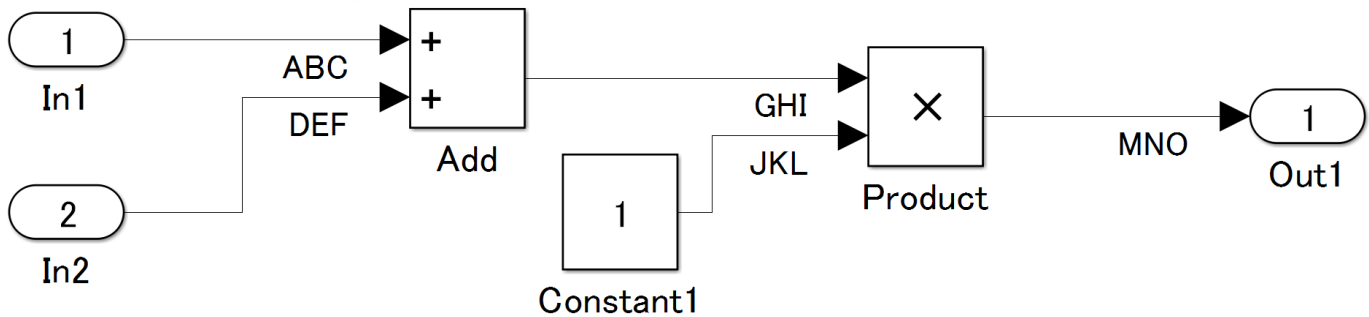
Signal line labels and bus labels shall not overlap other labels, signal lines, or blocks.

#### Custom Parameter

Not Applicable

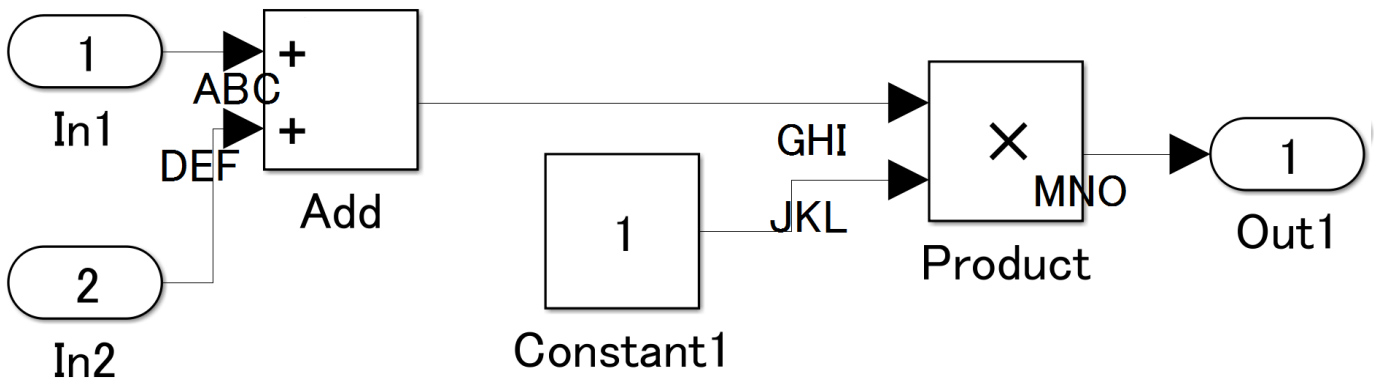
#### Example — Correct

Signal line labels and bus labels do not overlap other labels, signal lines, or blocks.



#### Example — Incorrect

Signal line labels and bus labels overlap other labels, signal lines, or blocks.





**Sub ID b**

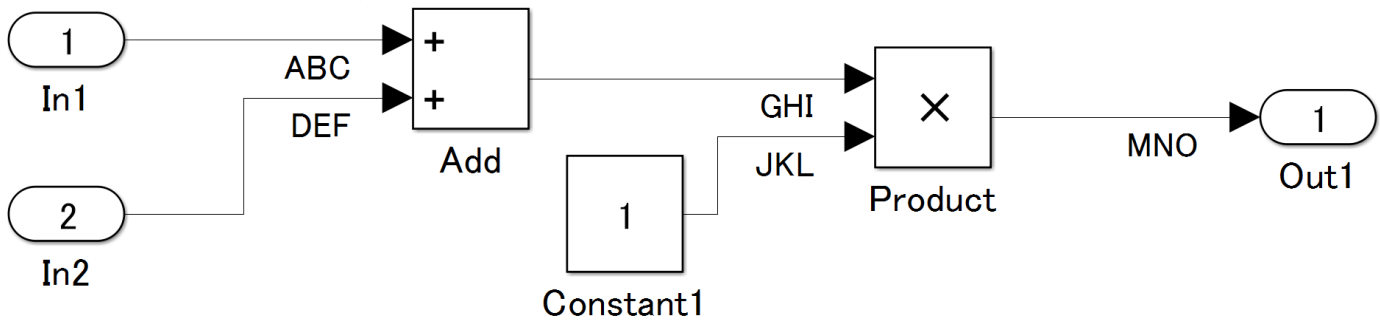
Signal line labels and bus labels shall be positioned below signal lines.

**Custom Parameter**

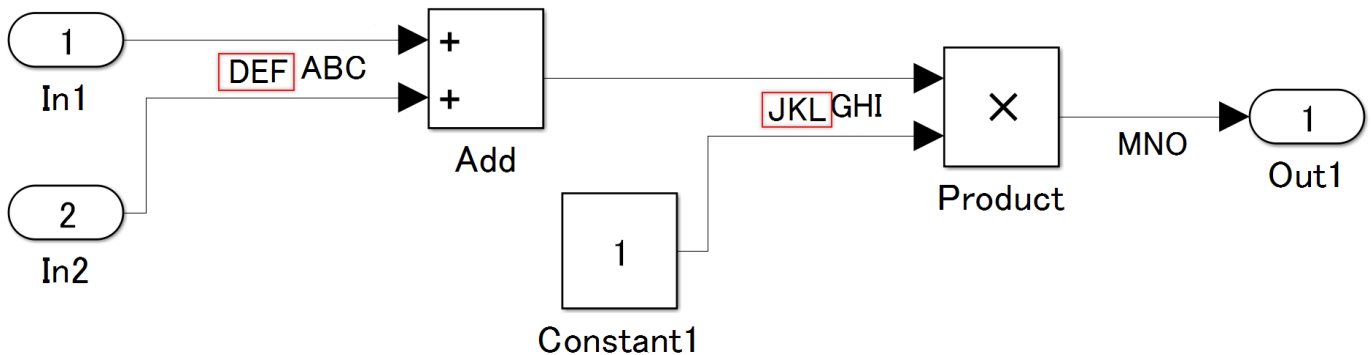
Not Applicable

**Example – Correct**

Signal line labels and bus labels are below signal lines.

**Example – Incorrect**

Signal line labels and bus labels are above the signal line.

**Sub ID c**

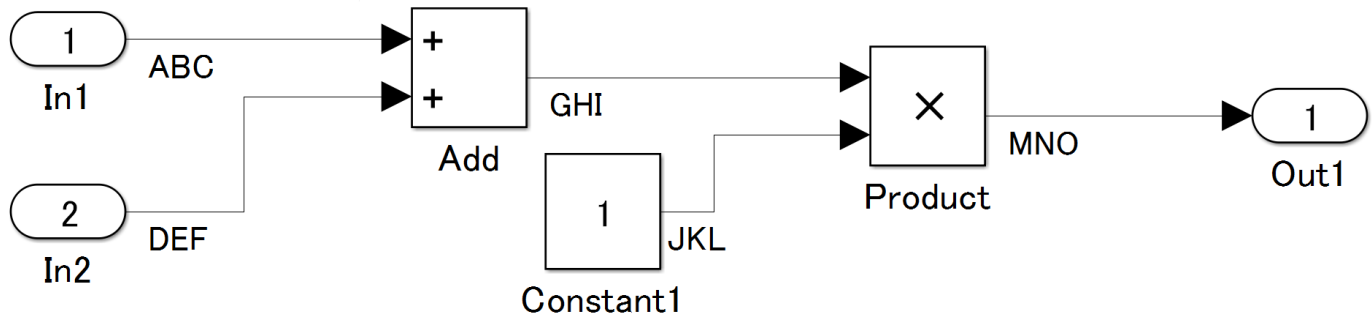
Signal line labels and bus labels shall be positioned at the origin of the connection.

**Custom Parameter**

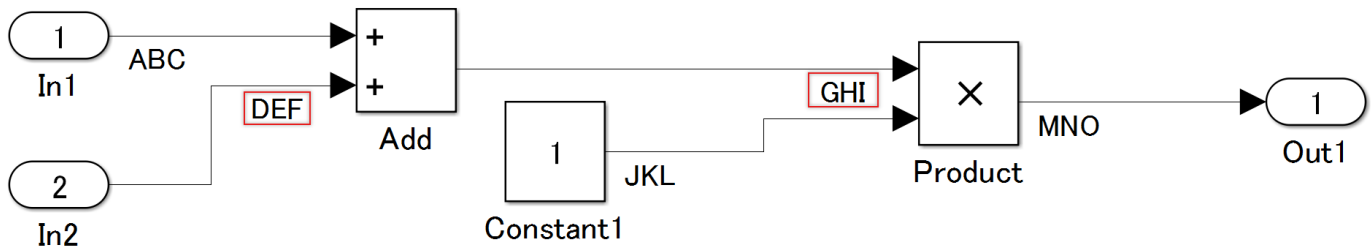
Not Applicable

**Example – Correct**

Signal line labels and bus labels are positioned at the origin of the signal line connection.

**Example — Incorrect**

Signal line labels and bus labels are positioned at the destination of the signal line connection.

**Rationale**

Sub ID a:

- Adherence to this rule prevents confusion with corresponding names, signal lines, and buses, which improves readability of the model.

Sub ID b, c:

- Consistent label position prevents confusion with corresponding labels, signal lines, and buses, which improves the readability of the model.

**Verification**

Model Advisor check: “Check signal flow in model Check position of signal labels” (Simulink Check)

**Last Changed**

R2020a

**See Also**

- JMAAB guideline db\_0097, which is available in *Control Algorithm Modeling Guidelines Using MATLAB, Simulink, and Stateflow* on the MathWorks website.
- “Signal Basics”

- “Signal Lines”
- “Explore Simulink Bus Capabilities”

**Introduced in R2020a**

## na\_0008: Display of labels on signals

### Sub ID Recommendations

- NA-MAAB — a, b
- JMAAB — Not supported

### MATLAB Versions

All

### Rule

#### Sub ID a

A label shall be displayed on the signal line originating from these blocks:

- Inport
- From (see exception)
- Subsystem or Stateflow Chart (see exception)
- Bus Selector (the tool forces this to happen)
- Demux
- Selector
- Data Store Read (see exception)
- Constant (see exception)

#### Exception

When the signal label is visible in the originating block icon display, the signal does not need not to have the label displayed *unless* the signal label is needed elsewhere due to a destination-based rule.

#### Custom Parameter

Not Applicable

#### Sub ID b

A label shall be displayed on a signal line that connects (either directly or by way of a basic block that performs a non-transformative operation) to these destination blocks:

- Outport
- Goto
- Data Store Write
- Bus Creator
- Mux
- Subsystem

- Stateflow Chart

**Custom Parameter**

Not Applicable

**Rationale**

Sub ID a:

- Improves readability, model simulation, and workflow.
- Code generation may not be possible.

Sub ID b:

- Improves readability, model simulation, and workflow.

**Verification**

Model Advisor check: "Check signal line labels" (Simulink Check)

**Last Changed**

R2020a

**See Also**

- "Signal Basics"
- "Manage Signal Lines"
- "Types of Subsystems"

**Introduced in R2020a**

## na\_0009: Entry versus propagation of signal labels

### Sub ID Recommendations

- NA-MAAB — a
- JMAAB — Not supported

### MATLAB Versions

All

### Rule

#### Sub ID a

When a label is displayed for a signal, the following rules define whether that label is created there (entered directly on the signal) or propagated from its true source (inherited from elsewhere in the model by using the < character).

Signal labels shall be entered for signals that originate from:

- The Inport block at the root (top) level of a model
- Basic blocks that perform a transformative operation (For the purpose of interpreting this rule only, the Bus Creator, Mux, and Selector blocks also perform transformative operations.)

Signal labels shall be propagated for signals that originate from:

- Inport block in a nested subsystem
- Basic blocks that perform a non-transformative operation
- Subsystem block or Stateflow Chart block.

#### Exceptions

When the nested subsystem is a library subsystem, a label can be entered on the signal coming from the Inport block to accommodate reuse of the library block.

When the connection originates from the output of a library subsystem block, a new label can be entered on the signal to accommodate readability.

#### Custom Parameter

Not Applicable

### Rationale

Sub ID a:

- The result of executing a MATLAB command is reflected in the code, which makes consistency between the model and code difficult to maintain.

## **Verification**

Model Advisor check: “Check for propagated signal labels” (Simulink Check)

## **Last Changed**

R2020a

## **See Also**

- “Signal Basics”
- “Manage Signal Lines”
- “Signal Label Propagation”
- “Types of Subsystems”

**Introduced in R2020a**

## db\_0110: Block parameters

### Sub ID Recommendations

- NA-MAAB — a
- JMAAB — a

### MATLAB Versions

All

### Rule

#### Sub ID a

Block parameters shall not be used to describe:

- Operation expressions
- Data type conversion
- Selection of rows or columns
- MATLAB commands

#### Custom Parameter

Not Applicable

### Rationale

Sub ID a:

- Operation expressions, data type conversion, or row or column selection become a magic number in generated code, which makes consistency between the model and code difficult to maintain. Adjusting parameters also becomes difficult.
- Describing the calculation formula within the block decreases readability.
- The result of executing a MATLAB command is reflected in the code, which makes consistency between the model and code difficult to maintain.

### Verification

Model Advisor check: “Check usage of tunable parameters in blocks” (Simulink Check)

### Last Changed

R2020a



**See Also**

- JMAAB guideline db\_0110, which is available in *Control Algorithm Modeling Guidelines Using MATLAB, Simulink, and Stateflow* on the MathWorks website.

**Introduced in R2020a**

## db\_0112: Usage of index

### Sub ID Recommendations

- NA-MAAB — a1/a2
- JMAAB — a1/a2

### MATLAB Versions

All

### Rule

#### Sub ID a1

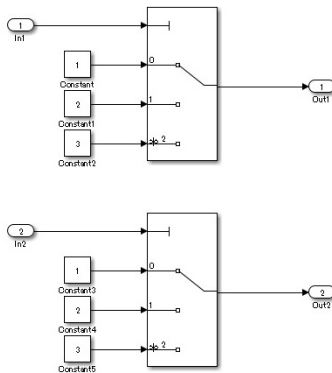
A vector signal shall use a one-based index mode.

#### Custom Parameter

Not Applicable

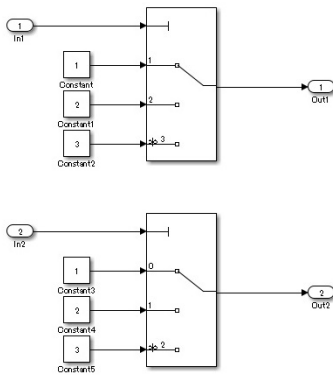
#### Example — Correct

A uniform zero-based index mode is used.



#### Example — Incorrect

A uniform index mode is not used.

**Sub ID a2**

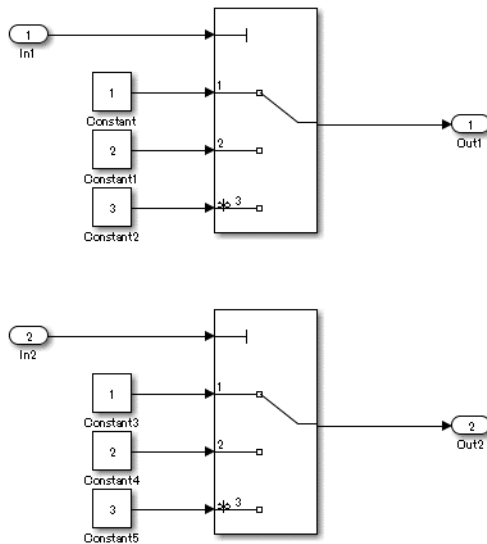
A vector signal shall use a one-based index mode.

**Custom Parameter**

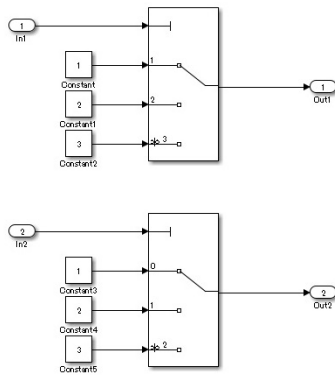
Not Applicable

**Example — Correct**

A uniform one-based index mode is used.

**Example — Incorrect**

A uniform index mode is not used (same as the incorrect example for sub ID a1).



## Rationale

Sub IDs a1, a2

- Logic is easier to understand when using a uniform index mode.

## Verification

Model Advisor check: “Check Indexing Mode” (Simulink Check)

## Last Changed

R2020a

## See Also

- JMAAB guideline db\_0112, which is available in *Control Algorithm Modeling Guidelines Using MATLAB, Simulink, and Stateflow* on the MathWorks website.
- Index Vector

**Introduced in R2020a**

# jc\_0645: Parameter definition for calibration

## Sub ID Recommendations

- NA-MAAB — No recommendations
- JMAAB — a

## MATLAB Versions

All

## Rule

### Sub ID a

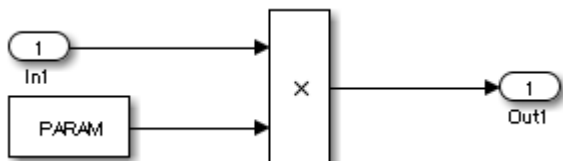
Block parameters that are targets of calibration shall be defined as named constants. Examples of parameters that are outside of the calibration target include:

- Initial value parameter 0
- Increment, decrement 1

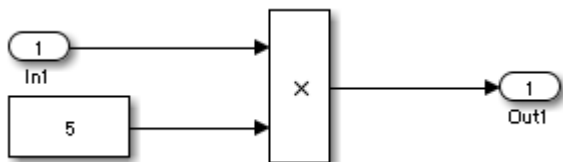
### Custom Parameter

Not Applicable

### Example — Correct



### Example — Incorrect



## Rationale

Sub ID a:

- A literal constant in the model will propagate as a literal constant in the generated code, making calibration impossible.

## Verification

Model Advisor check: “Check if tunable block parameters are defined as named constants” (Simulink Check)

## Last Changed

R2020a

## See Also

- JMAAB guideline jc\_0645, which is available in *Control Algorithm Modeling Guidelines Using MATLAB, Simulink, and Stateflow* on the MathWorks website.
- “Set Block Parameter Values”

**Introduced in R2020a**

# jc\_0641: Sample time setting

## Sub ID Recommendations

- NA-MAAB — No recommendations
- JMAAB — a

## MATLAB Versions

All

## Rule

### Sub ID a

Block parameter **Sample time** shall be set to -1 (inherited).

### Exceptions

- Inport block
- Outport block
- Atomic subsystem
- Blocks with state variables, such as Unit Delay and Memory
- Signal conversion blocks, such as Data Type Conversion and Rate Transition
- Blocks that do not have external inputs, such as Constant
- Stateflow charts

### Custom Parameter

Not Applicable

## Rationale

Sub ID a:

- Discrepancies can occur in the processing of the model because of different simulation times.
- Maintainability of the model deteriorates when a specific sample time is set for each block individually.

## Verification

Model Advisor check: “Check for sample time setting” (Simulink Check)

## Last Changed

R2020a

## See Also

- JMAAB guideline jc\_0641, which is available in *Control Algorithm Modeling Guidelines Using MATLAB, Simulink, and Stateflow* on the MathWorks website.
- “What Is Sample Time?”
- “Types of Subsystems”
- “Construct and Run a Stateflow Chart” (Stateflow)

## Introduced in R2020a



# jc\_0643: Fixed-point setting

## Sub ID Recommendations

- NA-MAAB — No recommendations
- JMAAB — a

## MATLAB Versions

All

## Rule

### Sub ID a

When block parameter **Data type** is set to `fixdt` (fixed-point) and **Scaling** is set to `Slope` and `bias`, parameter **Bias** shall be set to `0`.

### Custom Parameter

Not Applicable

## Rationale

Sub ID a:

- When the bias in a model is not uniform:
  - Behavior of the model is impossible to determine by its appearance.
  - Unintended overflows and underflows occur.
  - Results in wasteful operation and deterioration of code efficiency/computing load.

## Verification

Model Advisor check: “Check usage of fixed-point data type with non-zero bias” (Simulink Check)

## Last Changed

R2020a

## See Also

- JMAAB guideline jc\_0643, which is available in *Control Algorithm Modeling Guidelines Using MATLAB, Simulink, and Stateflow* on the MathWorks website.
- “Specify Fixed-Point Data Types”
- “Specify Data Types Using Data Type Assistant”

- “Scaling, Precision, and Range”

**Introduced in R2020a**

# jc\_0644: Type setting

## Sub ID Recommendations

- NA-MAAB — No recommendations
- JMAAB — a

## MATLAB Versions

All

## Rule

### Sub ID a

The data type shall not be set by using a block or Stateflow data dictionary when the data type is set by a data object.

### Exceptions

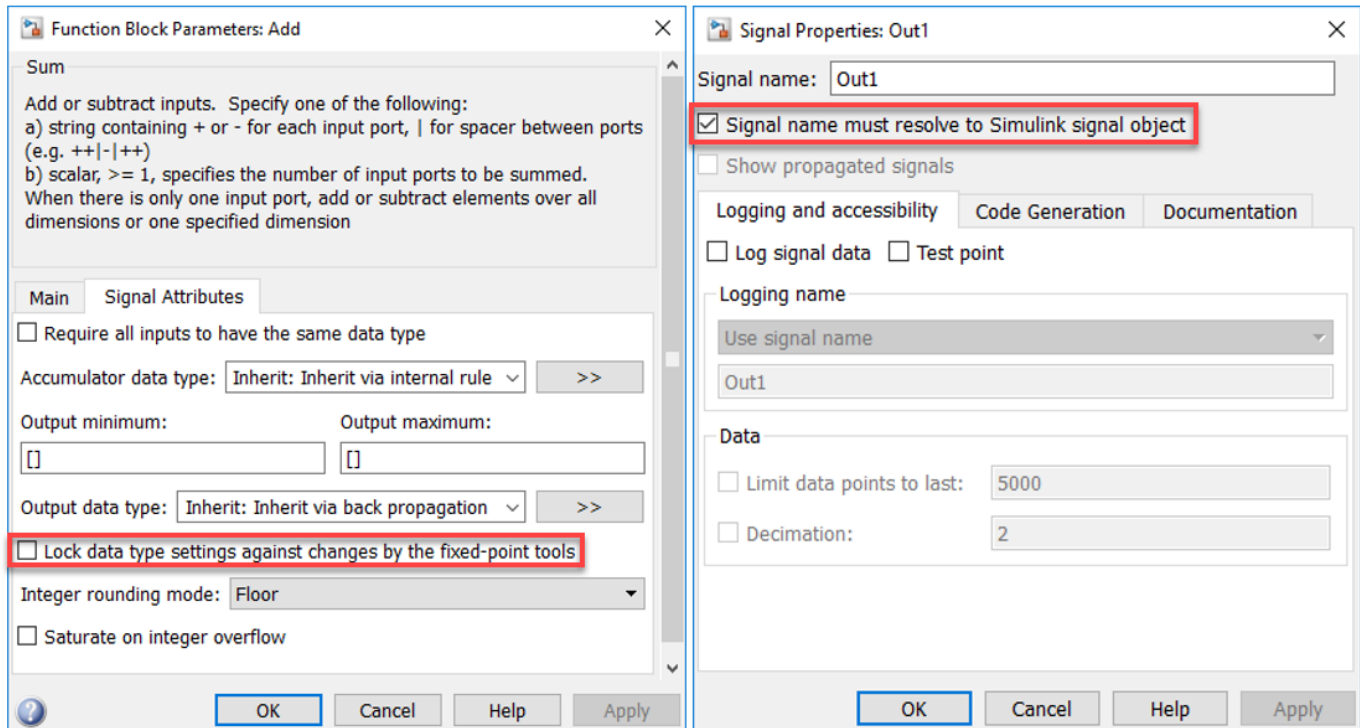
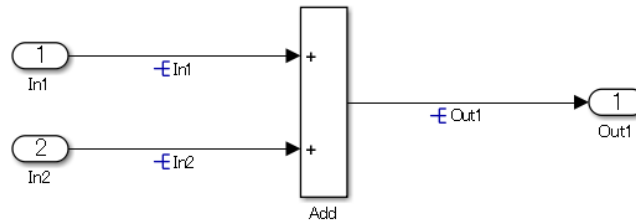
- Inside a reusable function
- Data Type Conversion block
- Data types set by using `fixdt`
- Boolean or double types

### Custom Parameter

Not Applicable

### Example — Correct

Type is set the data object.



## Rationale

Sub ID a:

- When the data type is set in a block and it differs from the type setting in the data object, it can be difficult to determine which setting is correct. This can impair readability.
- When the type is set in the block, maintainability is affected when the signal line type changes.
- Exceptions:
  - When block structures are identical, differences between input/output data type can result in different C source code that is not reusable. For reusable functions, data types of input/output blocks should be specified at the subsystem level.
  - The Data Type Conversion block is used to explicitly set the data type.
  - When the data type is `fixdt` (fixed-point), data type must be set individually because each block can have different data points. In this scenario, it is impossible to use only the data object to set the data type.

- Some block types must be set to Boolean.

Double type is generally used in plant models and for Rapid Control Prototyping (RCP), therefore it is not within scope of this rule. Embedded software uses double type in specific situations. Use caution when configuring the settings on these blocks to minimize the use of double type.

## Verification

Model Advisor check: “Check type setting by data objects” (Simulink Check)

## Last Changed

R2020a

## See Also

- JMAAB guideline jc\_0644, which is available in *Control Algorithm Modeling Guidelines Using MATLAB, Simulink, and Stateflow* on the MathWorks website.
- “About Data Types in Simulink”
- “Simulink Functions Overview”

## Introduced in R2020a

## **Conditional Subsystem Relations**

# db\_0146: Block layout in conditional subsystems

## Sub ID Recommendations

- NA-MAAB — a, b
- JMAAB — a, b

## MATLAB Versions

All

## Rule

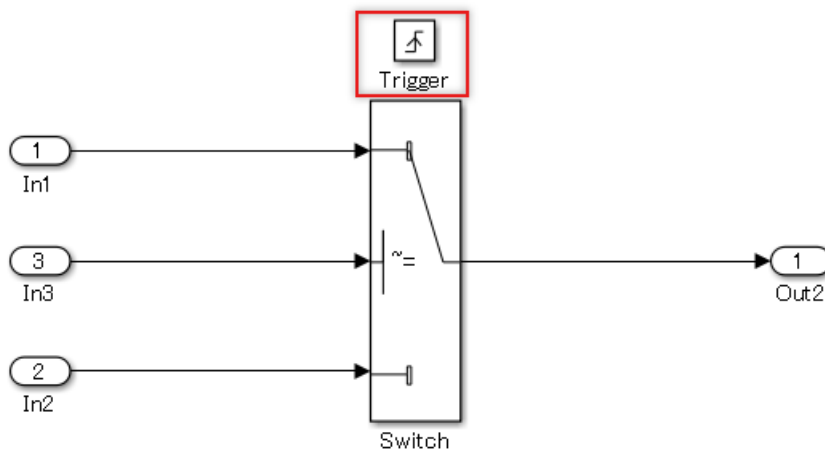
### Sub ID a

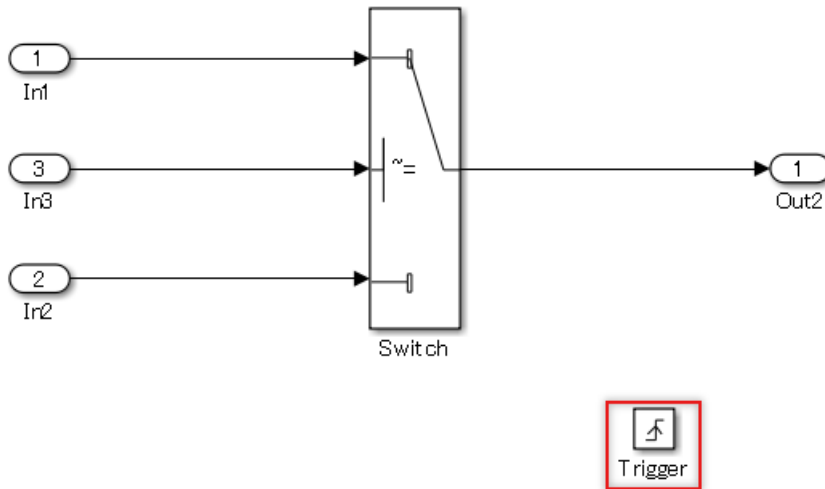
Conditional input blocks shall be positioned at the top of the subsystem.

### Custom Parameter

Not Applicable

### Example — Correct



**Example — Incorrect****Sub ID b**

The position of these blocks shall be defined by the project:

- For Each
- For Iterator
- While Iterator

**Custom Parameter**

Location layout

**Rationale**

Sub IDs a, b:

- Unifying the internal and external layout of the conditional subsystem improves readability of the model.

**Verification**

Model Advisor check: “Check position of conditional blocks and iterator blocks” (Simulink Check)

**Last Changed**

R2020a

**See Also**

- JMAAB guideline db\_0146, which is available in *Control Algorithm Modeling Guidelines Using MATLAB, Simulink, and Stateflow* on the MathWorks website.



- “Conditionally Executed Subsystems Overview”
- “Types of Subsystems”

**Introduced in R2020a**

## jc\_0640: Initial value settings for Outport blocks in conditional subsystems

### Sub ID Recommendations

- NA-MAAB — No recommendations
- JMAAB — a

### MATLAB Versions

All

### Rule

#### Sub ID a

The initial condition shall be defined on an Outport block when both of these conditions are met for a conditional subsystem:

- Includes a block with initial conditions (i.e. Constant and Delay blocks)
- Connects to Outport block

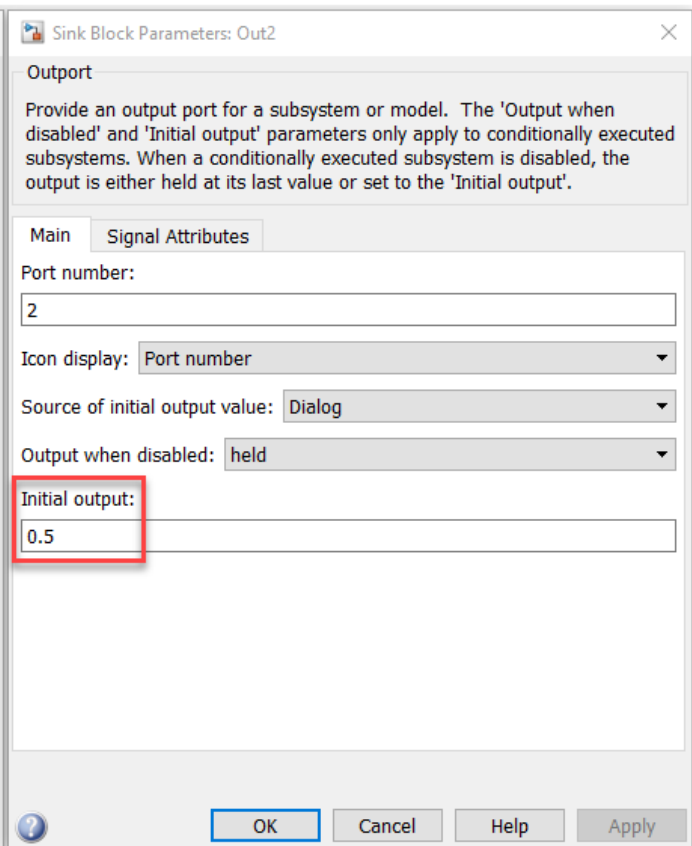
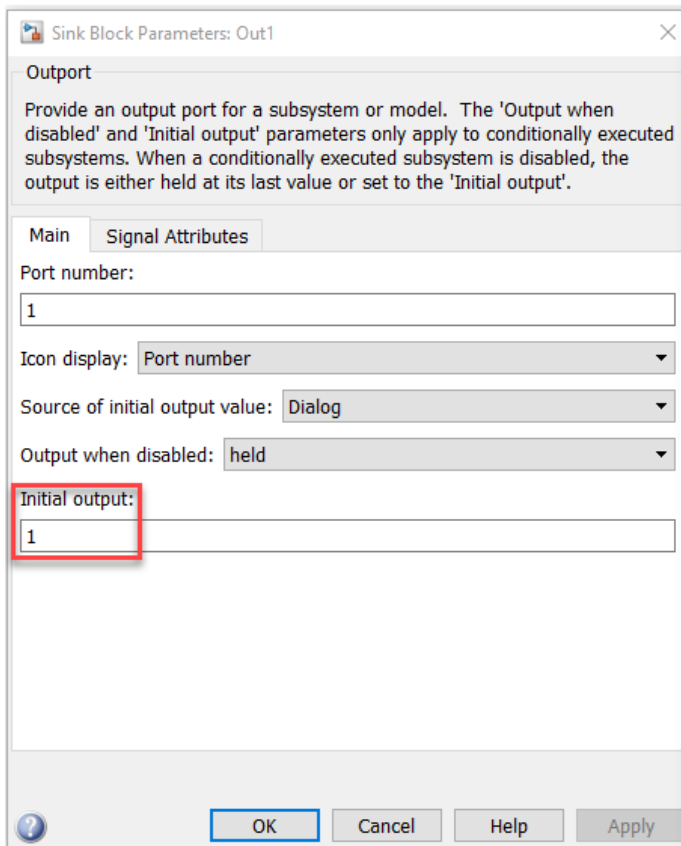
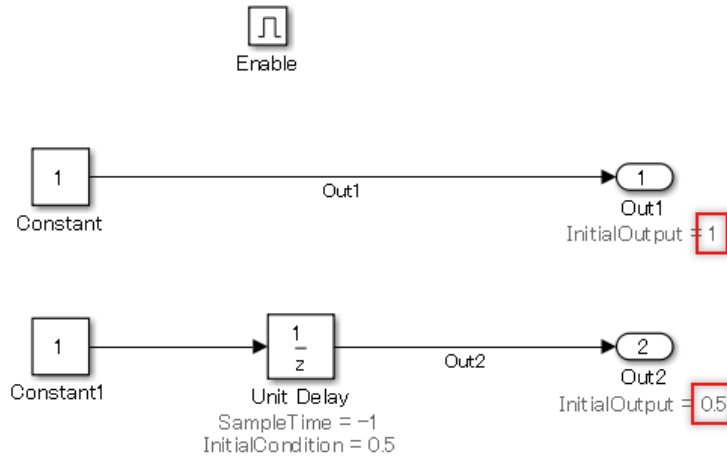
When the output signal from a conditional subsystem is connected to a Merge block, the initial condition shall be defined on the Merge block.

#### Custom Parameter

Not Applicable

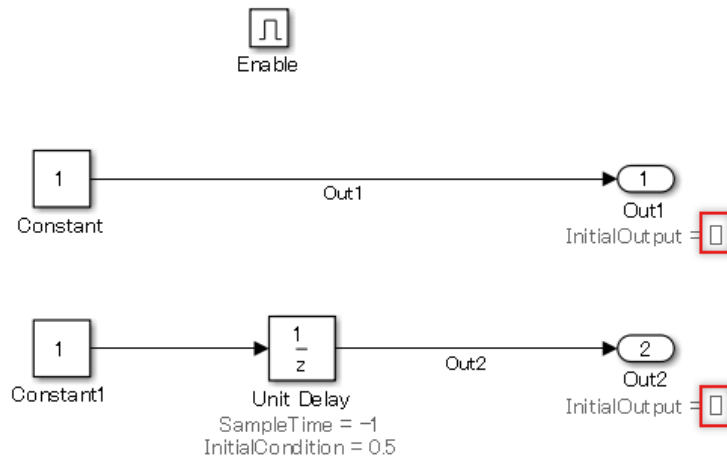
#### Example — Correct

The initial condition is defined.



**Example — Incorrect**

The initial condition is not defined.



Sink Block Parameters: Out1

Output

Provide an output port for a subsystem or model. The 'Output when disabled' and 'Initial output' parameters only apply to conditionally executed subsystems. When a conditionally executed subsystem is disabled, the output is either held at its last value or set to the 'Initial output'.

Main | Signal Attributes

Port number: 1

Icon display: Port number

Source of initial output value: Dialog

Output when disabled: held

Initial output: []

OK Cancel Help Apply

Sink Block Parameters: Out2

Output

Provide an output port for a subsystem or model. The 'Output when disabled' and 'Initial output' parameters only apply to conditionally executed subsystems. When a conditionally executed subsystem is disabled, the output is either held at its last value or set to the 'Initial output'.

Main | Signal Attributes

Port number: 2

Icon display: Port number

Source of initial output value: Dialog

Output when disabled: held

Initial output: []

OK Cancel Help Apply

### Rationale

Sub ID a:

- The model may not behave as intended when the initial condition is unclear.

## Verification

Model Advisor check: “Check undefined initial output for conditional subsystems” (Simulink Check)

## Last Changed

R2020a

## See Also

- JMAAB guideline jc\_0640, which is available in *Control Algorithm Modeling Guidelines Using MATLAB, Simulink, and Stateflow* on the MathWorks website.
- “Types of Subsystems”
- “Conditionally Executed Subsystems and Models”

## Introduced in R2020a

## jc\_0659: Usage restrictions of signal lines input to Merge blocks

### Sub ID Recommendations

- NA-MAAB — No recommendations
- JMAAB — a

### MATLAB Versions

All

### Rule

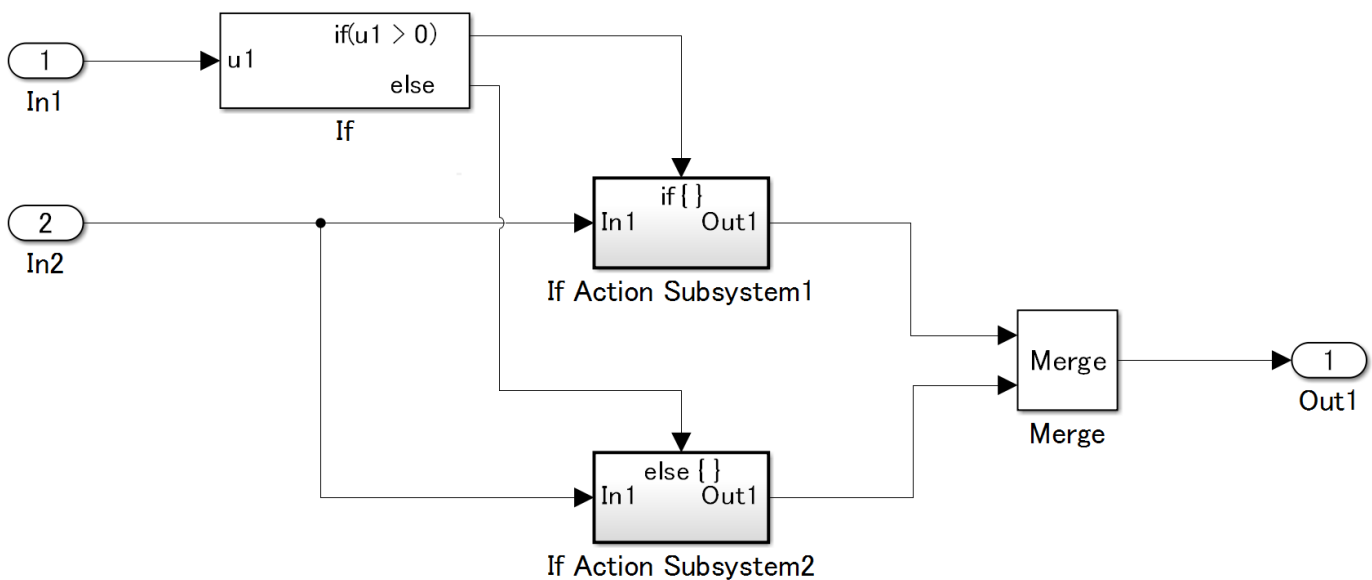
#### Sub ID a

Only conditional subsystem output signals shall input to Merge blocks.

#### Custom Parameter

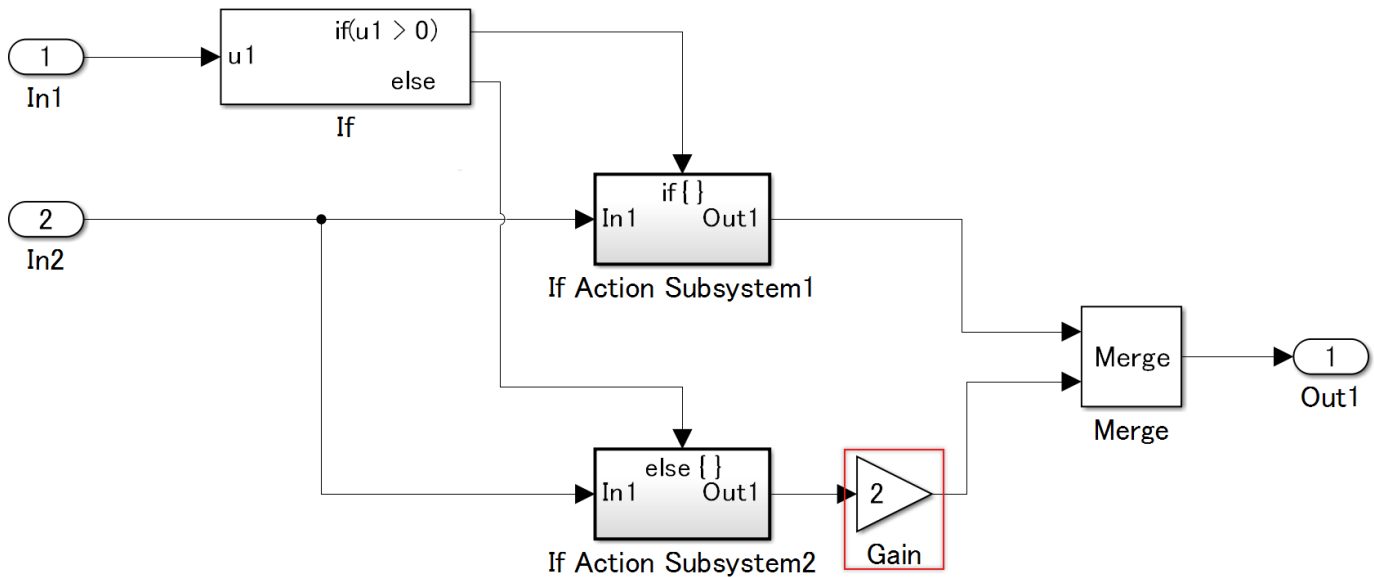
Not Applicable

#### Example — Correct



#### Example — Incorrect

A Gain block output signal is input to Merge.



## Rationale

Sub ID a:

- Prevents the simulation from proceeding as intended.

## Verification

Model Advisor check: “Check usage of Merge block” (Simulink Check)

## Last Changed

R2020a

## See Also

- JMAAB guideline jc\_0659, which is available in *Control Algorithm Modeling Guidelines Using MATLAB, Simulink, and Stateflow* on the MathWorks website.
- “Types of Subsystems”
- “Conditionally Executed Subsystems Overview”

**Introduced in R2020a**

## na\_0003: Usage of If blocks

### Sub ID Recommendations

- NA-MAAB — No recommendations
- JMAAB — a

### MATLAB Versions

All

### Rule

#### Sub ID a

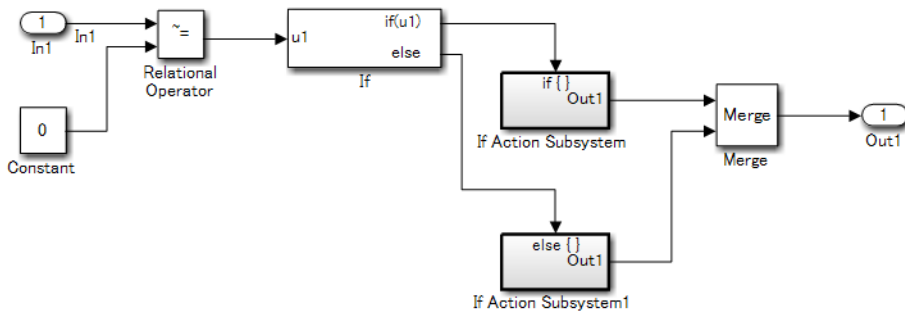
For the If block, the `if` expression and `elseif` expression shall be used only to define input signals.

#### Custom Parameter

Not Applicable

#### Example — Correct

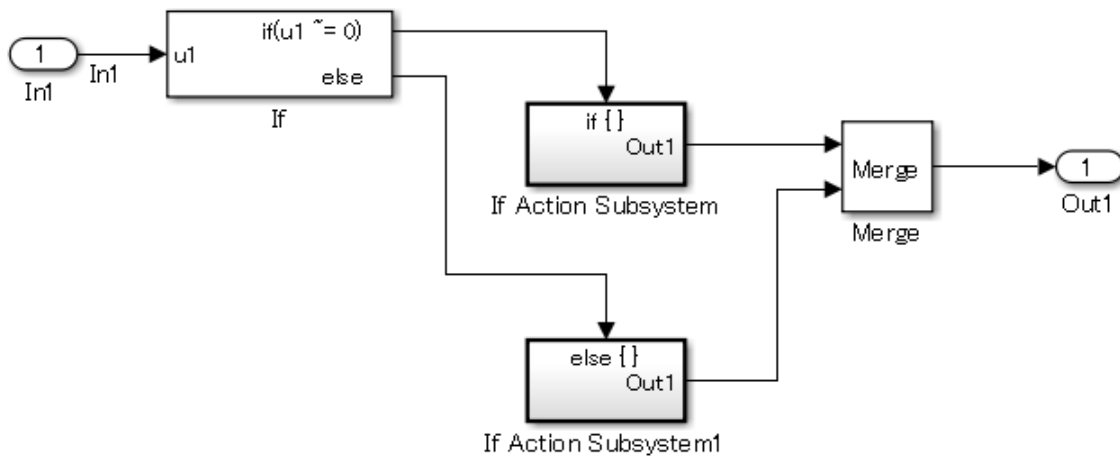
The `if` expression only defines the input variables.



#### Example — Incorrect

The `if` expression defines a comparison operation.





## Rationale

Sub ID a:

- Visual comprehension of control conditions is easier when logical operations are described outside of the If block.
- Describing logical operations outside of the If block allows verification to focus on the logical operation.

## Verification

Model Advisor check: “Check logical expressions in If blocks” (Simulink Check)

## Last Changed

R2020a

## See Also

- JMAAB guideline na\_0003, which is available in *Control Algorithm Modeling Guidelines Using MATLAB, Simulink, and Stateflow* on the MathWorks website.
- “Loops and Conditional Statements”

**Introduced in R2020a**

## jc\_0656: Usage of Conditional Control blocks

### Sub ID Recommendations

- NA-MAAB — No recommendations
- JMAAB — a

### MATLAB Versions

All

### Rule

#### Sub ID a

To make all actions in the conditions explicit, these block parameters shall be set as follows :

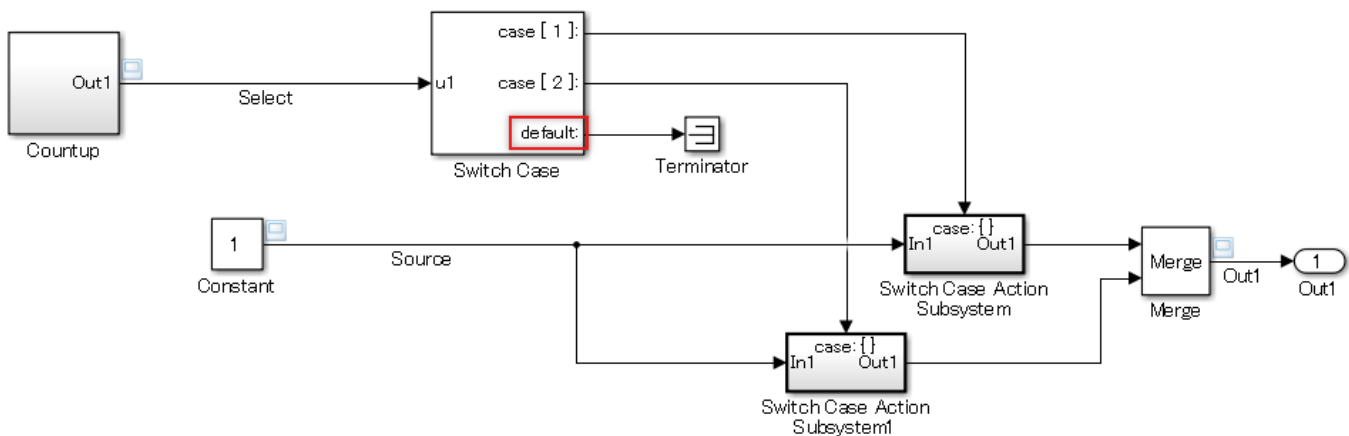
- For If blocks, select **Show else condition**
- For Switch Case blocks, select **Show default case**

#### Custom Parameter

Not Applicable

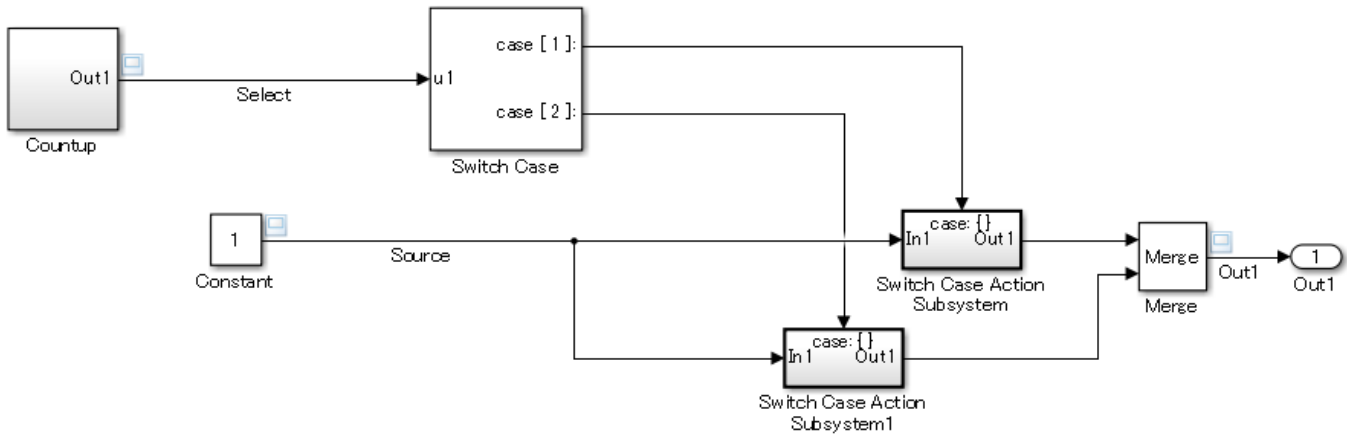
#### Example — Correct

Using default behavior in the Switch Case block.



#### Example — Incorrect

Not using default behavior in the Switch Case block.



## Rationale

Sub ID a:

- Determining whether there is pointless processing or if something is missing from the design (such as a missing description) is easier when the processing of exceptions (else, default) is explicitly set in the model.

## Verification

Model Advisor check: “Check default/else case in Switch Case blocks and If blocks” (Simulink Check)

## Last Changed

R2020a

## See Also

- JMAAB guideline jc\_0656, which is available in *Control Algorithm Modeling Guidelines Using MATLAB, Simulink, and Stateflow* on the MathWorks website.
- “Conditionally Executed Subsystems Overview”
- “Set Block Parameters”
- “Select Subsystem Execution”

**Introduced in R2020a**

## jc\_0657: Retention of output value based on conditional control flow blocks and Merge blocks

### Sub ID Recommendations

- NA-MAAB — a2
- JMAAB — a1/a2

### MATLAB Versions

All

### Rule

#### Sub ID a1

Unused action ports shall connect to Terminator block when these conditions are met:

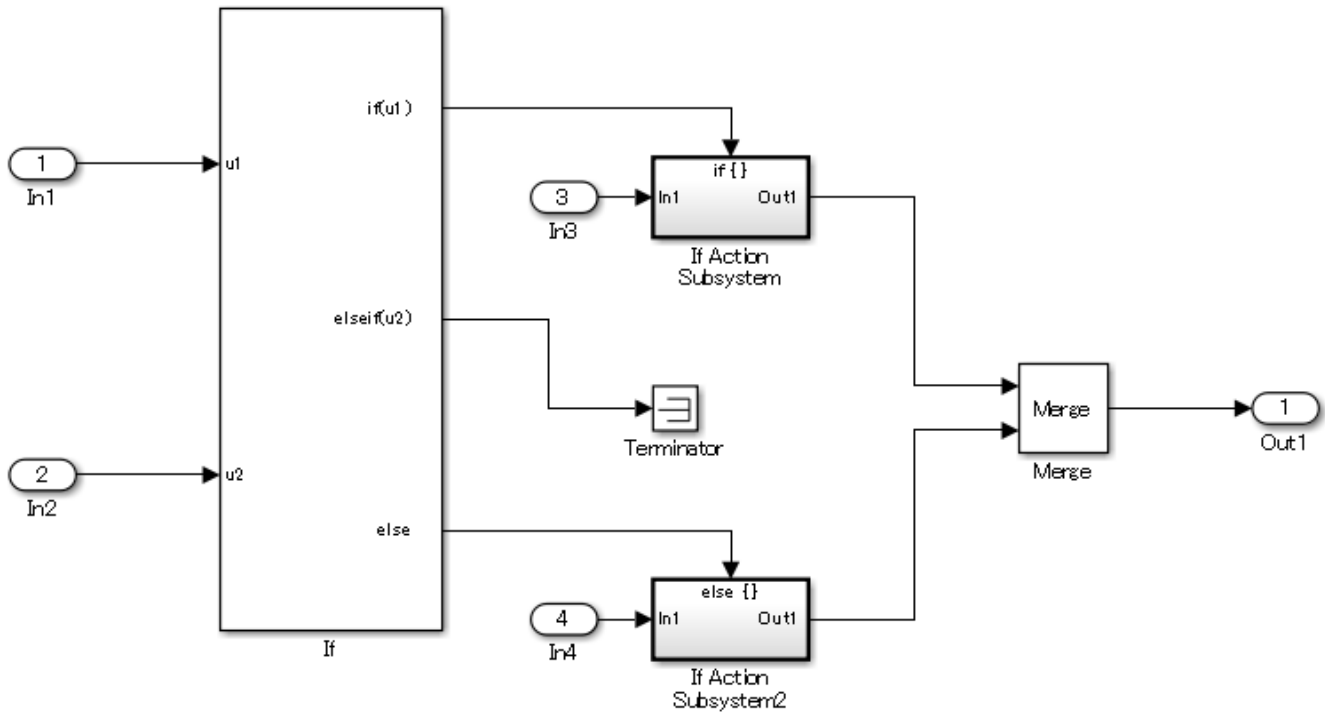
- Past value is retained
- Merge block and a conditional flow block, such as an If or Switch Case block, are used to switch functions.

#### Custom Parameter

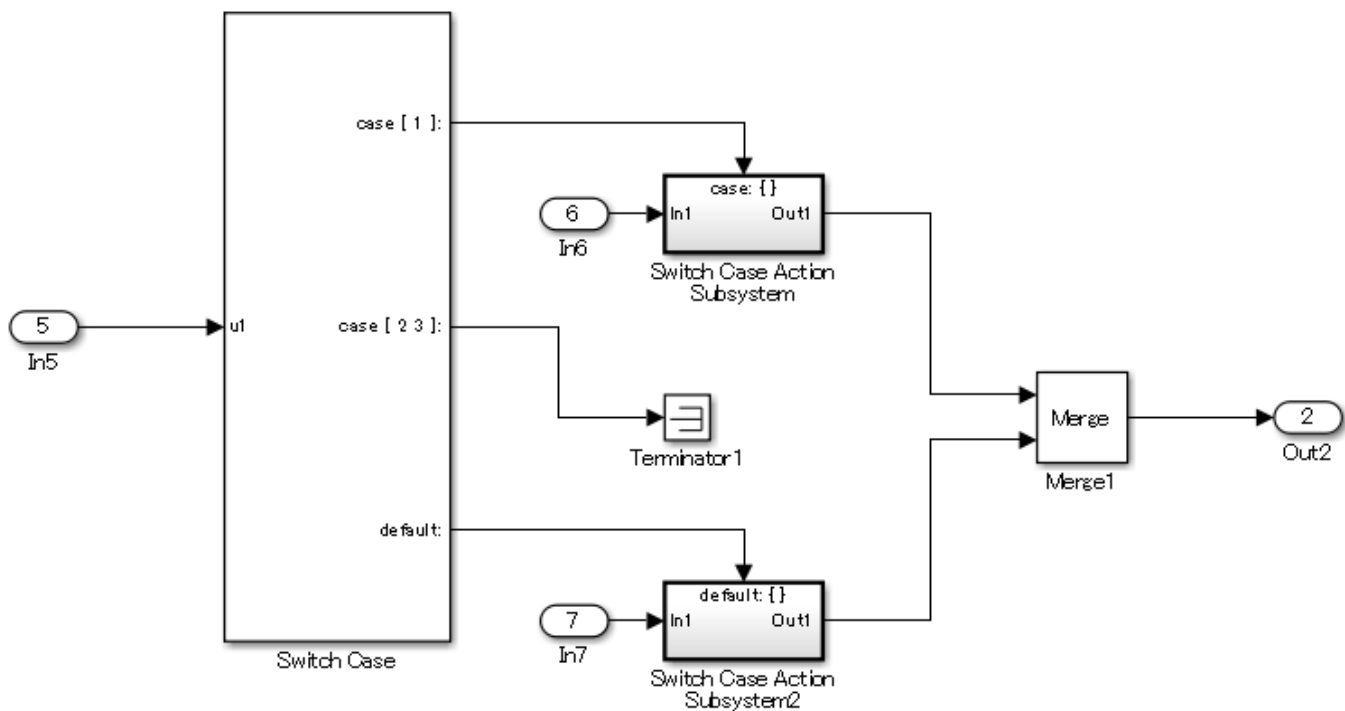
Not Applicable

#### Example — Correct

If block example

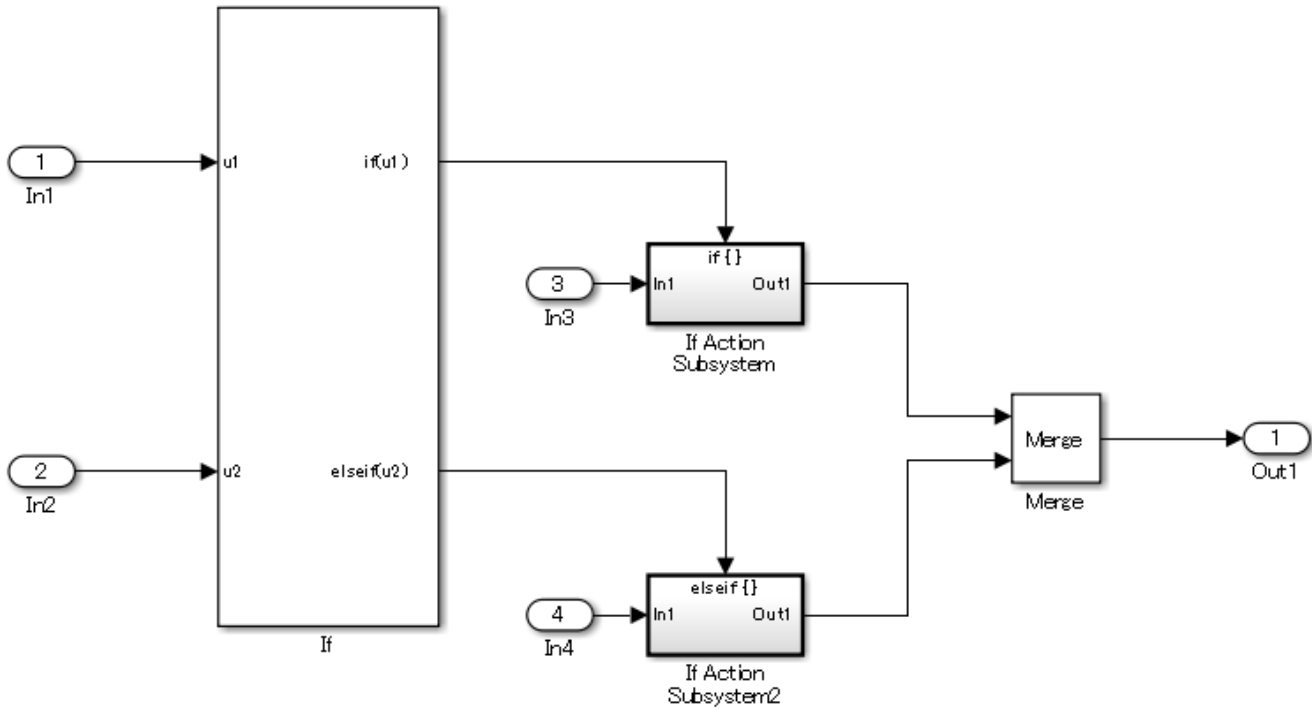


Switch Case block example

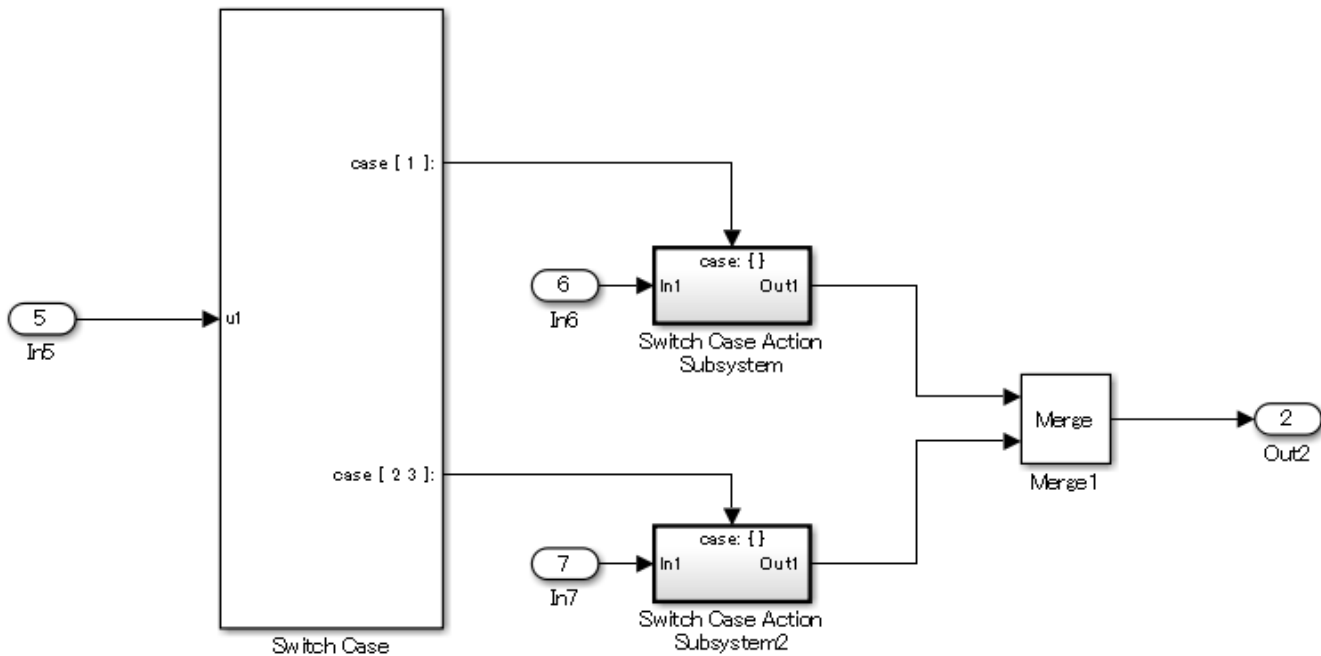


**Example – Incorrect**

If block example



Switch Case block example

**Sub ID a2**

A feedback loop using a Delay block shall be implemented when these conditions are met:

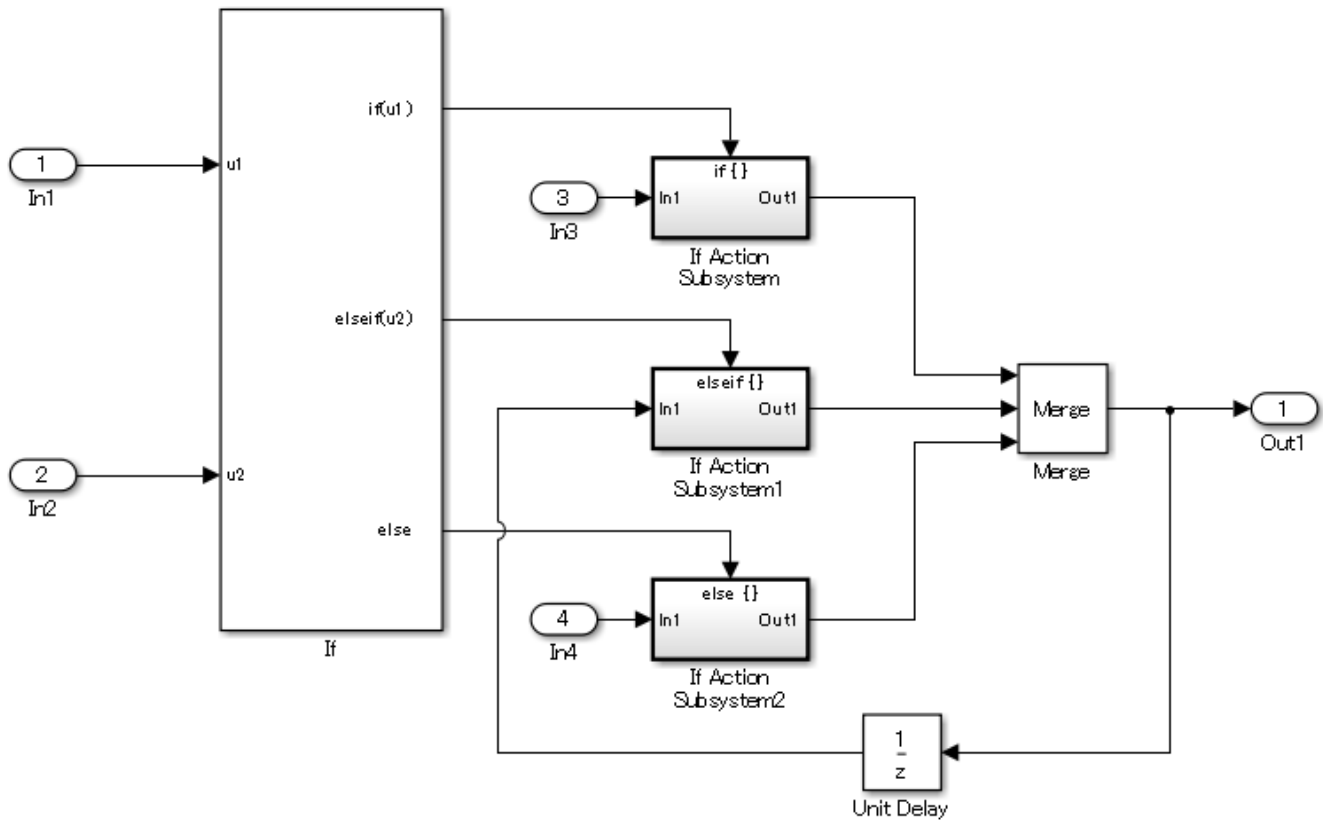
- Past value is retained
- Merge block and a conditional flow block, such as an If or Switch Case block, are used to switch functions.

**Custom Parameter**

Not Applicable

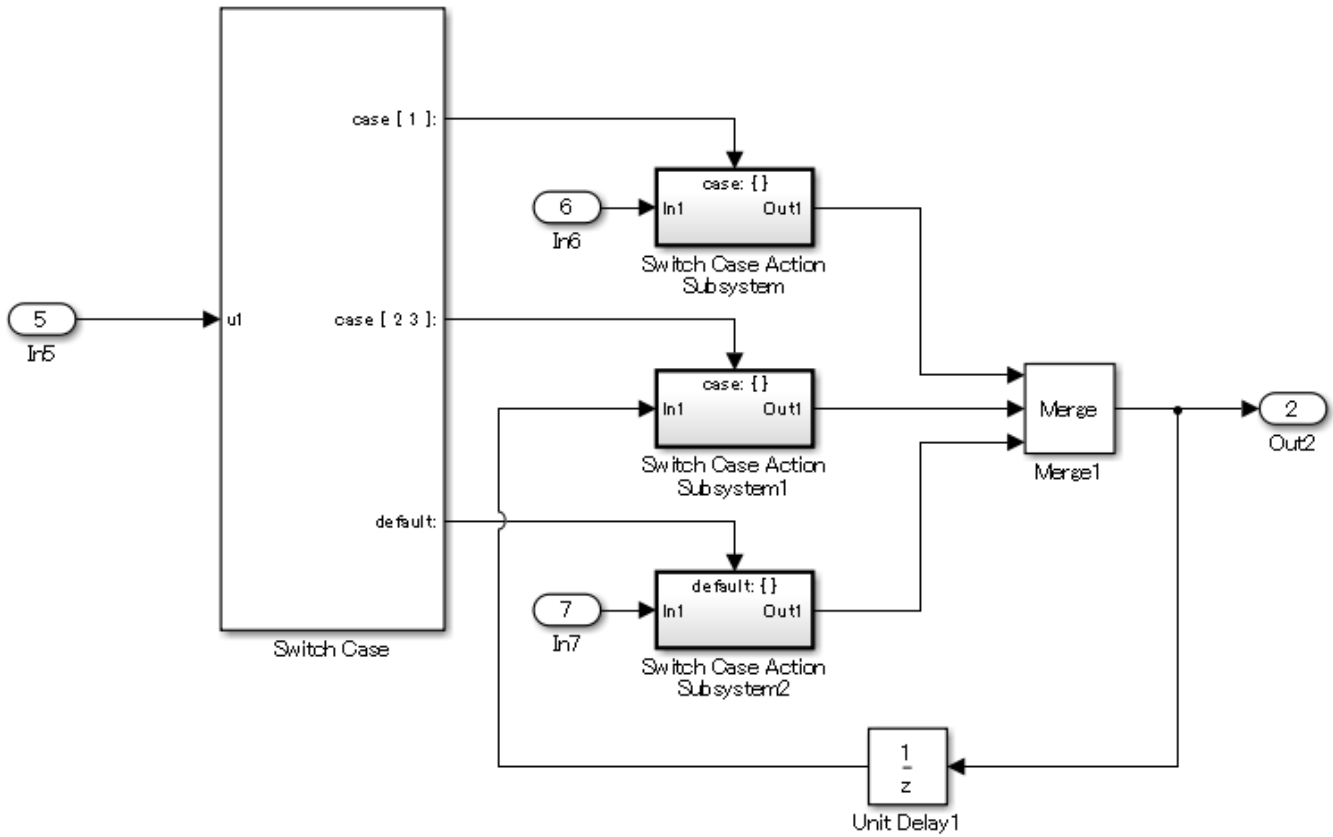
**Example — Correct**

If block example



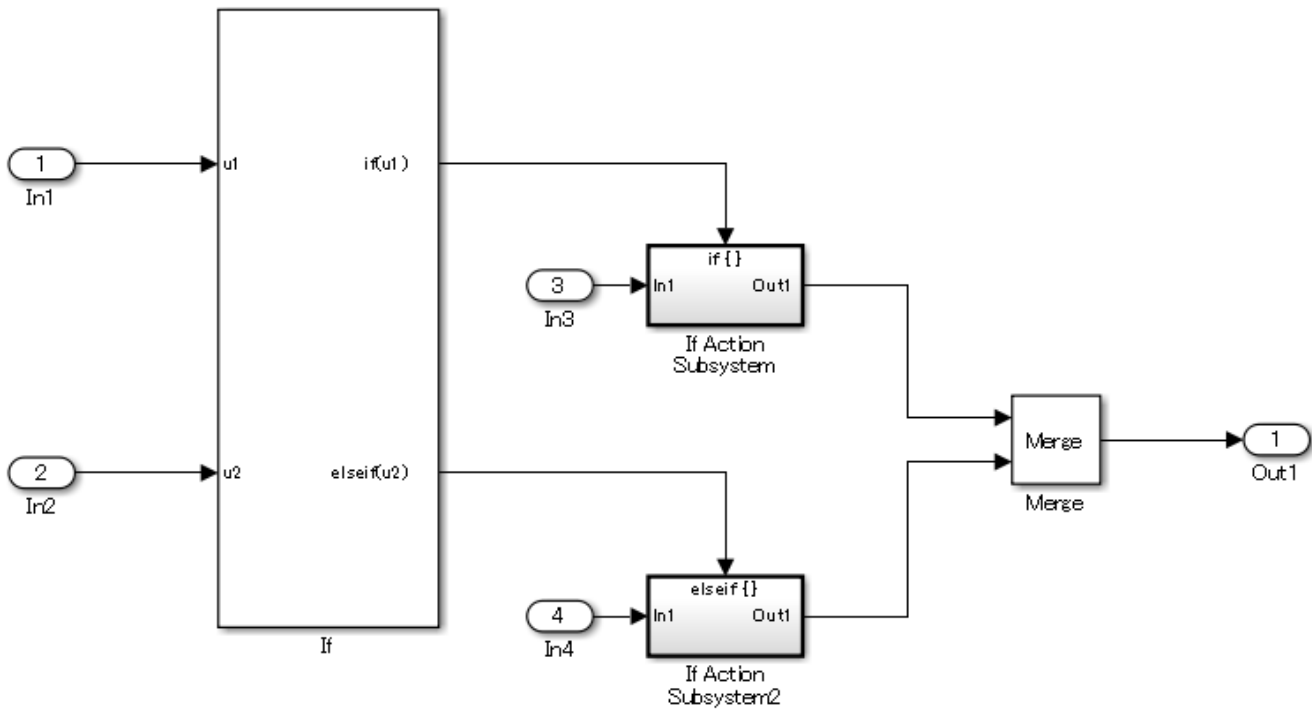
Switch Case block example



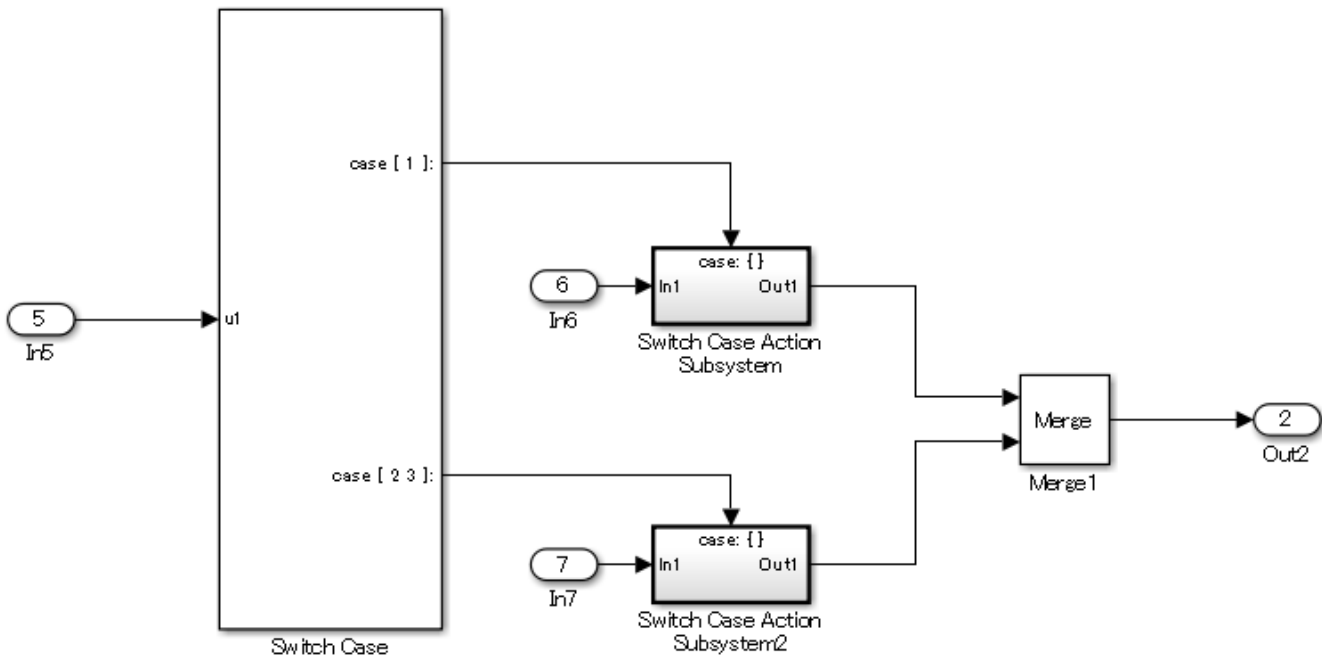


**Example — Incorrect**

If block example



Switch Case block example



## Rationale

Sub ID a1:

- Improves code efficiency.
- Connections to Terminator block can be used when past values are held other than by the default (`else`).

Sub ID a2:

- Retaining past values is explicit.

## Verification

Adherence to this modeling guideline cannot be verified by using a Model Advisor check.

## Last Changed

R2020a

## See Also

- JMAAB guideline `jc_0657`, which is available in *Control Algorithm Modeling Guidelines Using MATLAB, Simulink, and Stateflow* on the MathWorks website.

**Introduced in R2020a**

# Operation Blocks

# na\_0002: Appropriate usage of basic logical and numerical operations

## Sub ID Recommendations

- NA-MAAB — a, b
- JMAAB — a, b

## MATLAB Versions

All

## Rule

### Sub ID a

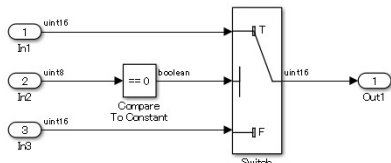
Logical signals shall not connect to blocks that operate on numerical signals.

### Custom Parameter

Blocks receiving numerical signals

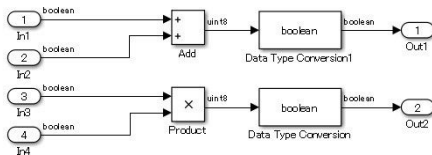
### Example — Correct

Numerical values are compared to determine if they are equal.

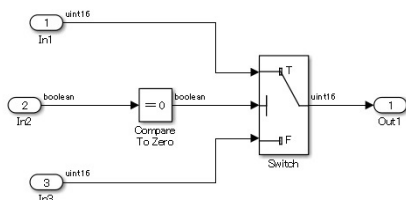


### Example — Incorrect

A logical output is connected directly to the input of blocks that process numerical inputs.



A logical signal is compared with a numerical value.



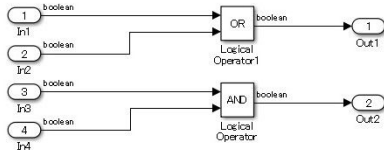
**Sub ID b**

Numerical signals shall not connect to blocks that operate on logical signals.

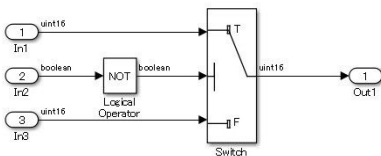
**Custom Parameter**

Blocks receiving logical signals

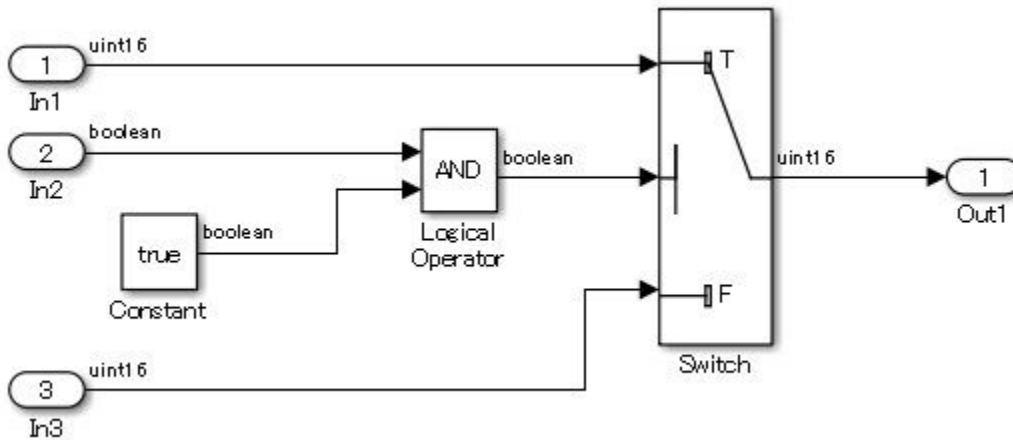
**Example — Correct**



Logical signal is inverted by using a logical operation.



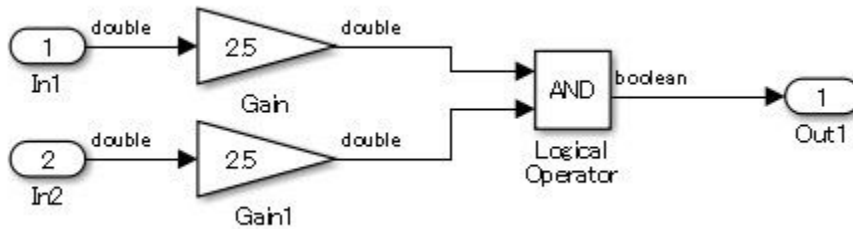
Logical signal is evaluated by using a logical operation.



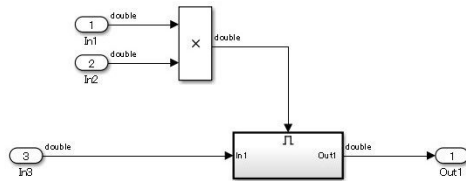
**Example — Incorrect**

Logical signal is inverted by using a logical operation.

A block that is used to perform logical operations is being used to perform numerical operations. A numerical output is connected to the input of blocks that process logical inputs.



A block that is used to perform numerical operations is being used to perform logical operations. Inputs other than logical values can be provided to the block. However, the Enable port block can receive only logical signals that have On/Off. The Product block performs logical operations when it connects the numerical operations result to a block that receives the logical value Enable port.



## Rationale

Sub IDs a, b:

- When numerical and logical values are treated the same, the original intention becomes unclear and the next operation in the model can be incorrectly interpreted, further compounding the error.

## Verification

Model Advisor check: “Check fundamental logical and numerical operations” (Simulink Check)

## Last Changed

R2020a

## See Also

- JMAAB guideline na\_0002, which is available in *Control Algorithm Modeling Guidelines Using MATLAB, Simulink, and Stateflow* on the MathWorks website.
- “Signal Basics”

**Introduced in R2020a**

## jc\_0121: Usage of add and subtraction blocks

### Sub ID Recommendations

- NA-MAAB — a
- JMAAB — a, b, c

### MATLAB Versions

All

### Rule

#### Sub ID a

The icon shape of the add and subtraction Sum block shall be rectangular.

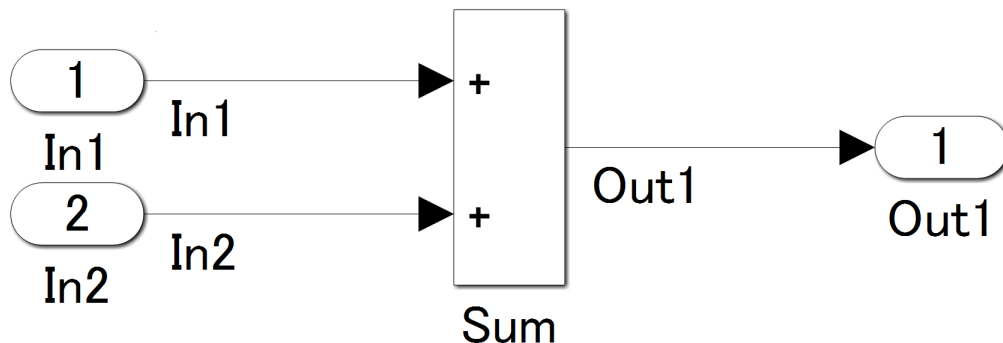
When used in a feedback loop, the *icon shape* can be round.

#### Custom Parameter

Not Applicable

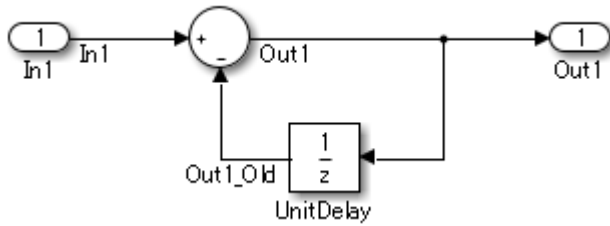
#### Example — Correct

The icon shape of the add and subtraction Sum block shall be rectangular.



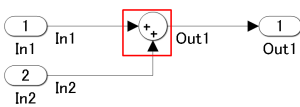
The second input to the add and subtraction Sum block is a feedback loop, so the *icon shape* is round.





**Example – Incorrect**

This is not a feedback loop, but the *icon shape* of the add and subtractionSum block is round.



**Sub ID b**

The + mark shall be used for the first input to the add and subtraction Sum block.

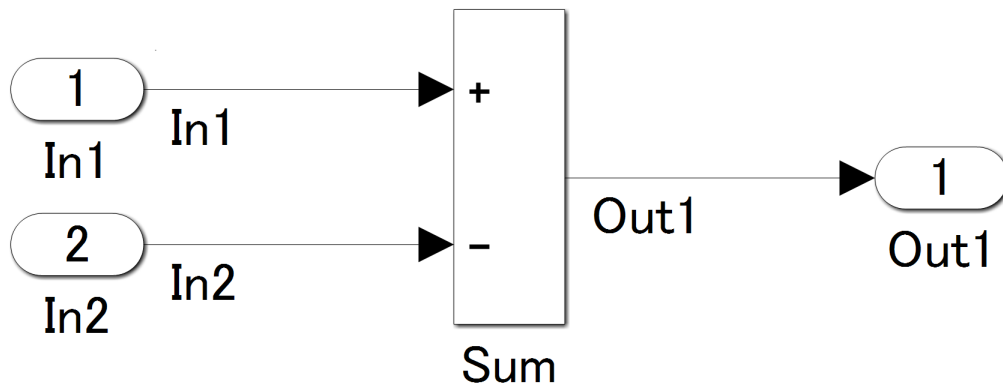
For a feedback loop, the first input can be set by using the - mark.

**Custom Parameter**

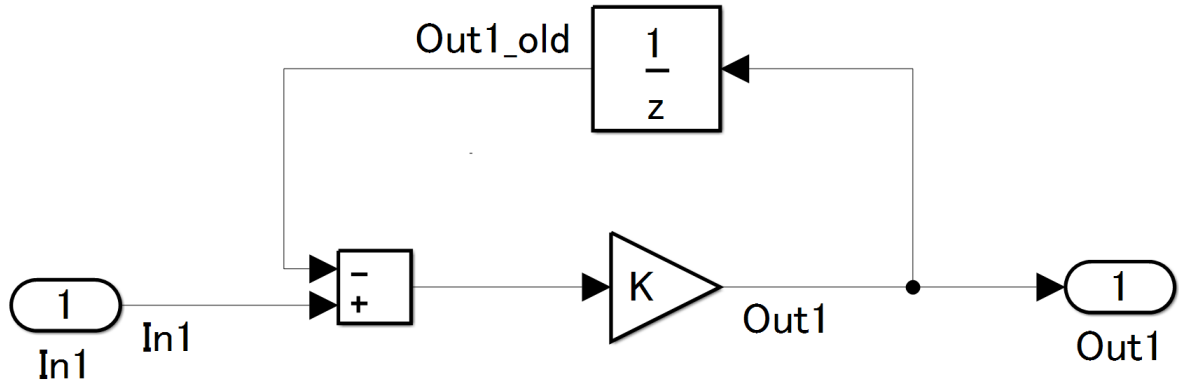
Not Applicable

**Example – Correct**

The + mark is used for the first input to the add and subtraction Sum block.

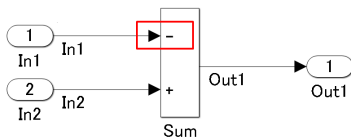


The second input to the add and subtraction Sum block is a feedback loop, so the - mark is used



**Example — Incorrect**

The sign for the first input to the add and subtraction Sum block is the - mark.

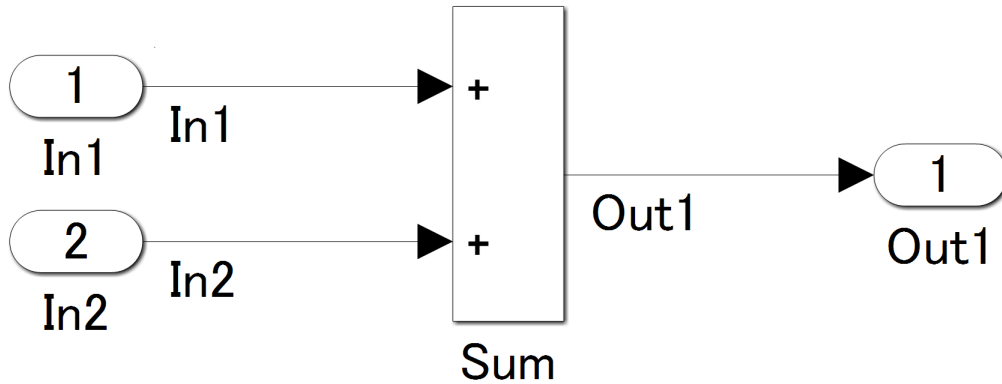


**Sub ID c**

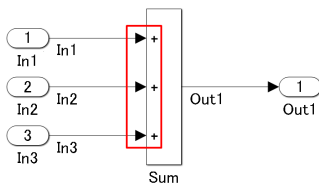
The add and subtraction Sum block shall not have more than two inputs.

**Custom Parameter**

Not Applicable

**Example — Correct****Example — Incorrect**

The add and subtraction Sum block has three inputs.

**Rationale**

Sub ID a:

- Adherence to the guideline improves readability of the model.

Sub ID b:

- Readability of the control specification improves when the sign for the first input is consistent.

Sub ID c:

- The order of operations is clearly defined.

**Verification**

Model Advisor check: “Check usage of Sum blocks” (Simulink Check)

**Last Changed**

R2020a

## **See Also**

- JMAAB guideline jc\_0121, which is available in *Control Algorithm Modeling Guidelines Using MATLAB, Simulink, and Stateflow* on the MathWorks website.

**Introduced in R2020a**

# jc\_0610: Operator order for multiplication and division block

## Sub ID Recommendations

- NA-MAAB — No recommendations
- JMAAB — a, b

## MATLAB Versions

All

## Rule

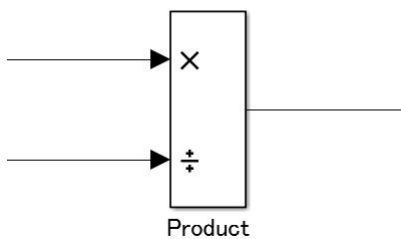
### Sub ID a

The \* mark shall be used for the first input to a multiplication and division Product block.

### Custom Parameter

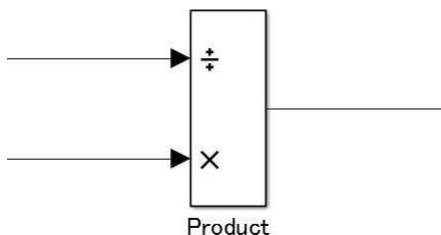
Not Applicable

### Example — Correct



### Example — Incorrect

The / mark is used for the first input.



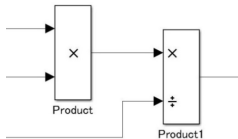
**Sub ID b**

The multiplication and division Product block shall not have more than two inputs.

**Custom Parameter**

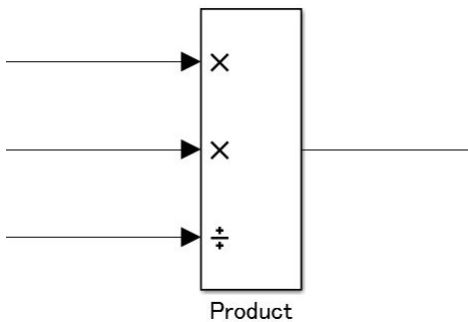
Not Applicable

**Example — Correct**



**Example — Incorrect**

The block has three inputs.



**Rationale**

Sub ID a:

- When checking the block, the input order of the expression and block is reversed, which impairs readability.
- For floating point numbers, the code is generated according to the operation order in the block --  $((1 \div 1st \text{ input})) \times 2nd \text{ input}$ . However, if division is performed later, then the number of operations can be reduced.

Sub ID b:

- The order of operations is clearly defined.

**Verification**

Model Advisor check: “Check operator order of Product blocks” (Simulink Check)

**Last Changed**

R2020a

## See Also

- JMAAB guideline jc\_0610, which is available in *Control Algorithm Modeling Guidelines Using MATLAB, Simulink, and Stateflow* on the MathWorks website.
- “Multiply and Divide Inputs Using the Product Block”

## Introduced in R2020a

# jc\_0611: Input sign for multiplication and division blocks

## Sub ID Recommendations

- NA-MAAB — a
- JMAAB — a

## MATLAB Versions

All

## Rule

### Sub ID a

When using fixed-point values as the input to the multiplication and division Product block, the sign of the data type shall be the same for all input signals.

### Custom Parameter

Not Applicable

## Rationale

Sub ID a:

- A utility function is created for each least significant bit (LSB) when fixed-point code is generated. Unification of data type signs can reduce the number of utility functions.

## Verification

Model Advisor check: “Check signs of input signals in product blocks” (Simulink Check)

## Last Changed

R2020a

## See Also

- JMAAB guideline jc\_0611, which is available in *Control Algorithm Modeling Guidelines Using MATLAB, Simulink, and Stateflow* on the MathWorks website.
- “Multiply and Divide Inputs Using the Product Block”

**Introduced in R2020a**



# jc\_0794: Division in Simulink

## Sub ID Recommendations

- NA-MAAB — a
- JMAAB — a

## MATLAB Versions

All

## Rule

### Sub ID a

When using division, implementation of the algorithm shall avoid division by zero.

### Custom Parameter

Not Applicable

## Rationale

Sub ID a:

- Deviation from the rule can cause unintended operation and code generation results.

## Verification

Adherence to this modeling guideline cannot be verified by using a Model Advisor check.

## Last Changed

R2020a

## See Also

- JMAAB guideline jc\_0794, which is available in *Control Algorithm Modeling Guidelines Using MATLAB, Simulink, and Stateflow* on the MathWorks website.
- Multiply “Multiply and Divide Inputs Using the Product Block”

## Introduced in R2020a

## jc\_0805: Numerical operation block inputs

### Sub ID Recommendations

- NA-MAAB — a1/a2, b, c1/c2, d, e, f1/f2, g, h, i, j
- JMAAB — a1/a2, b, c1/c2, d, e, f1/f2, g, h, i, j

### MATLAB Versions

All

### Rule

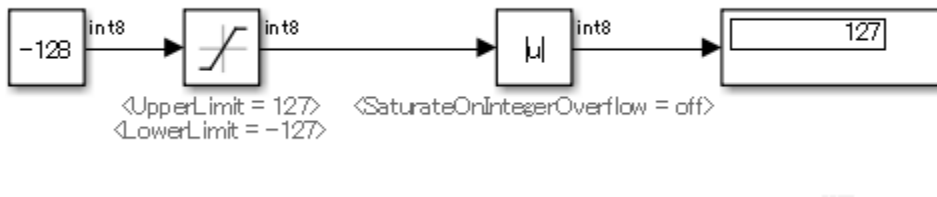
#### Sub ID a1

When using and Abs block with signed integer types, the input shall not be the most negative value.

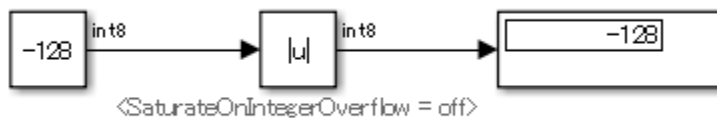
#### Custom Parameter

Not Applicable

#### Example — Correct



#### Example — Incorrect



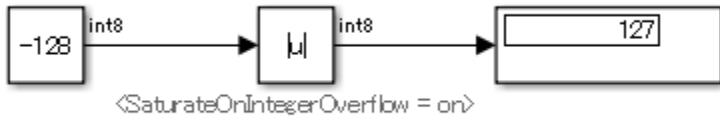
#### Sub ID a2

Abs block parameter **Saturation on Integer Overflow** shall be selected.

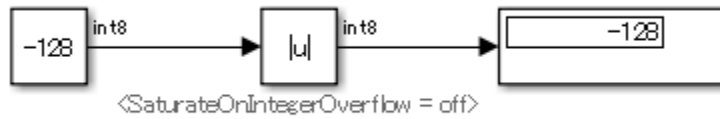
#### Custom Parameter

Not Applicable

**Example — Correct**



**Example — Incorrect**



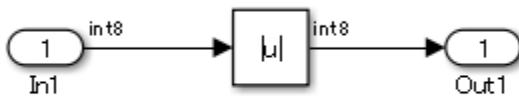
**Sub ID b**

Input to the Abs block shall not be unsigned integer types or fixed-point types.

**Custom Parameter**

Not Applicable

**Example — Correct**



**Example — Incorrect**



**Sub ID c1**

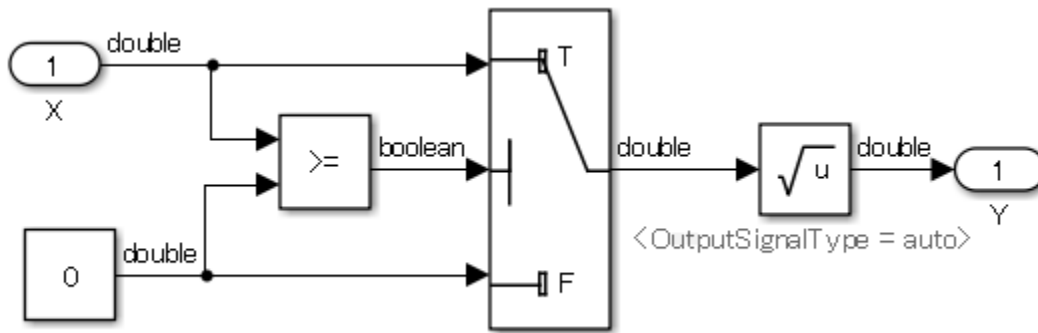
Input to the Sqrt block shall not be a negative value.

**Custom Parameter**

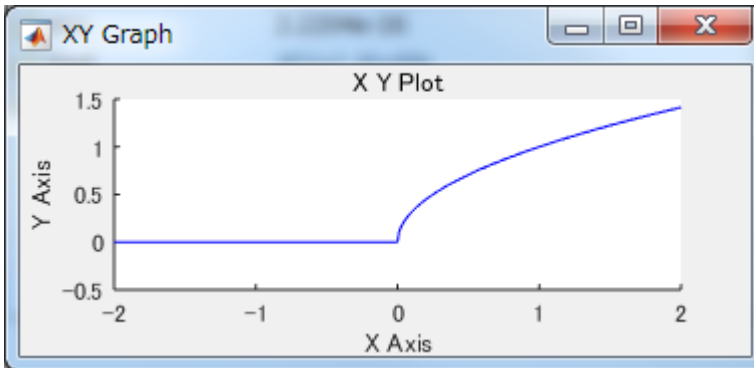
Not Applicable

**Example – Correct**

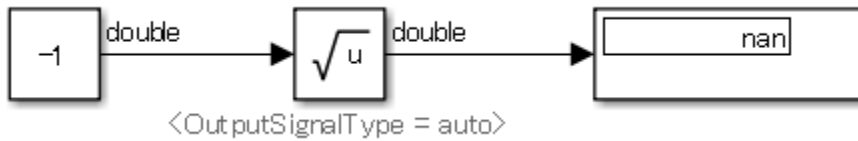
Negative number is saturated with 0.



Simulation result



**Example – Incorrect**



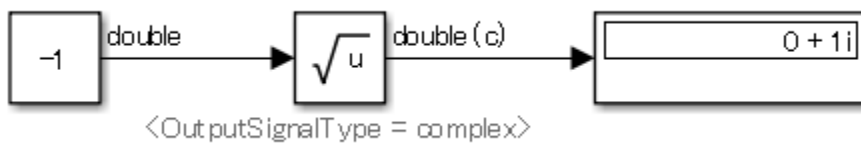
**Sub ID c2**

Sqrt block parameter **Output Signal Type** shall be set to complex.

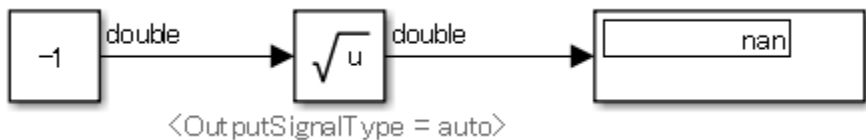
**Custom Parameter**

Not Applicable

**Example – Correct**



**Example – Incorrect**



**Sub ID d**

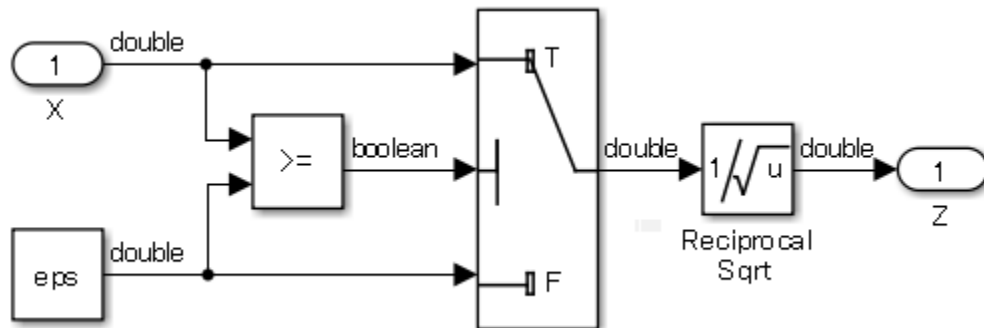
Input to the Reciprocal Sqrt block shall not be less than zero.

**Custom Parameter**

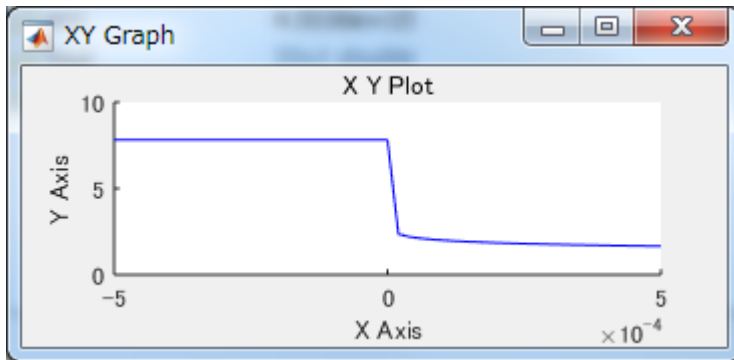
Not Applicable

**Example – Correct**

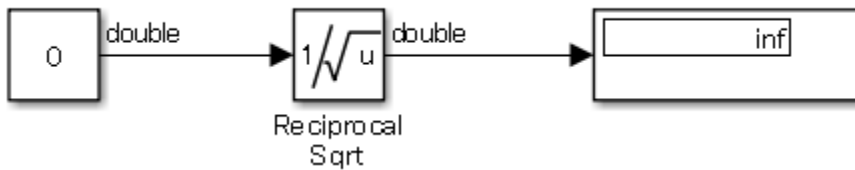
Less than eps saturated with eps.



Simulation result: Plot as  $Y = \log_{10}(Z)$



**Example – Incorrect**



**Sub ID e**

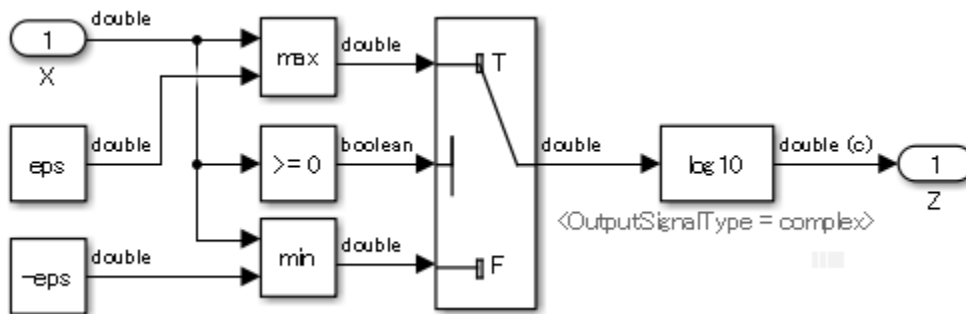
When Math Function block parameter **Function** is set to **log** or **log10**, the input to the block shall not be zero.

**Custom Parameter**

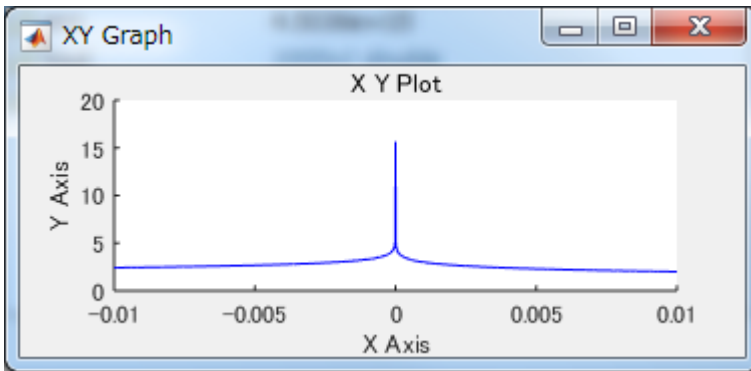
Not Applicable

**Example – Correct**

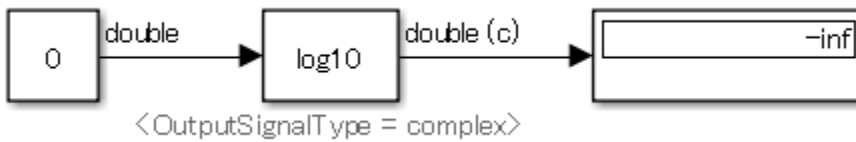
Replace within  $\pm\text{eps}$  with  $\pm\text{eps}$



Simulation result: Plot as  $Y = |Z|$



**Example – Incorrect**



**Sub ID f1**

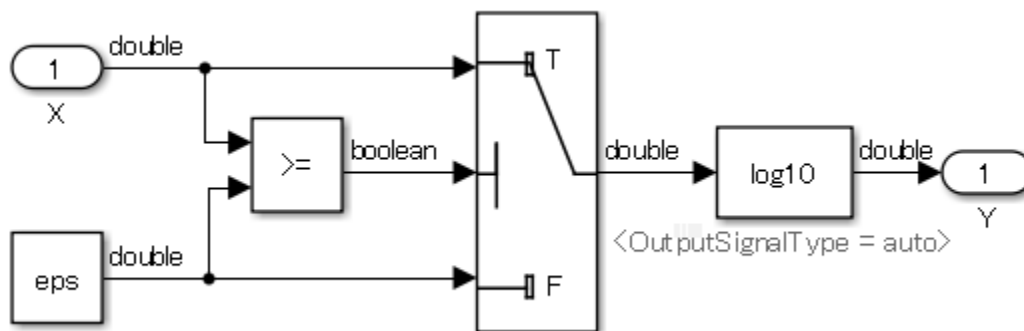
When Math Function block parameter **Function** is set to `log` or `log10`, the input to the block shall not be a negative number.

**Custom Parameter**

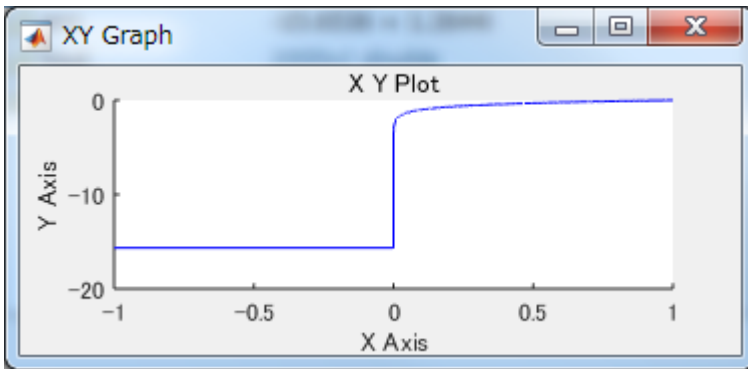
Not Applicable

**Example – Correct**

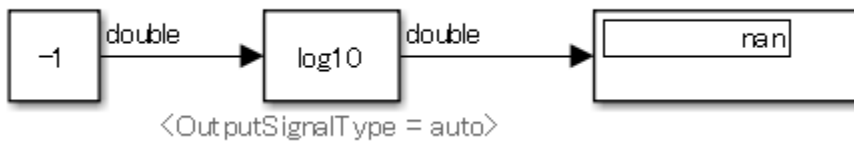
When the input is less than eps, the value is saturated to eps. Less than eps saturated with eps.



Simulation result



**Example – Incorrect**



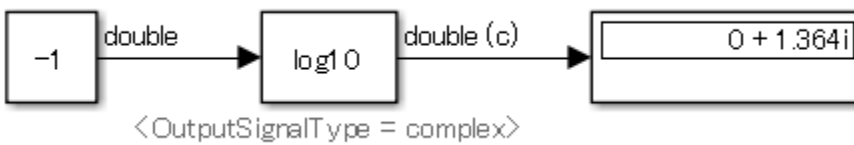
**Sub ID f2**

When Math Function block parameter **Function** is set to log or log10, block parameter **Output Signal Type** shall be set to complex.

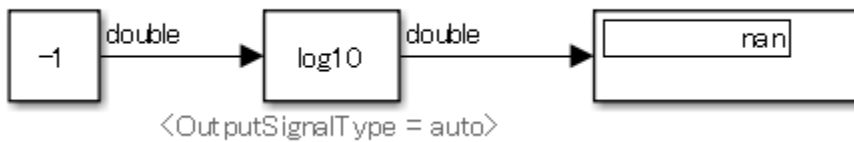
**Custom Parameter**

Not Applicable

**Example – Correct**



**Example – Incorrect**



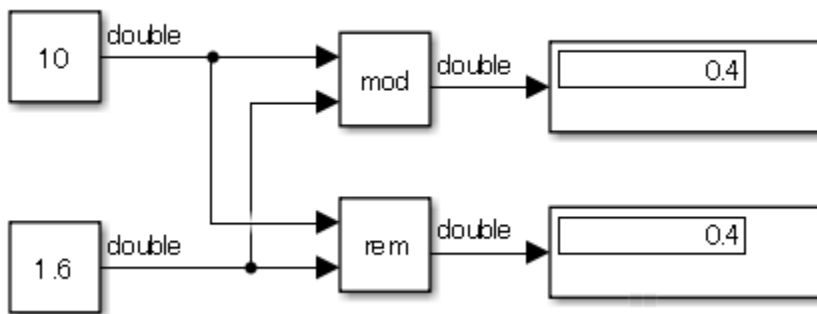
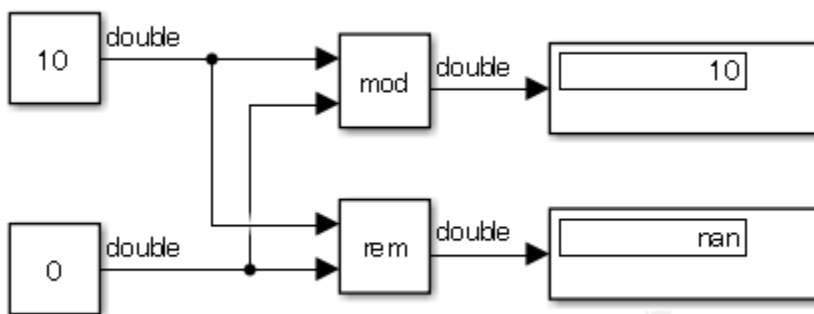
**Sub ID g**

When Math Function block parameter **Function** is set to mod or rem, the second argument input shall not be zero.



**Custom Parameter**

Not Applicable

**Example — Correct****Example — Incorrect****Sub ID h**

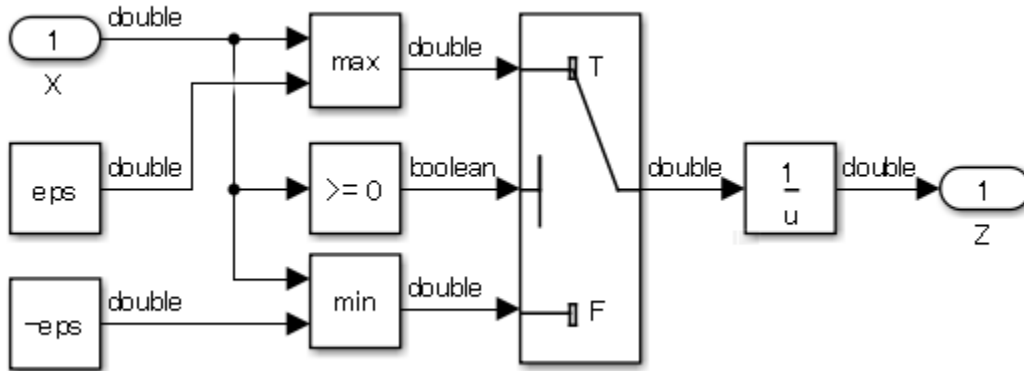
When Math Function block parameter **Function** is set to `reciprocal`, the input to the block shall not be zero.

**Custom Parameter**

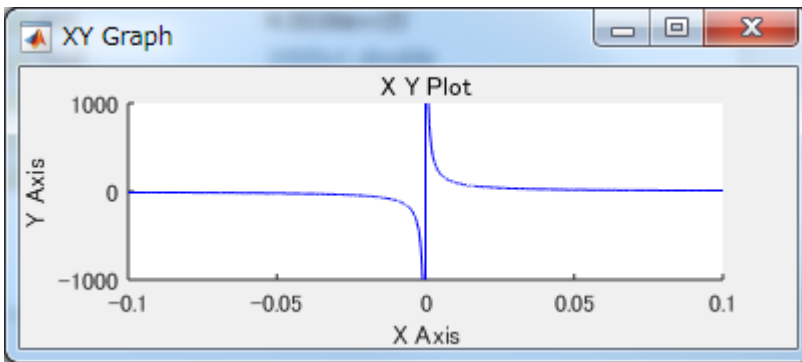
Not Applicable

**Example — Correct**

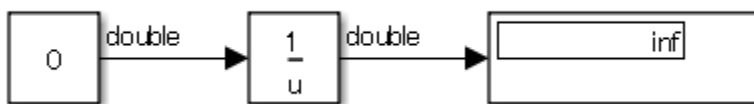
Replace within  $\pm\text{eps}$  with  $\pm\text{eps}$



Simulation result: Simulation results is not inf, but since it is close to zero, the change in the output value is significant.



**Example — Incorrect**



**Sub ID i**

When Product block parameter **Multiplication** is set to Element-wise (`.*`), the divisor input shall not be zero.

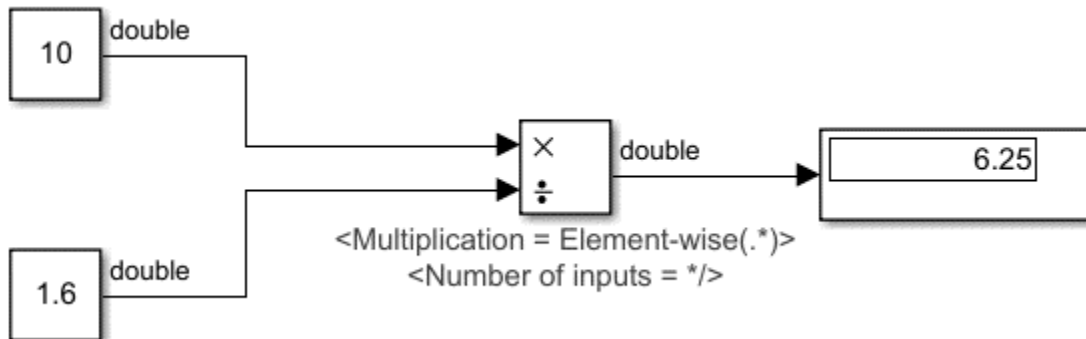
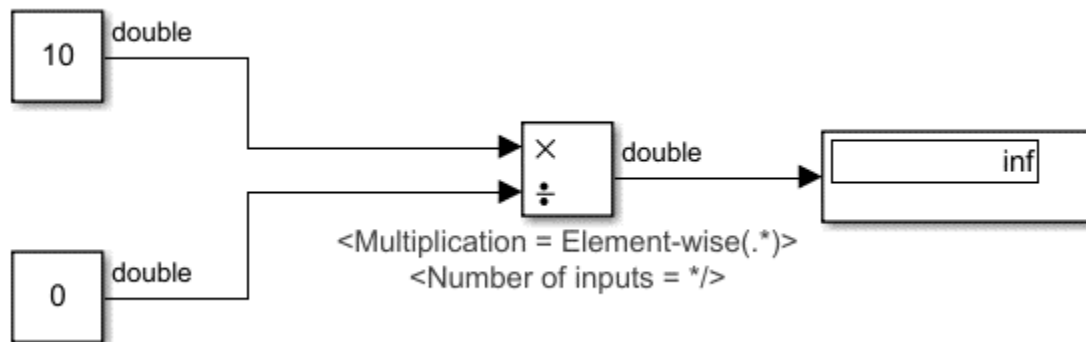
---

**Note** To specify a divisor input, set Product block parameter **Number of inputs** to `*/`.

---

**Custom Parameter**

Not Applicable

**Example – Correct****Example – Incorrect****Sub ID j**

When Product block parameter **Multiplication** is set to **Matrix(\*)**, the divisor input shall not be set to a singular matrix.

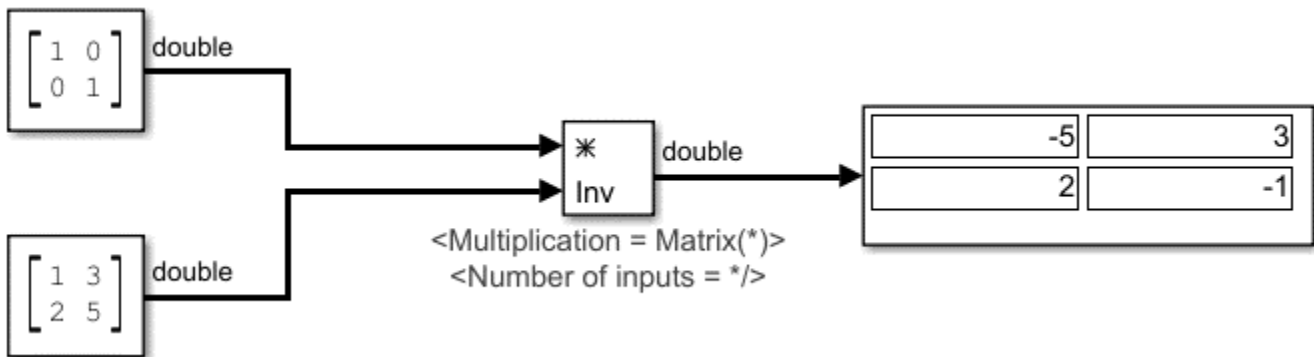
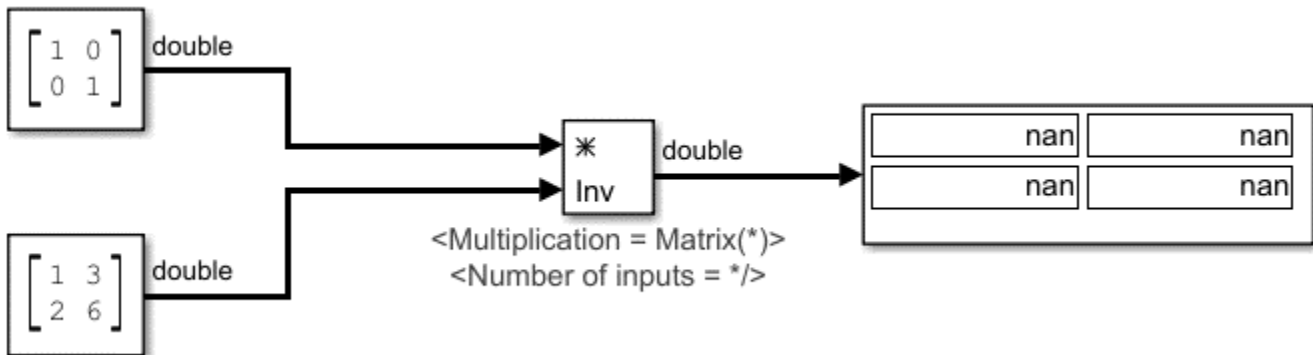
---

**Note** To specify a divisor input, set Product block parameter **Number of inputs** to **\*/**.

---

**Custom Parameter**

Not Applicable

**Example — Correct****Example — Incorrect****Rationale**

Sub IDs a1, c1, d, e, f1, g, h, i, j:

- The result of entering an invalid value is implementation dependent. Deviation from the rules can result in unintended behavior.

Sub ID a2:

- Correct settings prevent unintended behavior that can result from using invalid values.

Sub ID b:

- The block can become optimized out of the generated code, resulting in a block that you cannot trace to the generated code.

Sub IDs c2, f2:

- Correct settings prevent unintended behavior that can result from using negative values.

**Verification**

Adherence to this modeling guideline cannot be verified by using a Model Advisor check.

## Last Changed

R2020a

## See Also

- JMAAB guideline jc\_0805, which is available in *Control Algorithm Modeling Guidelines Using MATLAB, Simulink, and Stateflow* on the MathWorks website.
- “Specify Block Properties”
- “Control Data Types of Signals”

## Introduced in R2020a

## jc\_0622: Usage of Fcn blocks

### Sub ID Recommendations

- NA-MAAB — No recommendations
- JMAAB — a

### MATLAB Versions

All

### Rule

#### Sub ID a

When a Fcn block has operators with different priorities, parentheses shall be used to specify the priority order.

#### Custom Parameter

Not Applicable

### Rationale

Sub ID a:

- When operators have different priorities and the computation order is not clearly specified by using parentheses, readability is impaired and can be misinterpreted. This can result in unintended behavior.

### Verification

Model Advisor check: “Check for parentheses in Fcn block expressions” (Simulink Check)

### Last Changed

R2020a

### See Also

- JMAAB guideline jc\_0622, which is available in *Control Algorithm Modeling Guidelines Using MATLAB, Simulink, and Stateflow* on the MathWorks website.
- “Algebraic Loop Concepts”

### Introduced in R2020a

# jc\_0621: Usage of Logical Operator blocks

## Sub ID Recommendations

- NA-MAAB — a
- JMAAB — a

## MATLAB Versions

All

## Rule

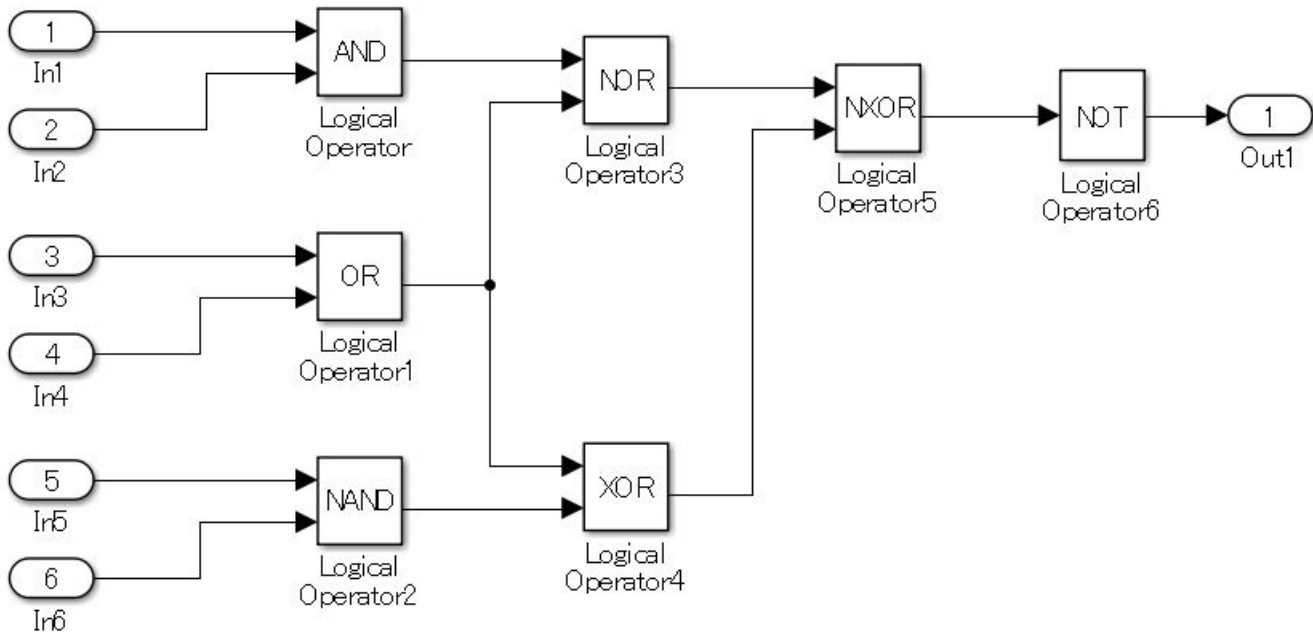
### Sub ID a

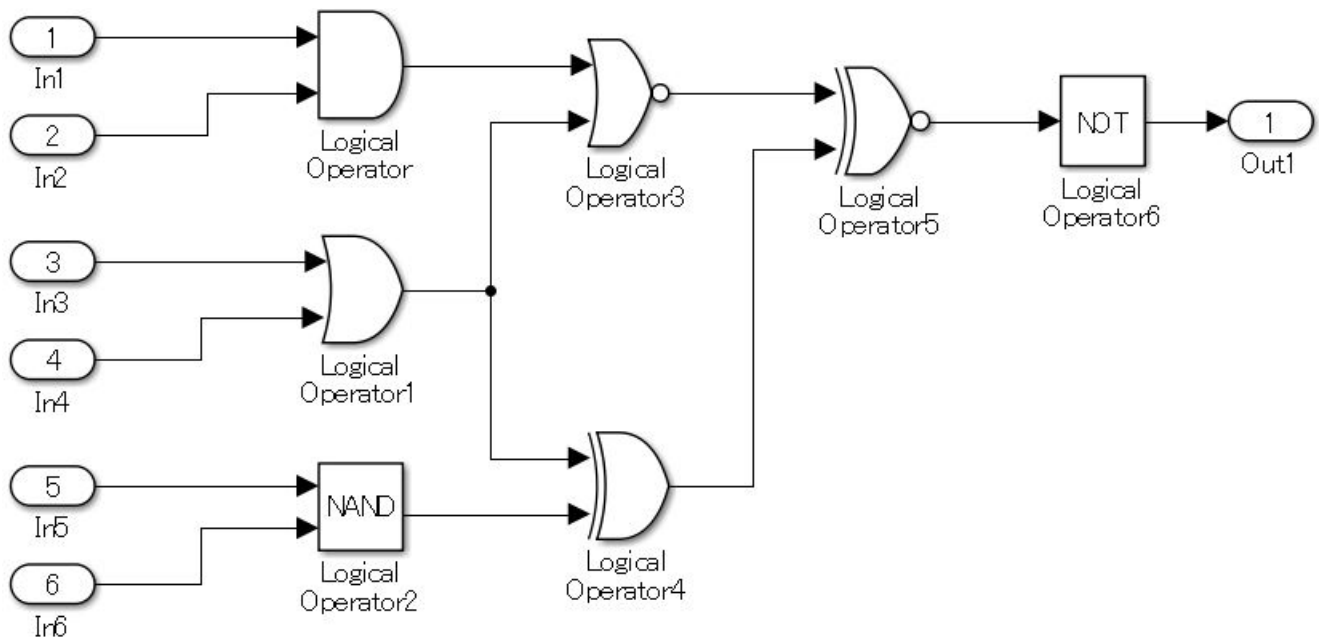
The **icon shape** for the Logical Operator block shall be set to rectangular.

### Custom Parameter

Not Applicable

### Example — Correct



**Example — Incorrect****Rationale**

Sub ID a:

- When describing the same function, using a consistent expression improves readability. Since "characteristics" shapes are similar, the risk of misinterpretation is greater than with rectangular shapes.

**Verification**

Model Advisor check: "Check icon shape of Logical Operator blocks" (Simulink Check)

**Last Changed**

R2020a

**See Also**

- JMAAB guideline jc\_0621, which is available in *Control Algorithm Modeling Guidelines Using MATLAB, Simulink, and Stateflow* on the MathWorks website.

**Introduced in R2020a**



# jc\_0131: Usage of Relational Operator blocks

## Sub ID Recommendations

- NA-MAAB — a
- JMAAB — a

## MATLAB Versions

All

## Rule

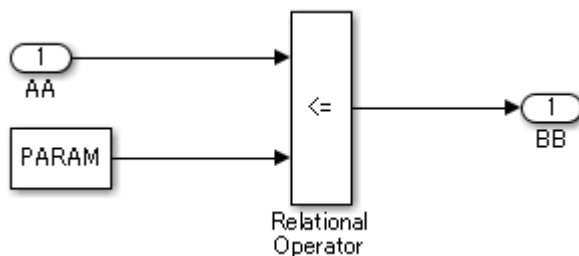
### Sub ID a

When using a Relational Operator block for comparison of signals and constants, the second (bottom) input shall be used as the constant input.

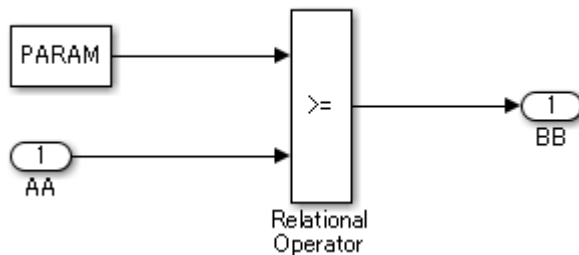
### Custom Parameter

Not Applicable

### Example — Correct



### Example — Incorrect



## Rationale

Sub ID a:

- Using constant values and the same comparison method reduces misinterpretation of the model.

## **Verification**

Model Advisor check: “Check usage of Relational Operator blocks” (Simulink Check)

## **Last Changed**

R2020a

## **See Also**

- JMAAB guideline jc\_0131, which is available in *Control Algorithm Modeling Guidelines Using MATLAB, Simulink, and Stateflow* on the MathWorks website.
- “Relational and Logical Operators” (Embedded Coder)

**Introduced in R2020a**

# jc\_0800: Comparing floating-point types in Simulink

## Sub ID Recommendations

- NA-MAAB — a
- JMAAB — a

## MATLAB Versions

All

## Rule

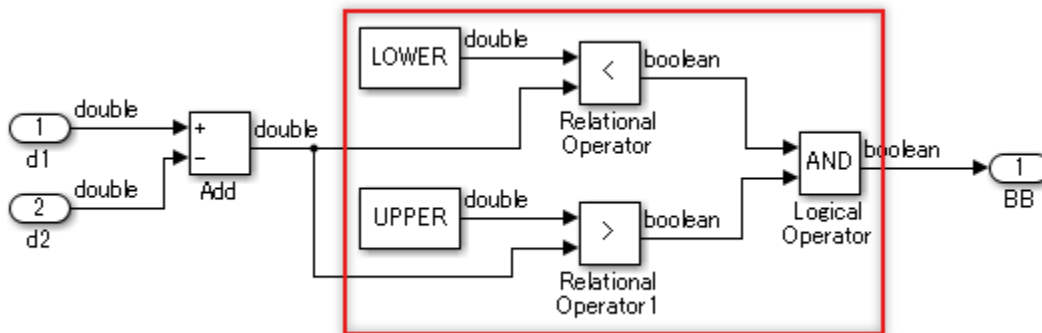
### Sub ID a

Equivalence comparison operators (`==`, `~=`) shall not be used on floating-point data types.

### Custom Parameter

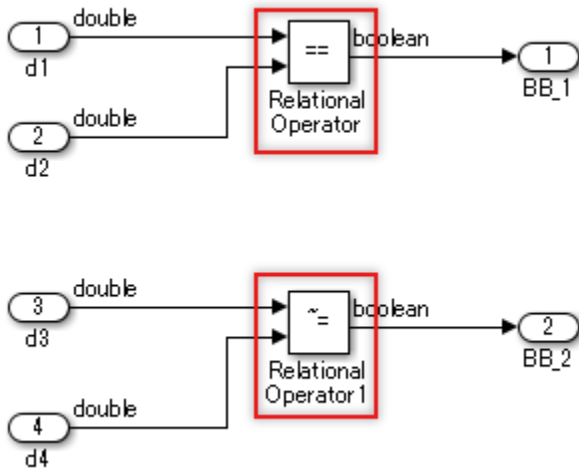
Not Applicable

### Example — Correct



### Example — Incorrect

Uses equivalence comparison operators `==` and `~=` on the floating-point data type.



## Rationale

Sub ID a:

- Due to the characteristics of the floating-point, since the error is included in the value, the result of the equivalence comparison operation may be false when it was expected to be true.

## Verification

Model Advisor check: “Comparing floating point types in Simulink” (Simulink Check)

## Last Changed

R2020a

## See Also

- JMAAB guideline jc\_0800, which is available in *Control Algorithm Modeling Guidelines Using MATLAB, Simulink, and Stateflow* on the MathWorks website.
- “Validate a Floating-Point Embedded Model”

**Introduced in R2020a**

# jc\_0626: Usage of Lookup Table blocks

## Sub ID Recommendations

- NA-MAAB — a, b
- JMAAB — a, b

## MATLAB Versions

All

## Rule

### Sub ID a

The Lookup Table Dynamic block parameter **Lookup Method** shall be set to Interpolation – Use End Values.

#### Custom Parameter

Not Applicable

### Sub ID b

These n-D Lookup Table block parameters shall be set as follows:

- Set **Interpolation Method** to Linear point-slope or Linear Lagrange.
- Set **Extrapolation Method** to Clip.
- Select **Use last table value for inputs at or above last breakpoint**.

#### Custom Parameter

Not Applicable

## Rationale

Sub IDs a, b:

- When an unexpected value is entered for the Lookup Table block, the output is determined by using the extrapolation method and can become an impossible value or cause the Lookup Table output to overflow.

## Verification

Model Advisor check: “Check usage of Lookup Tables” (Simulink Check)

## Last Changed

R2020a

## See Also

- JMAAB guideline jc\_0626, which is available in *Control Algorithm Modeling Guidelines Using MATLAB, Simulink, and Stateflow* on the MathWorks website.
- “Methods for Approximating Function Values”

## Introduced in R2020a

# jc\_0623: Usage of continuous-time Delay blocks and discrete-time Delay blocks

## Sub ID Recommendations

- NA-MAAB — a
- JMAAB — a

## MATLAB Versions

All

## Rule

### Sub ID a

Unit Delay or Delay blocks shall be used in a discrete model or subsystem.

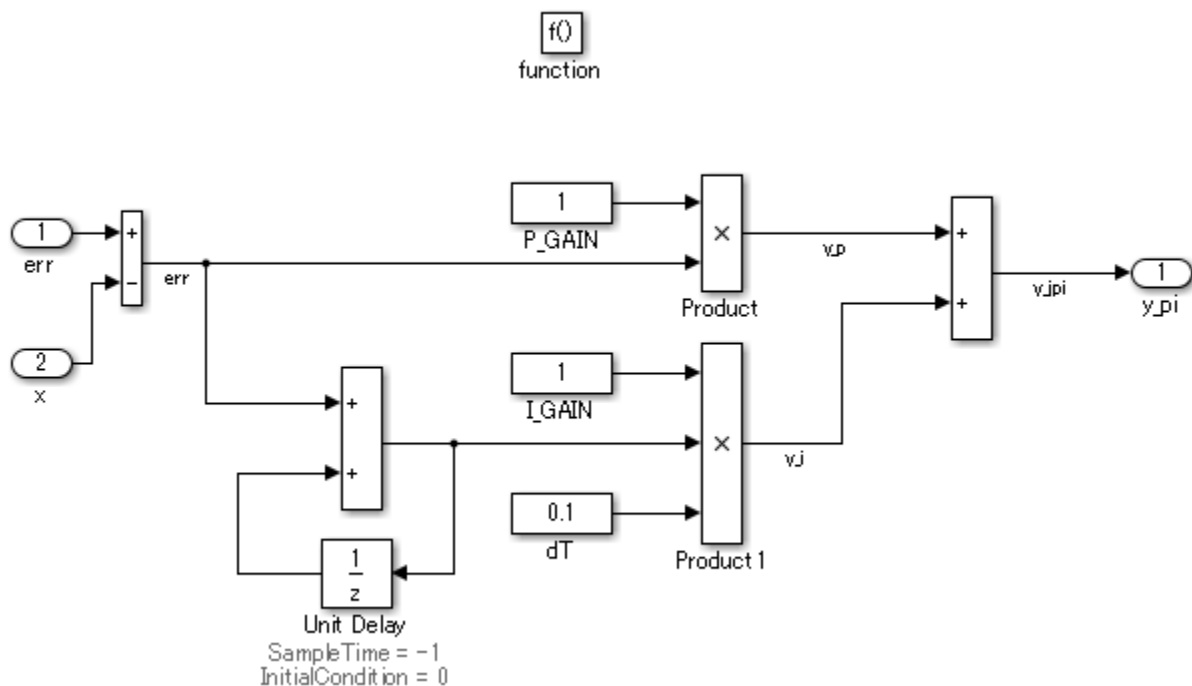
A Memory block shall be used in a continuous type model or subsystem.

### Custom Parameter

Not Applicable

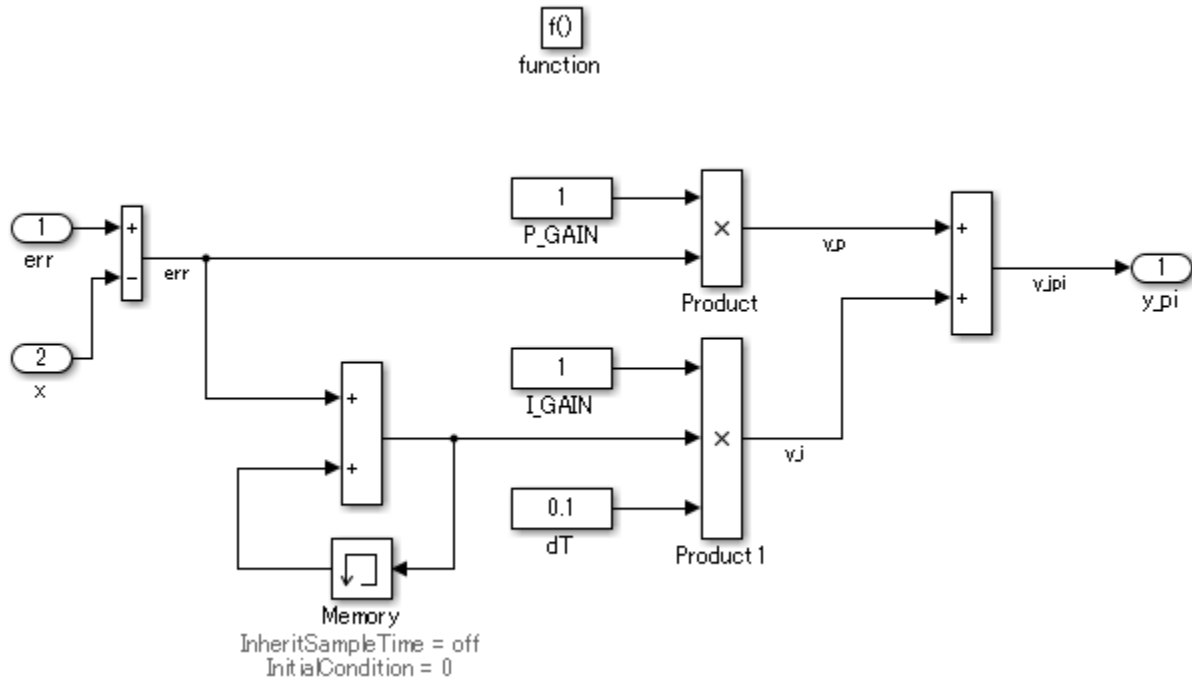
### Example — Correct

A Unit Delay block is used in the discrete type model.



**Example — Incorrect**

A Memory block is used in the discrete type model.

**Rationale**

Sub ID a:

- Adherence to the rule improves readability of the model.

**Verification**

Model Advisor check: “Check usage of Memory and Unit Delay blocks” (Simulink Check)

**Last Changed**

R2020a

**See Also**

- JMAAB guideline jc\_0623, which is available in *Control Algorithm Modeling Guidelines Using MATLAB, Simulink, and Stateflow* on the MathWorks website.
- “Types of Subsystems”
- “Model a Continuous System”
- “Convert Signals Between Continuous Time and Discrete Time”
- “Discrete and Continuous Resettable Subsystems”



**Introduced in R2020a**

## jc\_0624: Usage of Tapped Delay blocks/Delay blocks

### Sub ID Recommendations

- NA-MAAB — No recommendations
- JMAAB — a, b

### MATLAB Versions

All

### Rule

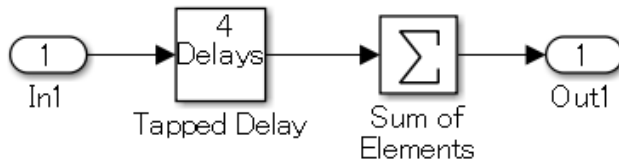
#### Sub ID a

When holding previous past values, Tapped Delay block shall be used to create a vector signal from all held values.

#### Custom Parameter

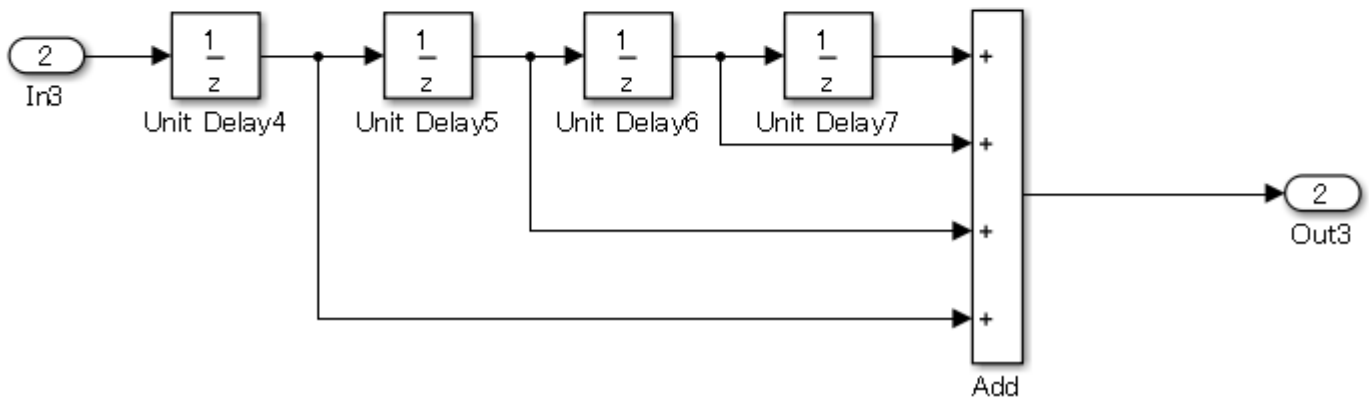
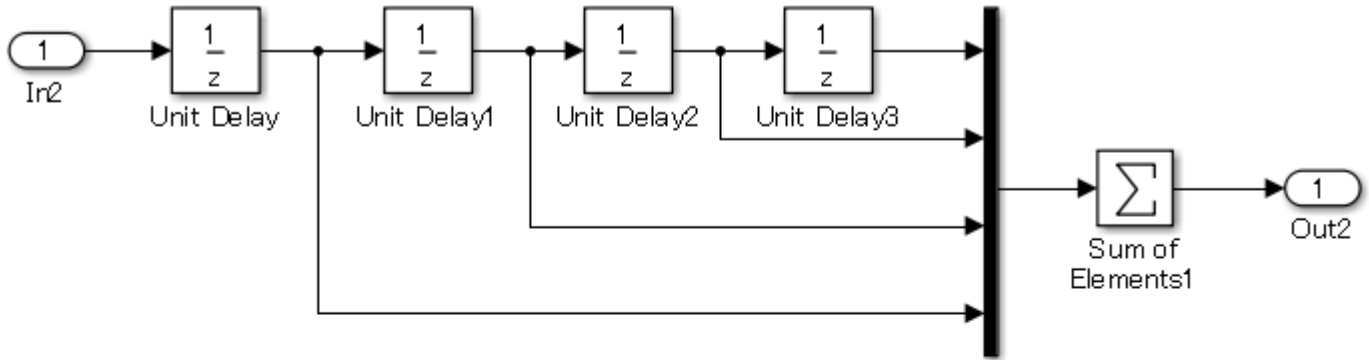
Not Applicable

#### Example — Correct



#### Example — Incorrect

The Tapped Delay block is not used.



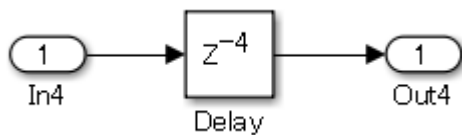
**Sub ID b**

When holding past values, Delay block shall be used to obtain the oldest value only

**Custom Parameter**

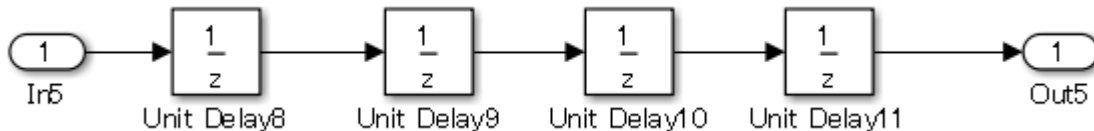
Not Applicable

**Example – Correct**



**Example – Incorrect**

The Delay block is not used.



## Rationale

Sub ID a:

- Tapped Delay is set with arrays that hold past values, which improves code readability to assist code efficiency.

Sub ID b:

- Improves model readability and code efficiency.

## Verification

Model Advisor check: “Check for cascaded Unit Delay blocks” (Simulink Check)

## Last Changed

R2020a

## See Also

- JMAAB guideline jc\_0624, which is available in *Control Algorithm Modeling Guidelines Using MATLAB, Simulink, and Stateflow* on the MathWorks website.
- “Signal Lines”

**Introduced in R2020a**

# jc\_0627: Usage of Discrete-Time Integrator blocks

## Sub ID Recommendations

- NA-MAAB — a
- JMAAB — a, b

## MATLAB Versions

All

## Rule

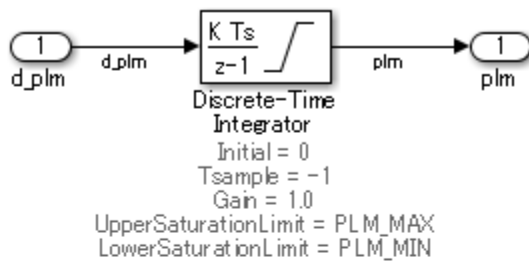
### Sub ID a

Discrete-Time Integrator block parameters **Upper saturation limit** and **Lower saturation limit** shall be defined.

### Custom Parameter

Not Applicable

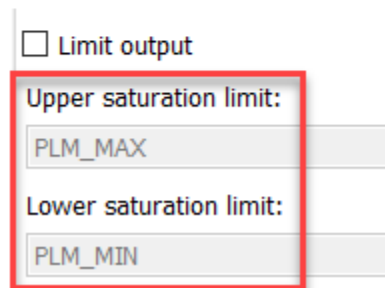
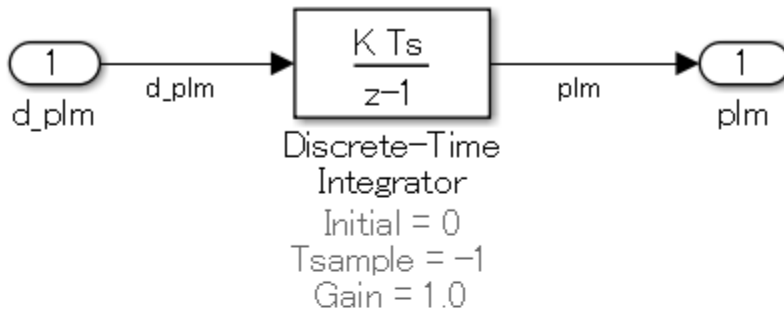
### Example — Correct



Limit output

Upper saturation limit:  
 PLM\_MAX

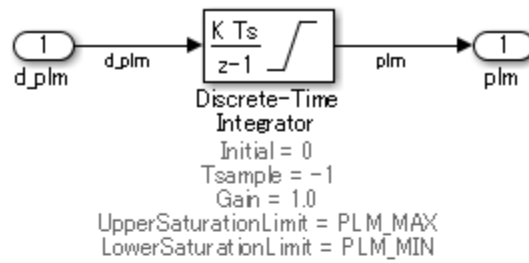
Lower saturation limit:  
 PLM\_MIN

**Example – Incorrect****Sub ID b**

When Discrete-Time Integrator block parameters **Upper saturation limit** and **Lower saturation limit** are defined as Simulink.Parameter, parameter **Data type** shall be set to auto.

**Custom Parameter**

Not Applicable

**Example — Correct**

Simulink.Parameter: PLM\_MAX

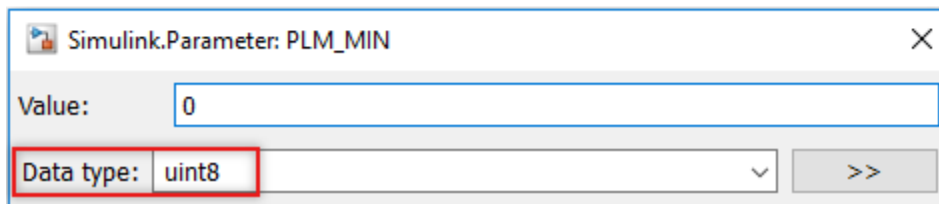
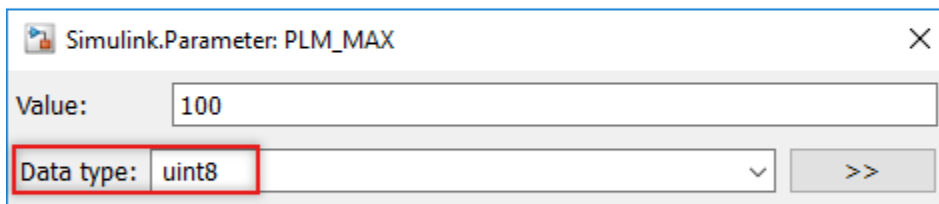
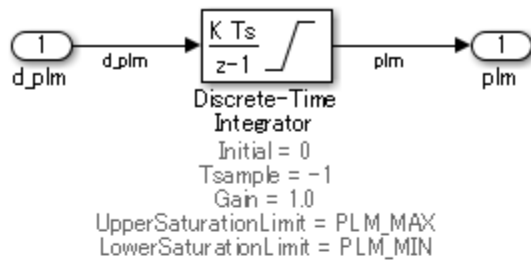
Value:

Data type:  >>

Simulink.Parameter: PLM\_MIN

Value:

Data type:  >>

**Example — Incorrect****Rationale**

Sub ID a:

- Avoids block output overflow and prevents other computation blocks that use the output of this block from producing unexpected results.

Sub ID b:

- Simulation errors occur when **Data type** is set to a value other than auto, single, or double.

**Verification**

Model Advisor check: “Check usage of Discrete-Time Integrator block” (Simulink Check)

**Last Changed**

R2020a

**See Also**

- JMAAB guideline jc\_0627, which is available in *Control Algorithm Modeling Guidelines Using MATLAB, Simulink, and Stateflow* on the MathWorks website.



- `Simulink.Parameter`
- “Simulink.Parameter Property Dialog Box”

**Introduced in R2020a**

## jc\_0628: Usage of Saturation blocks

### Sub ID Recommendations

- NA-MAAB — a
- JMAAB — a

### MATLAB Versions

All

### Rule

#### Sub ID a

Saturation and Saturation Dynamic blocks shall be used to limit physical quantity.

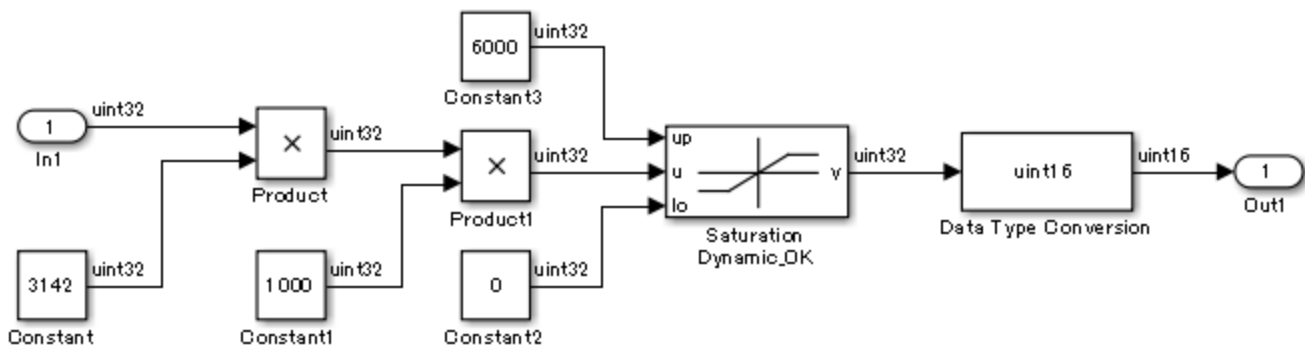
Type conversion shall not be used. Block parameters **Upper limit** and **Lower limit** shall not be set.

#### Custom Parameter

Not Applicable

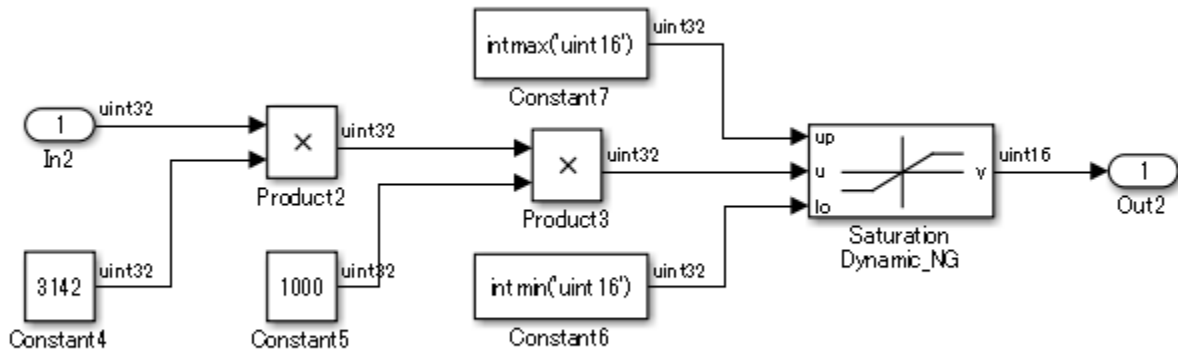
#### Example — Correct

The Saturation Dynamic block is limiting physical quality.



#### Example — Incorrect

The Saturation Dynamic block is not being used to limit physical quantity. Type conversion is being used. The upper and lower limits for the data type maximum and minimum values are set.



## Rationale

Sub ID a:

- Consistent use of Saturation blocks improve maintainability of the model.

## Verification

Model Advisor check: "Check usage of the Saturation blocks" (Simulink Check)

## Last Changed

R2020a

## See Also

- JMAAB guideline jc\_0628, which is available in *Control Algorithm Modeling Guidelines Using MATLAB, Simulink, and Stateflow* on the MathWorks website.

**Introduced in R2020a**

## jc\_0651: Implementing a type conversion

### Sub ID Recommendations

- NA-MAAB — No recommendations
- JMAAB — a

### MATLAB Versions

All

### Rule

#### Sub ID a

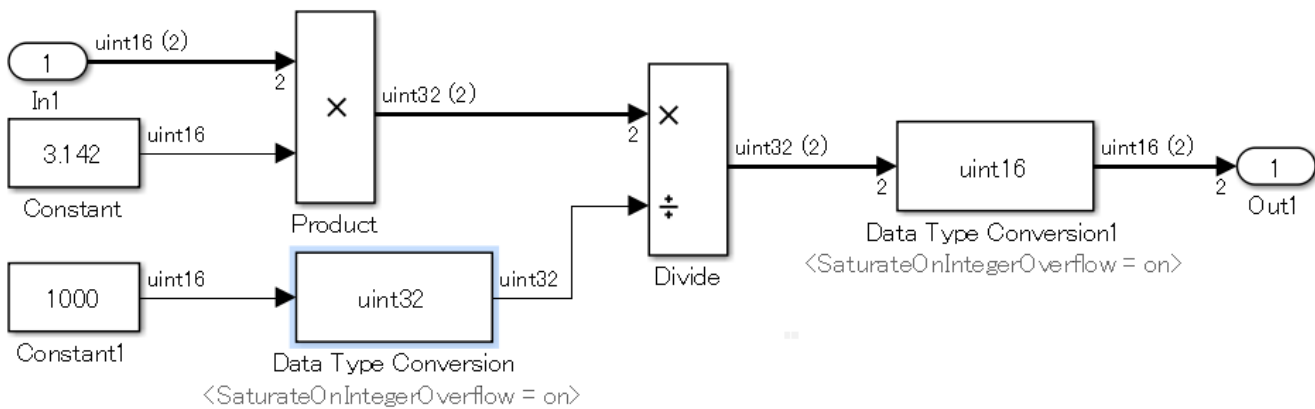
Data Type Conversion block shall be used when changing the data type of the block output signal.

#### Custom Parameter

Not Applicable

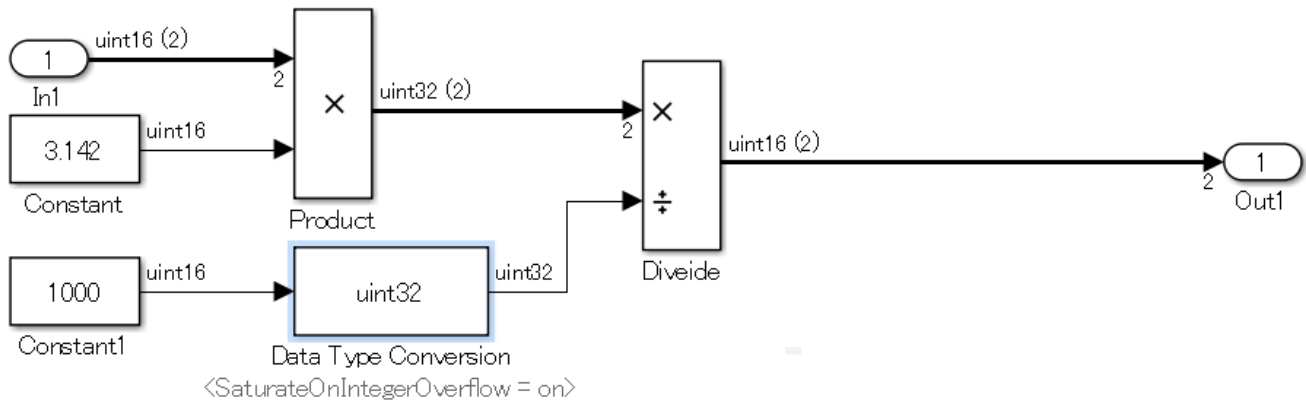
#### Example — Correct

Data Type Conversion block is used to convert the data type of the Divide block output signal.



#### Example — Incorrect

Data Type Conversion block is not used to convert the data type of the [Divide] output signal.



## Rationale

Sub ID a:

- Determining whether there is pointless processing or if something is missing from the design (such as a missing description) is easier when the processing of exceptions (else, default) is explicitly set in the model.

## Verification

Model Advisor check: “Check output data type of operation blocks” (Simulink Check)

## Last Changed

R2020a

## See Also

- JMAAB guideline jc\_0651, which is available in *Control Algorithm Modeling Guidelines Using MATLAB, Simulink, and Stateflow* on the MathWorks website.

**Introduced in R2020a**

# Other Blocks

## db\_0042: Usage of Inport and Outport blocks

### Sub ID Recommendations

- NA-MAAB — a, b
- JMAAB — a, b, c

### MATLAB Versions

All

### Rule

#### Sub ID a

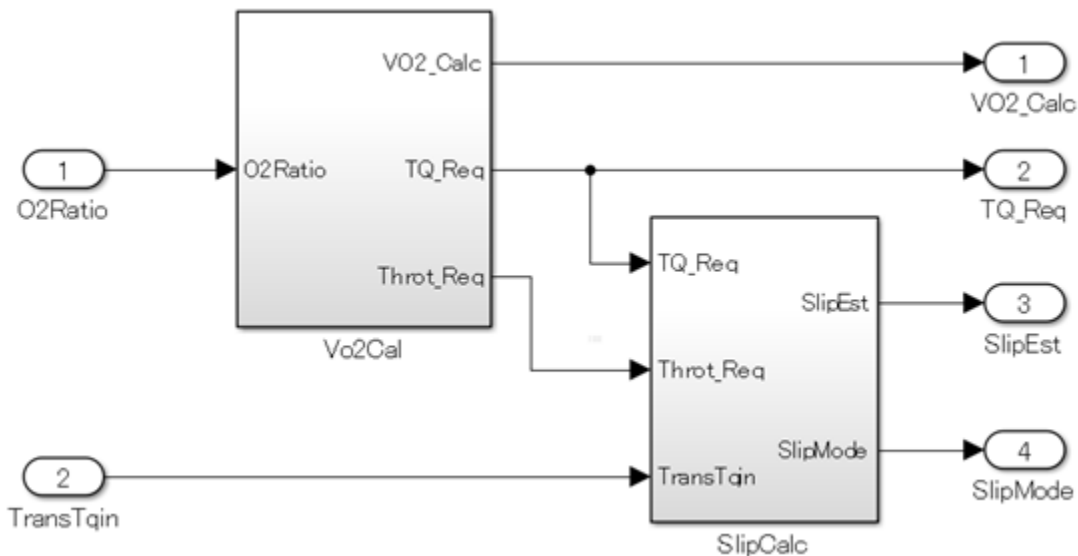
The Inport block shall be positioned on the left side of the diagram, but can be moved to prevent the crossing of signals.

#### Custom Parameter

Not Applicable

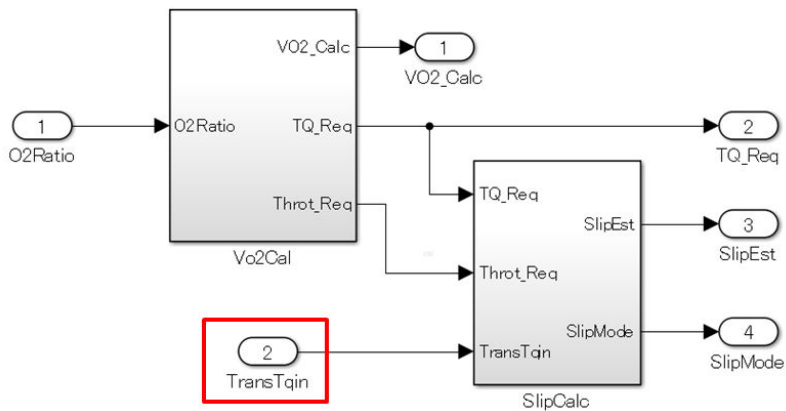
#### Example — Correct

Inport block is positioned on the left side of the diagram.



#### Example — Incorrect

Inport block is not positioned on the left side of the diagram.



**Sub ID b**

The Output block shall be positioned on the right side of the diagram, but can be moved to prevent the crossing of signals.

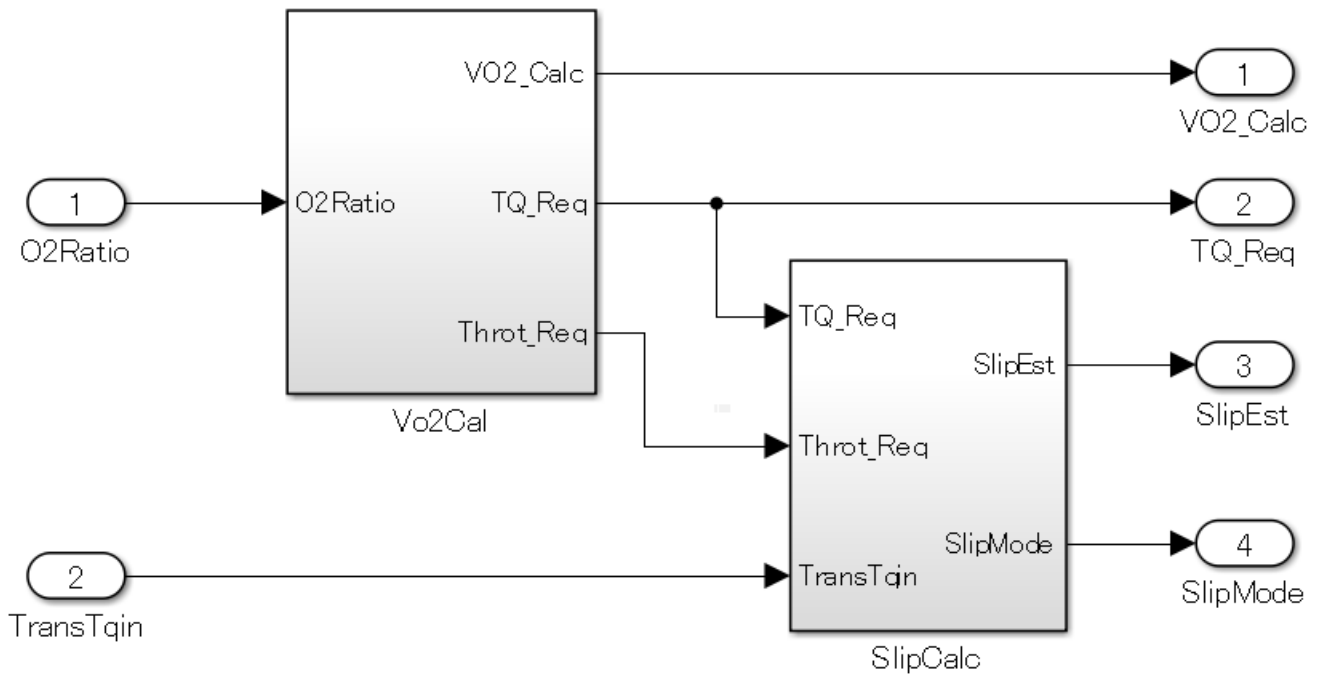
**Custom Parameter**

Not Applicable

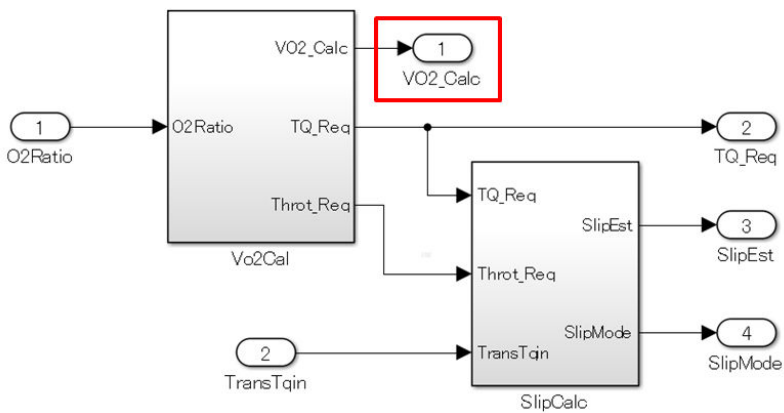
**Example – Correct**

Output block is positioned on the right side of the diagram.



**Example – Incorrect**

Output block is not positioned on the right side of the diagram.

**Sub ID c**

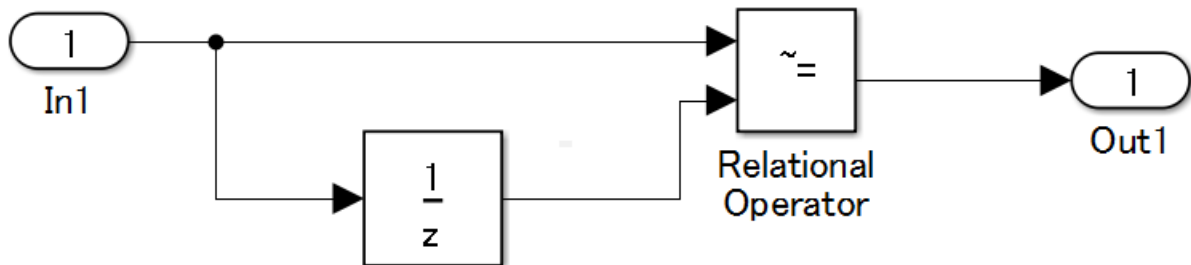
Duplicate Inport blocks shall be prohibited.

**Custom Parameter**

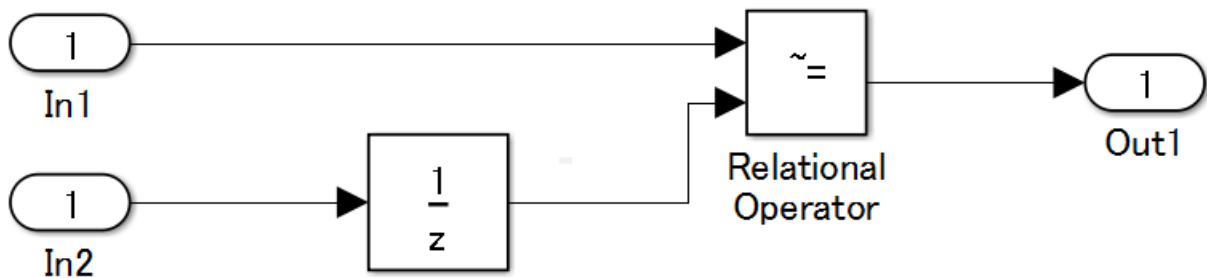
Not Applicable

**Example — Correct**

One Inport block is used.

**Example — Incorrect**

Inport blocks is duplicated.

**Rationale**

Sub IDs a, b, c:

- Defined operation rules improve readability.

**Verification**

Model Advisor check: “Check position of Inport and Outport blocks” (Simulink Check)

**Last Changed**

R2020a

## See Also

- JMAAB guideline db\_0042, which is available in *Control Algorithm Modeling Guidelines Using MATLAB, Simulink, and Stateflow* on the MathWorks website.

**Introduced in R2020a**

## jc\_0081: Inport and Outport block icon display

### Sub ID Recommendations

- NA-MAAB — a
- JMAAB — a

### MATLAB Versions

All

### Rule

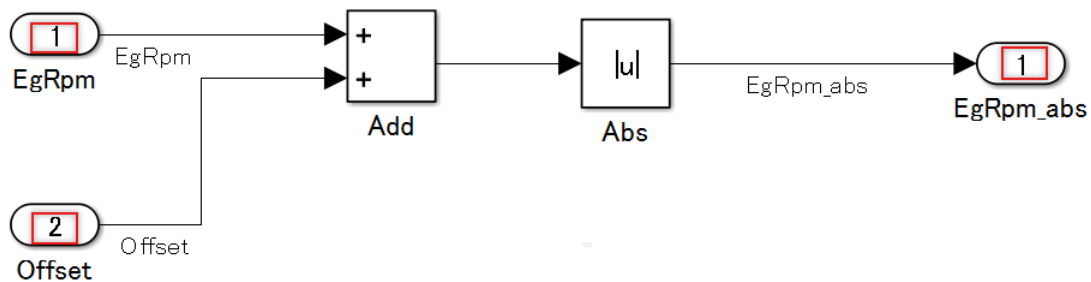
#### Sub ID a

For Inport and Outport blocks, parameter **Icon Display** shall be set to Port number.

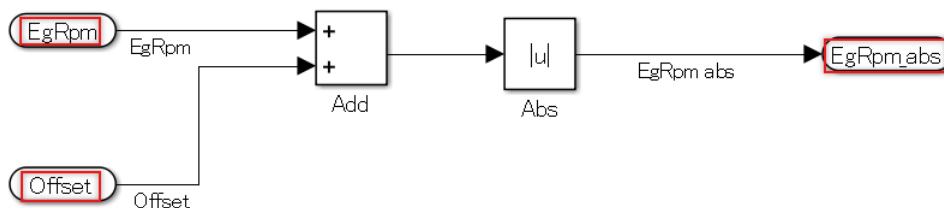
#### Custom Parameter

Not Applicable

#### Example — Correct



#### Example — Incorrect



## Rationale

Sub ID a:

- Improves readability by displaying the port number of Inport and Outport blocks.
- Allows for easy identification of port numbers that are within a subsystem.
- Prevents misconnections to hierarchized subsystems by displaying the block names and making the names of signal lines to the Inport and Outport blocks the same as the block names.

## Verification

Model Advisor check: “Check display for port blocks” (Simulink Check)

## Last Changed

R2020a

## See Also

- JMAAB guideline jc\_0081, which is available in *Control Algorithm Modeling Guidelines Using MATLAB, Simulink, and Stateflow* on the MathWorks website.
- “Set Block Parameter Values”
- “Signal Basics”
- “Explore Simulink Bus Capabilities”

## Introduced in R2020a

## na\_0011: Scope of Goto and From blocks

### Sub ID Recommendations

- NA-MAAB — a
- JMAAB — a

### MATLAB Versions

All

### Rule

#### Sub ID a

Goto block parameter **tag visibility** shall be set to Local.

#### Custom Parameter

Not Applicable

### Rationale

Sub ID a:

- When hierarchies of the Goto block and corresponding From block are different, the connection relationships can be difficult to understand.
- Simulation errors can occur when hierarchies of the Goto block and corresponding From block are different and a virtual subsystem changes to an Atomic subsystem.

### Verification

Model Advisor check: “Check scope of From and Goto blocks” (Simulink Check)

### Last Changed

R2020a

### See Also

- JMAAB guideline na\_0011, which is available in *Control Algorithm Modeling Guidelines Using MATLAB, Simulink, and Stateflow* on the MathWorks website.
- “Block-Specific Parameters”
- “Types of Subsystems”
- “Simulink Subsystem Semantics”

**Introduced in R2020a**

## jc\_0161: Definition of Data Store Memory blocks

### Sub ID Recommendations

- NA-MAAB — No recommendations
- JMAAB — a, b

### MATLAB Versions

All

### Rule

#### Sub ID a

The smallest scope level shall be used to define the Data Store Memory block.

#### Custom Parameter

Not Applicable

#### Sub ID b

Only data required for execution and code generation shall be defined in the Data Store Memory block.

#### Custom Parameter

Not Applicable

### Rationale

Sub ID a:

- Readability improves when usage is limited.

Sub ID b:

- Unused data can affect maintenance and operability.

### Verification

Model Advisor check: “Check for usage of Data Store Memory blocks” (Simulink Check)

### Last Changed

R2020a



## See Also

- JMAAB guideline jc\_0161, which is available in *Control Algorithm Modeling Guidelines Using MATLAB, Simulink, and Stateflow* on the MathWorks website.
- “Data Store Basics”

## Introduced in R2020a

## jc\_0141: Usage of the Switch blocks

### Sub ID Recommendations

- NA-MAAB — a
- JMAAB — a

### MATLAB Versions

All

### Rule

#### Sub ID a

The second Switch block input condition shall be a logical type. Switchblock parameter **Criteria for passing first input** shall be set to `u2~=0`.

#### Custom Parameter

Not Applicable

### Rationale

Sub ID a:

- It is easier to understand specifications when the configuration is applied by using Simulink blocks rather than by writing operation expressions in blocks.

### Verification

Model Advisor check: "Check usage of Switch blocks" (Simulink Check)

### Last Changed

R2020a

### See Also

- JMAAB guideline jc\_0141, which is available in *Control Algorithm Modeling Guidelines Using MATLAB, Simulink, and Stateflow* on the MathWorks website.

### Introduced in R2020a

# jc\_0650: Block input/output data type with switching function

## Sub ID Recommendations

- NA-MAAB — a
- JMAAB — a

## MATLAB Versions

All

## Rule

### Sub ID a

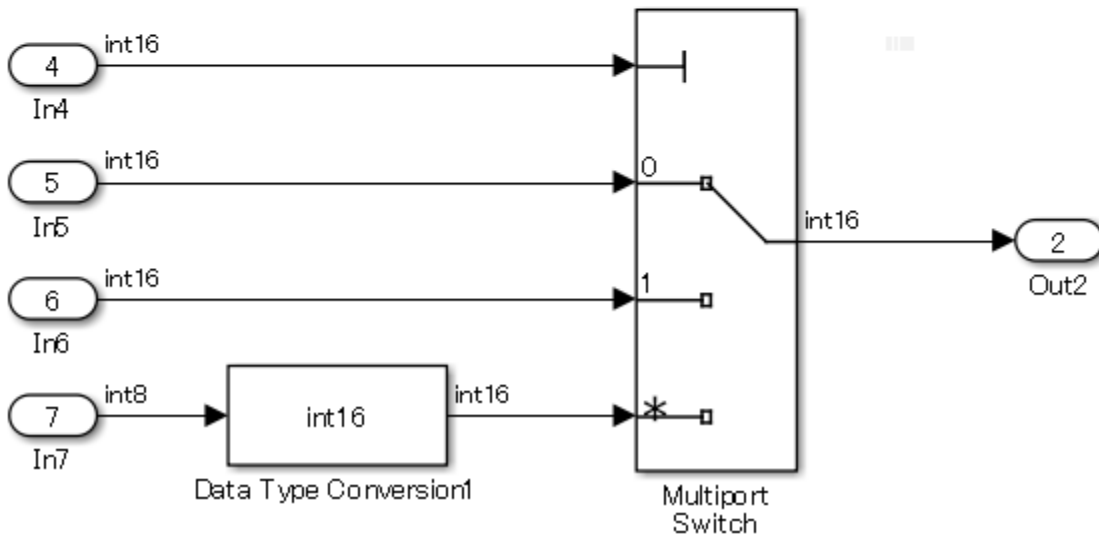
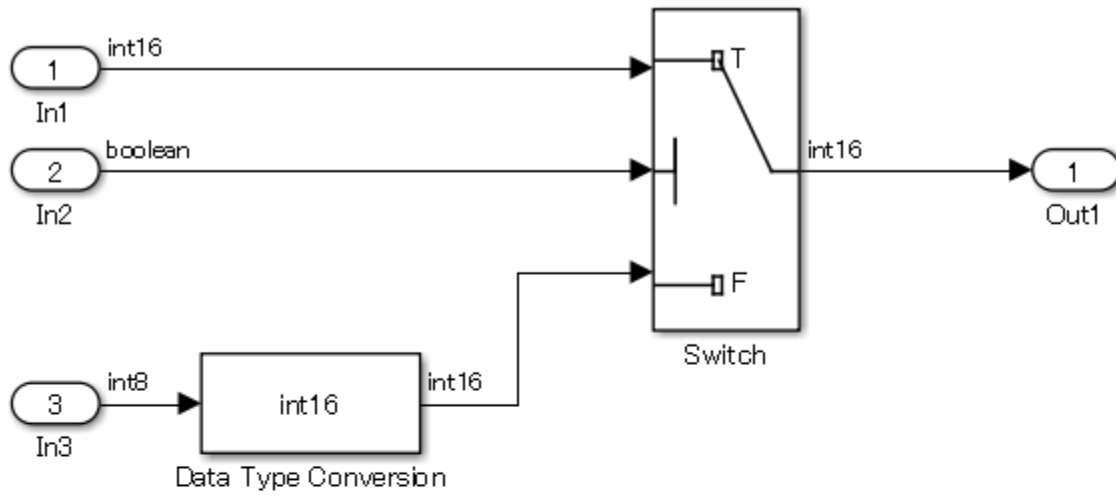
For blocks with switching functions (Switch, Multiport Switch, and Index Vector), the same data type shall be used for data ports and output ports.

### Custom Parameter

Not Applicable

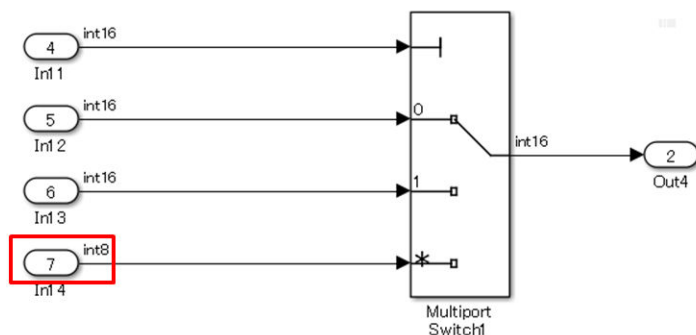
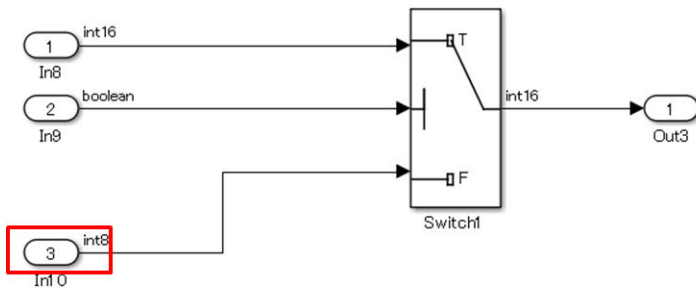
### Example — Correct

The data type for the data port and output port is the same.



**Example – Incorrect**

The data port and output port have different data types.



## Rationale

Sub ID a:

- Prevents implicit data conversion.

## Verification

Model Advisor check: "Check input and output datatype for Switch blocks" (Simulink Check)

## Last Changed

R2020a

## See Also

- JMAAB guideline jc\_0650, which is available in *Control Algorithm Modeling Guidelines Using MATLAB, Simulink, and Stateflow* on the MathWorks website.

**Introduced in R2020a**

## jc\_0630: Usage of Multiport Switch blocks

### Sub ID Recommendations

- NA-MAAB — a, c
- JMAAB — a, b, c

### MATLAB Versions

All

### Rule

#### Sub ID a

Multiport Switch block parameter **Number of data ports** shall be two or more.

#### Custom Parameter

Not Applicable

#### Sub ID b

The input to the Multiport Switch control port shall be an unsigned integer.

#### Custom Parameter

Not Applicable

#### Sub ID c

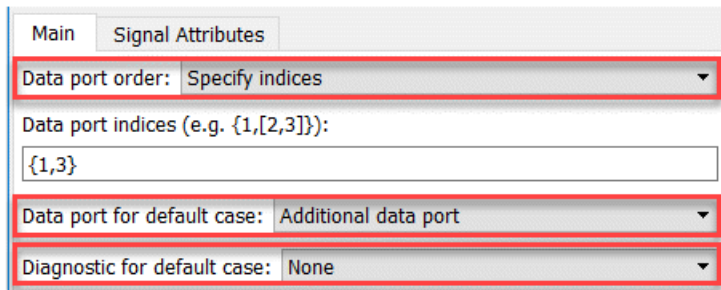
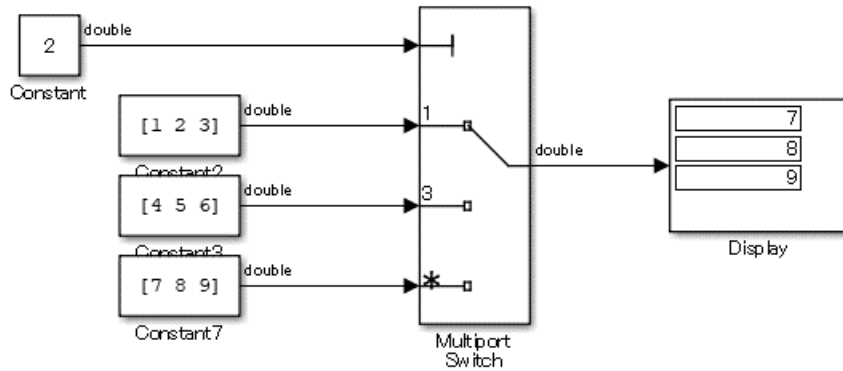
When Multiport Switch block parameter **Data port order** is set to `Specify indices`, these block parameters shall be set as follows:

- Set **Data port for default case** to `Additional data port`.
- Set **Diagnostic for default case** to `None`.

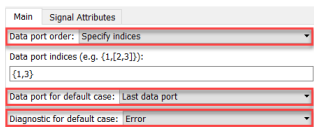
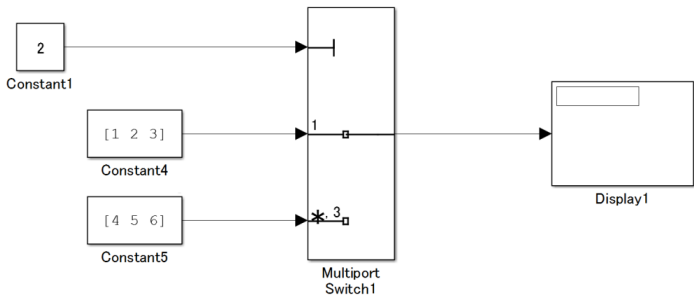
#### Custom Parameter

Not Applicable

**Example — Correct**



**Example — Incorrect**



**Rationale**

Sub ID a:

- Unintended output can occur when there is only one data port because the block changes to extract scalars from vectors.

Sub ID b:

- The control port is an input range that expects an integer value of zero or greater. When a signed or non-integer signal is connected to the control port, it can appear as a misconnection.

- There is a possibility of data ports being unintentionally selected when negative or non-integer values are input.

Sub ID c:

- When block parameter **Data port order** is set to `Specify indices`, a value that inputs to the Multiport Switch block, other than the index specified for the control port, is treated the same as the last value of the specified index. As a result, an unintended data port can be selected.

## Verification

Model Advisor check: “Check settings for data ports in Multiport Switch blocks” (Simulink Check)

## Last Changed

R2020a

## See Also

- JMAAB guideline `jc_0630`, which is available in *Control Algorithm Modeling Guidelines Using MATLAB, Simulink, and Stateflow* on the MathWorks website.

**Introduced in R2020a**



# na\_0020: Number of inputs to variant subsystems

## Sub ID Recommendations

- NA-MAAB — b
- JMAAB — a, b

## MATLAB Versions

All

## Rule

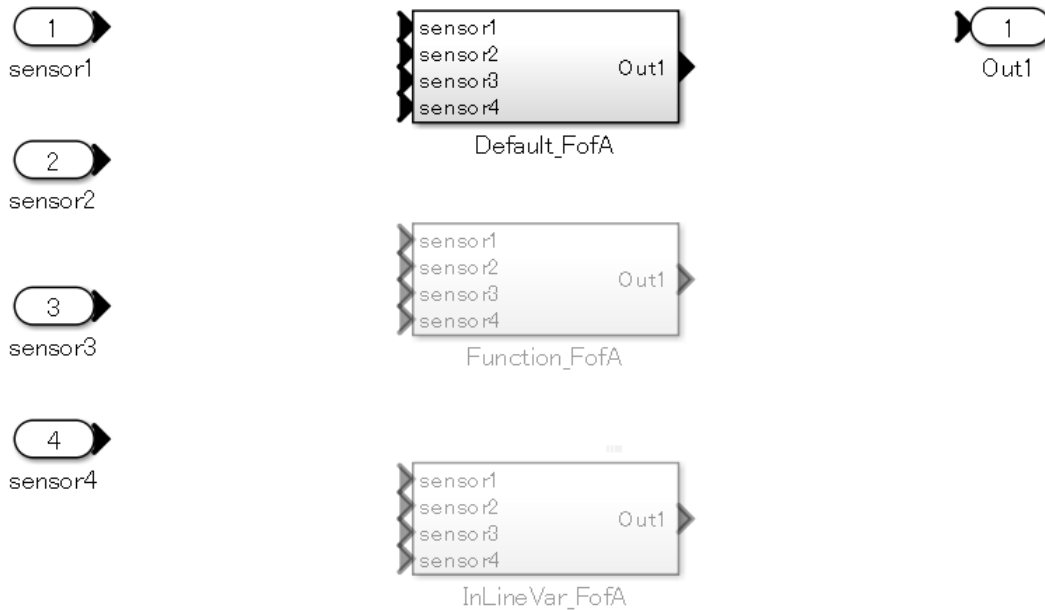
### Sub ID a

The number of inputs/outputs for a Variant Subsystem block and its child subsystem or model reference shall be the same.

### Custom Parameter

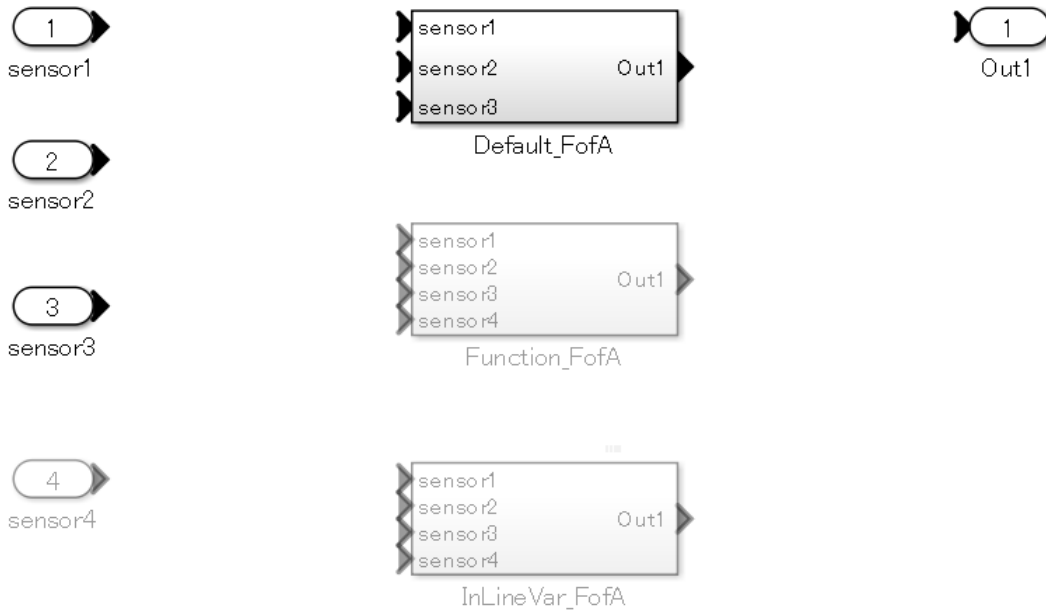
Not Applicable

### Example — Correct



### Example — Incorrect

The number of inputs to the child subsystem is different.



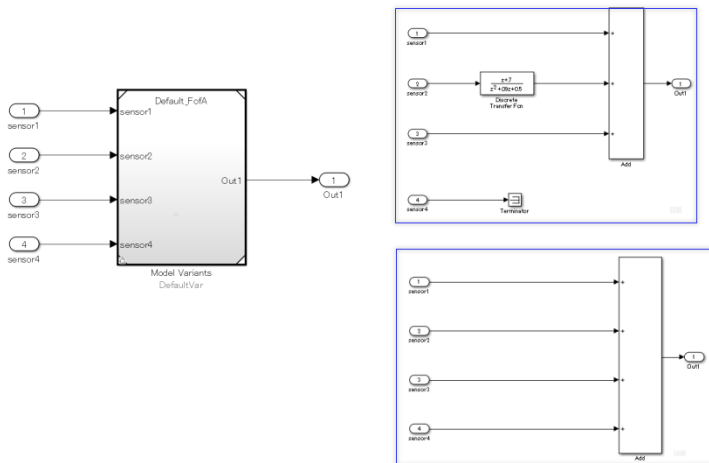
**Sub ID b**

The number of inputs/outputs for a Variant Model block shall be the same as its referenced model.

**Custom Parameter**

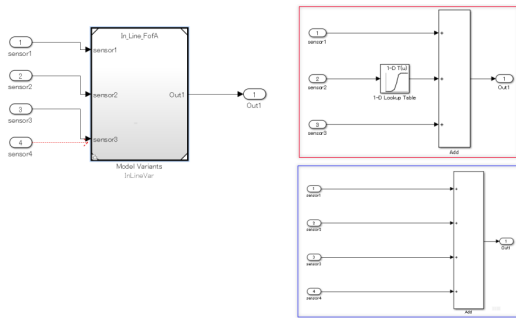
Not Applicable

**Example — Correct**



**Example — Incorrect**

The number of inputs to the referenced model is different than the inputs to the Variant Model block.



## Rationale

Sub IDs a, b:

- Unconnected signals can be unintentionally overlooked when the number of inputs/outputs is different.

## Verification

Model Advisor check: “Check for missing ports in Variant Subsystems” (Simulink Check)

## Last Changed

R2020a

## See Also

- JMAAB guideline na\_0020, which is available in *Control Algorithm Modeling Guidelines Using MATLAB, Simulink, and Stateflow* on the MathWorks website.
- “Types of Subsystems”
- “Model Reference Basics”
- “Create a Simple Variant Model”

## Introduced in R2020a

## na\_0036: Default variant

### Sub ID Recommendations

- NA-MAAB — a, b
- JMAAB — a, b

### MATLAB Versions

All

### Rule

#### Sub ID a

Variant subsystems shall be configured so that one subsystem is always selected. This is achieved by using one of these methods:

- Use the default variant for the variant.
- Define conditions that exhaustively cover all possible values of the conditional variables. For example, define conditions for true and false values of a Boolean.

#### Custom Parameter

Not Applicable

#### Example — Correct

A default variant is used.

Variant choices (list of child subsystems or model blocks)

|  | Name (read-only) | Variant control | Condition (read-only) |
|--|------------------|-----------------|-----------------------|
|  | Default_FofA     | (default) ▾     | (N/A)                 |
|  | Function_FofA    | functionVar ▾   | FUNC==1               |
|  | In_Line_FofA     | inLineVar ▾     | FUNC==2               |

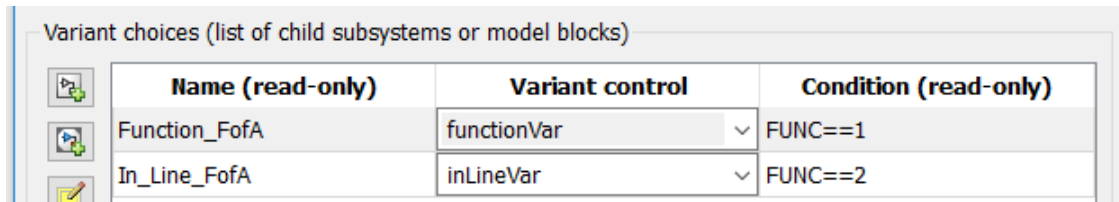
FUNC is a logical type.

Variant choices (list of child subsystems or model blocks)

|  | Name (read-only) | Variant control | Condition (read-only) |
|--|------------------|-----------------|-----------------------|
|  | Function_FofA    | functionVar ▾   | FUNC==1               |
|  | In_Line_FofA     | inLineVar ▾     | FUNC==0               |

**Example — Incorrect**

An active subsystem will not exist when FUNC is not 1 or 2.



| Variant choices (list of child subsystems or model blocks) |                 |                       |
|--|-----------------|-----------------------|
| Name (read-only)   | Variant control | Condition (read-only) |
| Function_FofA  | functionVar     | FUNC==1               |
| In_Line_FofA   | inLineVar       | FUNC==2               |

**Sub ID b**

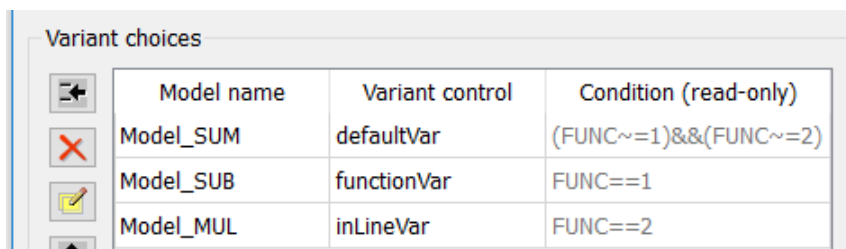
Model variant conditions shall be set so all values that can be applied to conditional variable signals are configured so one subsystem is always selected. For example, a condition is prepared for the variable signal value being true, as well as false.

**Custom Parameter**

Not Applicable

**Example — Correct**

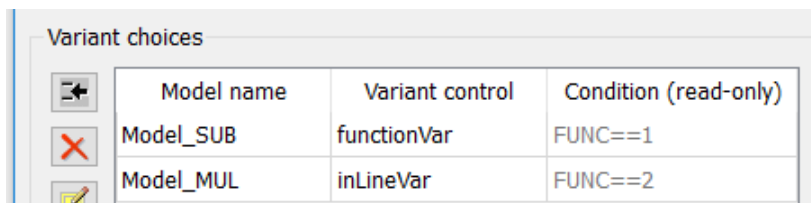
The condition is set so that all values for the conditional variable are covered.



| Variant choices |                 |                       |
|-----------------|-----------------|-----------------------|
| Model name      | Variant control | Condition (read-only) |
| Model_SUM       | defaultVar      | (FUNC~1)&&(FUNC~2)    |
| Model_SUB       | functionVar     | FUNC==1               |
| Model_MUL       | inLineVar       | FUNC==2               |

**Example — Incorrect**

An active subsystem will not exist when FUNC is not 1 or 2.



| Variant choices |                 |                       |
|-----------------|-----------------|-----------------------|
| Model name      | Variant control | Condition (read-only) |
| Model_SUB       | functionVar     | FUNC==1               |
| Model_MUL       | inLineVar       | FUNC==2               |

**Rationale**

Sub IDs a, b:

- Prevents the omission of conditions.
- There may not be an active subsystem when conditions are omitted.

## Verification

Model Advisor check: “Check use of default variants” (Simulink Check)

## Last Changed

R2020a

## See Also

- JMAAB guideline na\_0036, which is available in *Control Algorithm Modeling Guidelines Using MATLAB, Simulink, and Stateflow* on the MathWorks website.
- “Variant Subsystems”
- “Propagate Variant Conditions from Variant Source Blocks to Subsystem Blocks”

## Introduced in R2020a

# na\_0037: Use of single variable for variant condition

## Sub ID Recommendations

- NA-MAAB — a
- JMAAB — a

## MATLAB Versions

All

## Rule

### Sub ID a

Variant conditions shall be used to prohibit compound conditions that are formed from multiple variables.

### Exception

Conditional expressions that are formed from multiple variables can be used when using default variants.

### Custom Parameter

Not Applicable

### Example — Correct

The variant condition is set by a single condition that is formed from multiple variables.

The usage of enumerated type variables is recommended in a condition equation. This example uses numerical values to improve readability.

| Name              | Submodel Configuration | Variant Control | Condition              |
|-------------------|------------------------|-----------------|------------------------|
| na0037a_OK        |                        |                 |                        |
| Variant Subsystem |                        |                 |                        |
| Default_FofA      |                        | DefaultVar      | (INLINE==0)&&(FUNC==0) |
| Function_FofA     |                        | FunctionVar     | FUNC==1                |
| InLineVar_FofA    |                        | InLineVar       | INLINE==1              |

### Example — Incorrect

The variant condition is set by a compound condition that is formed from multiple variables.

| Name              | Submodel Configuration | Variant Control | Condition  |
|-------------------|------------------------|-----------------|--|
| na0037a_NG        |                        |                 |  |
| Variant Subsystem |                        |                 |  |
| AutoTrans         |                        | autoTrans       | (INLINE==0)&&(transType==5)                                    |
| Default_4speed    |                        | defaultTrans    | ((((INLINE==0)&&(transType==3))==0)&&(FUNC==0)&&(transType~=2) |
| ManualTrans       |                        | manualTrans     | (FUNC==1)  ((transType==2)                                     |

## Rationale

Sub ID a:

- Complicates the conditions, which makes it difficult to determine which subsystem will become active. This can result in conditions being omitted.
- When conditions are omitted, there is a risk that there may not be an active subsystem.

## Verification

Model Advisor check: “Check use of single variable variant conditionals” (Simulink Check)

## Last Changed

R2020a

## See Also

- JMAAB guideline na\_0037, which is available in *Control Algorithm Modeling Guidelines Using MATLAB, Simulink, and Stateflow* on the MathWorks website.
- “What Are Variants and When to Use Them”
- “Introduction to Variant Controls”

**Introduced in R2020a**



# Stateflow

---

- “Stateflow Blocks / Data / Events” on page 4-2
- “Stateflow Diagram” on page 4-29
- “Conditional Transition / Action” on page 4-82
- “Label Description” on page 4-143
- “Miscellaneous” on page 4-169

## **Stateflow Blocks / Data / Events**

# db\_0122: Stateflow and Simulink interface signals and parameters

## Sub ID Recommendations

- NA-MAAB — a
- JMAAB — a

## MATLAB Versions

All

## Rule

### Sub ID a

Chart block parameter **Use Strong Data Typing with Simulink I/O** shall be selected so that strong data typing between a Stateflow chart and Simulink is permitted.

---

**Note** **Use Strong Data Typing with Simulink I/O** is available only when Chart block property **Action Language** is set to C.

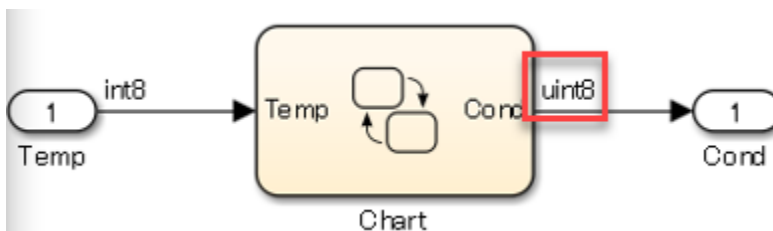
---

### Custom Parameter

Not Applicable

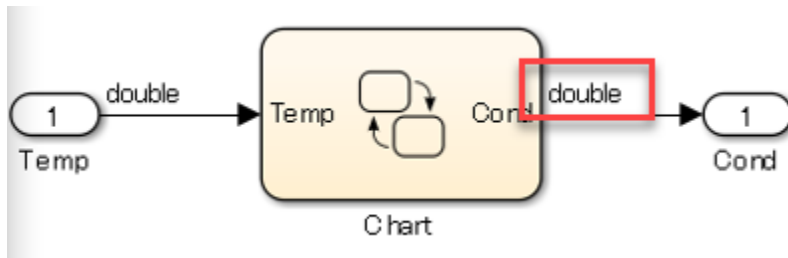
### Example — Correct

Parameter **Use Strong Data Typing with Simulink I/O** is selected, so the input and output is set to uint8 type.



### Example — Incorrect

Parameter **Use Strong Data Typing with Simulink I/O** is not selected, so the input and output is set to double type.



## Rationale

Sub ID a:

- When parameter **Use Strong Data Typing with Simulink I/O** is not selected, the Simulink signal data type that can input and output to a Stateflow Chart is set to **double** type:
  - As a result, type conversion is required prior to input and after output, which increases the number of blocks and decreases readability.
  - However, input data of any type in a Stateflow Chart can connect directly with that signal. When these two signals have different data types, an implicit data type conversion occurs. By selecting the parameter, the implicit data type conversion does not take place and a data type inconsistency error is generated. This prevents misunderstandings due to differences in data type, thus improving readability.

## Verification

Model Advisor check: “Check for Strong Data Typing with Simulink I/O” (Simulink Check)

## Last Changed

R2020a

## See Also

- JMAAB guideline db\_0122, which is available in *Control Algorithm Modeling Guidelines Using MATLAB, Simulink, and Stateflow* on the MathWorks website.
- Chart
- “Strong Data Typing with Simulink Inputs and Outputs” (Stateflow)
- “Differences Between MATLAB and C as Action Language Syntax” (Stateflow)

**Introduced in R2020a**

# db\_0123: Stateflow port names

## Sub ID Recommendations

- NA-MAAB — a
- JMAAB — Not supported

## MATLAB Versions

All

## Rule

### Sub ID a

The name of a Stateflow input/output shall be the same as the corresponding signal.

### Exception

Reusable Stateflow blocks can have different port names.

### Custom Parameter

Not Applicable

## Rationale

Sub ID a:

- Improves readability.
- Code generation may not be possible.

## Verification

Model Advisor check: “Check for names of Stateflow ports and associated signals” (Simulink Check)

## Last Changed

R2020a

## See Also

- “Set Data Properties” (Stateflow)
- “Reusable Components in Charts” (Stateflow)

## Introduced in R2020a

## db\_0125: Stateflow local data

### Sub ID Recommendations

- NA-MAAB — a, b, c, d
- JMAAB — a, b, c, d

### MATLAB Versions

All

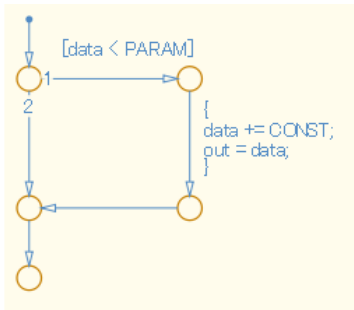
### Rule

#### Sub ID a

Data objects shall not be defined with Scope set to Local at the machine level.

#### Custom Parameter

Not Applicable

**Example — Correct**

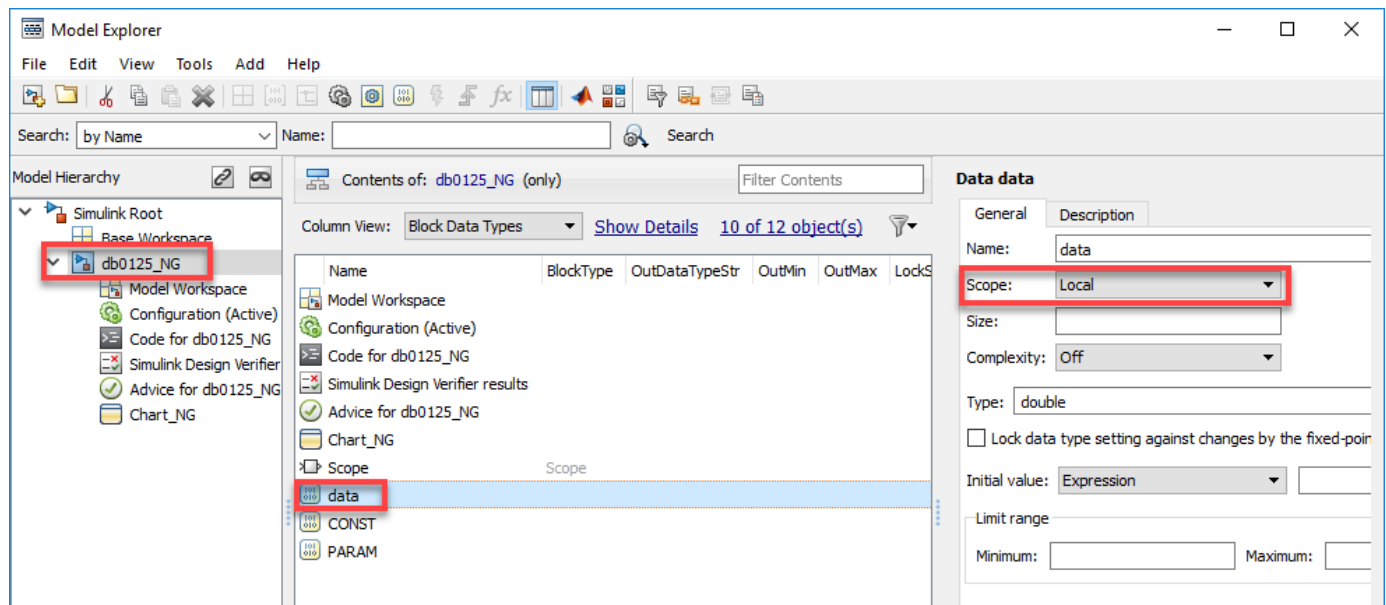
The screenshot shows the Simulink Model Explorer interface. The Model Hierarchy on the left shows the project structure, with 'Chart\_OK' selected. The main pane displays the contents of 'db0125\_OK/Chart\_OK' in Stateflow column view. A table lists the objects:

| Name  | Scope     | Port | Resolve Signal           | Data Type | Size | Initial Value |
|-------|-----------|------|--------------------------|-----------|------|---------------|
| data  | Local     |      | <input type="checkbox"/> | double    |      |               |
| CONST | Constant  |      | <input type="checkbox"/> | double    |      | 0.2           |
| PARAM | Parameter |      | <input type="checkbox"/> | double    |      |               |
| out   | Output    | 1    | <input type="checkbox"/> | double    |      |               |

The 'Scope' column for the 'data' object is highlighted with a red box. On the right, the 'Data data' configuration panel is shown, with the 'Scope' dropdown menu set to 'Local', also highlighted with a red box.

**Example — Incorrect**

Scope has set Local local data at the machine level.



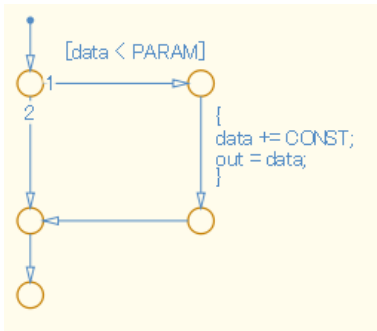
**Sub ID b**

Data objects shall not be defined with Scope set to Constant at the machine level.

**Custom Parameter**

Not Applicable



**Example — Correct**

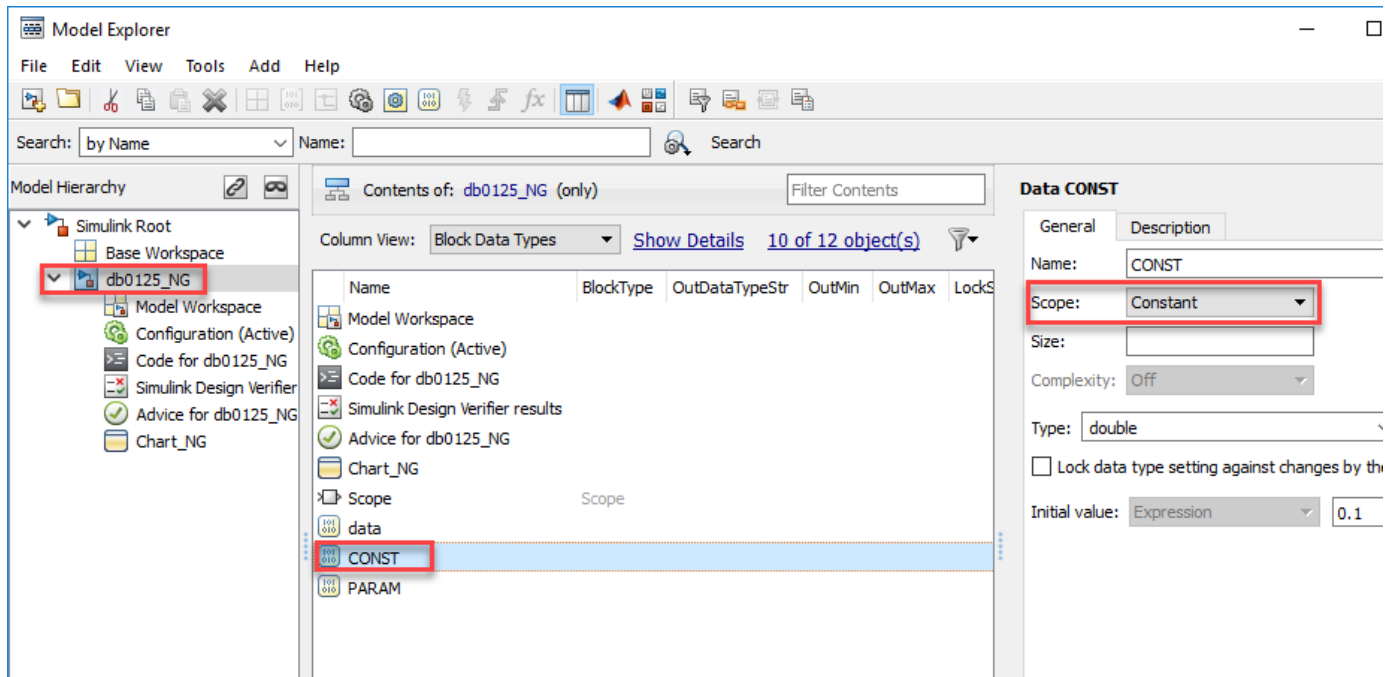
The screenshot shows the Simulink Model Explorer interface. The Model Hierarchy on the left shows the path `db0125_OK > Chart_OK`. The main pane displays the contents of the `Chart_OK` state in Stateflow column view. The table below summarizes the variables:

| Name  | Scope     | Port | Resolve Signal           | DataType | Size | Initial Value |
|-------|-----------|------|--------------------------|----------|------|---------------|
| data  | Local     |      | <input type="checkbox"/> | double   |      |               |
| CONST | Constant  |      | <input type="checkbox"/> | double   |      | 0.2           |
| PARAM | Parameter |      | <input type="checkbox"/> | double   |      |               |
| out   | Output    | 1    | <input type="checkbox"/> | double   |      |               |

The right-hand pane shows the properties for the `CONST` variable. The `Scope` is set to `Constant`, which is highlighted with a red box. Other properties include `Name: CONST`, `Size:` (empty), `Complexity: Off`, `Type: double`, and `Initial value: Expression 0.2`.

**Example — Incorrect**

Scope has set Constant local data at the machine level.

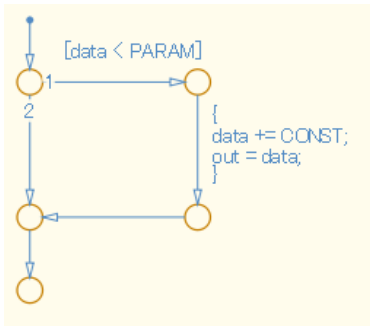


**Sub ID c**

Data objects shall not be defined with Scope set to Parameter at the machine level.

**Custom Parameter**

Not Applicable

**Example — Correct**

Model Explorer

File Edit View Tools Add Help

Search: by Name Name: Search

Model Hierarchy

- Simulink Root
  - Base Workspace
  - db0125\_OK
    - Model Workspace
    - Configuration (Active)
    - Code for db0125\_OK
    - Simulink Design Verifier
    - Advice for db0125\_OK
    - Chart\_OK

Contents of: db0125\_OK/Chart\_OK (only) Filter Contents

Column View: Stateflow Show Details 4 of 15 object(s)

| Name  | Scope     | Port | Resolve Signal           | DataType | Size | Initial Value |
|-------|-----------|------|--------------------------|----------|------|---------------|
| data  | Local     |      | <input type="checkbox"/> | double   |      |               |
| CONST | Constant  |      |                          | double   |      | 0.2           |
| PARAM | Parameter |      |                          | double   |      |               |
| out   | Output    | 1    | <input type="checkbox"/> | double   |      |               |

**Data PARAM**

General Description

Name: PARAM

Scope: Parameter  Tunable

Size:

Complexity: Off

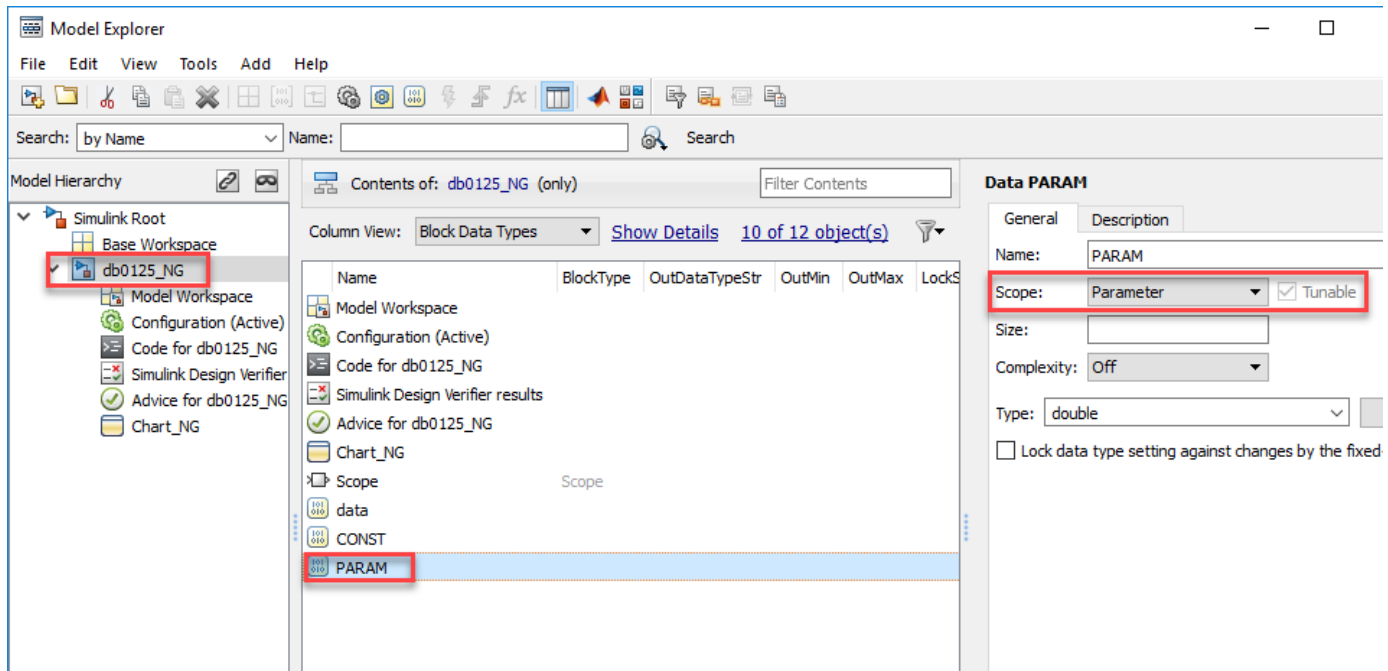
Type: double

Lock data type setting against changes by the fix

[Add to watch window](#)

**Example — Incorrect**

Scope has set Parameter local data at the machine level.



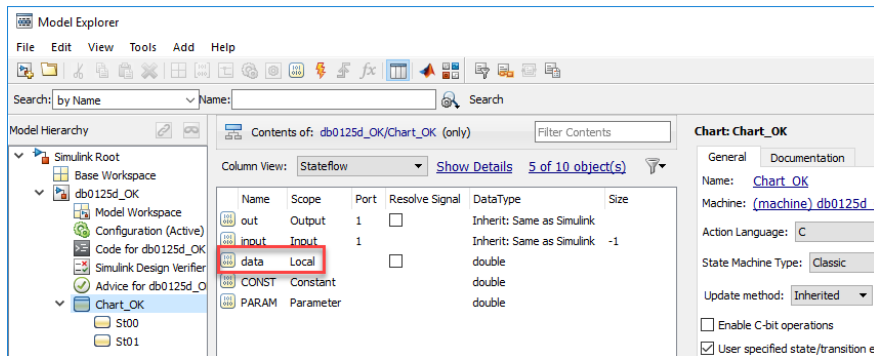
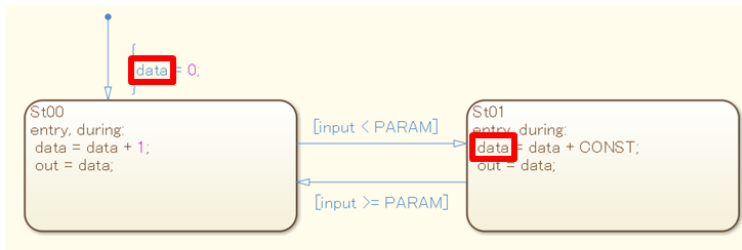
**Sub ID d**

A Stateflow block with parent-child relationships shall not include local data with the same name.

**Custom Parameter**

Not Applicable

**Example – Correct**



### Example — Incorrect

A Stateflow block with parent-child relationships has local data with the same name.

The screenshot shows the Simulink Model Explorer interface. The Model Hierarchy on the left shows the following structure:

- Simulink Root
  - Base Workspace
  - db0125d\_NG\*
    - Model Workspace
    - Configuration (Active)
    - Code for db0125d\_NG
    - Simulink Design Verifier
    - Advice for db0125d\_NG
    - Chart\_NG
      - St01
      - St00

The main pane shows the contents of the selected block: db0125d\_NG/Chart\_NG (only). The Column View is set to Stateflow, showing 5 of 10 object(s). The following table represents the data objects:

| Name  | Scope     | Port | Resolve Signal           | Data Type                 | Size |
|-------|-----------|------|--------------------------|---------------------------|------|
| out   | Output    | 1    | <input type="checkbox"/> | Inherit: Same as Simulink |      |
| input | Input     | 1    | <input type="checkbox"/> | Inherit: Same as Simulink | -1   |
| data  | Local     |      | <input type="checkbox"/> | double                    |      |
| CONST | Constant  |      | <input type="checkbox"/> | double                    |      |
| PARAM | Parameter |      | <input type="checkbox"/> | double                    |      |

The 'data' row is highlighted with a red box.

The screenshot shows the Simulink Model Explorer interface. The Model Hierarchy on the left shows the following structure:

- Simulink Root
  - Base Workspace
  - db0125d\_NG\*
    - Model Workspace
    - Configuration (Active)
    - Code for db0125d\_NG
    - Simulink Design Verifier
    - Advice for db0125d\_NG
    - Chart\_NG
      - St01
      - St00

The main pane shows the contents of the selected block: ...25d\_NG/Chart\_NG/St01 (only). The Column View is set to Stateflow, showing 1 object(s). The following table represents the data objects:

| Name | Scope | Port | Resolve Signal           | Data Type | Size |
|------|-------|------|--------------------------|-----------|------|
| data | Local |      | <input type="checkbox"/> | double    |      |

The 'data' row is highlighted with a red box.

The right pane shows the State St01 properties:

- General
  - Name: St01
- State Output
  - Create o
- Function Inline
  - Label:

The label field contains the following code:

```
St01
entry, during
data = data;
out = data;
```

### Rationale

Sub ID a:

- When local data is defined at the machine level, it is shared with all blocks in the model. The data will not behave like a local variable and can be influenced by any operation.
- Adherence to the rules prevent the definition from disappearing when copying a Stateflow block to another model.

Sub IDs b, c:

- Adherence to the rules prevent the definition from disappearing when copying a Stateflow block to another model.

Sub ID d:

- When a Stateflow block with parent-child relationships includes local data with the same name, readability decreases due to lack of clarity with regard to the influence of the local data.

### Verification

Model Advisor check: “Check definition of Stateflow data” (Simulink Check)

### Last Changed

R2020a

### See Also

- JMAAB guideline db\_0125, which is available in *Control Algorithm Modeling Guidelines Using MATLAB, Simulink, and Stateflow* on the MathWorks website.
- “Stateflow Data Properties” (Stateflow)
- “Use the Model Explorer with Stateflow Objects” (Stateflow)
- “State Hierarchy” (Stateflow)

### Introduced in R2020a

# db\_0126: Defining Stateflow events

## Sub ID Recommendations

- NA-MAAB — a
- JMAAB — a

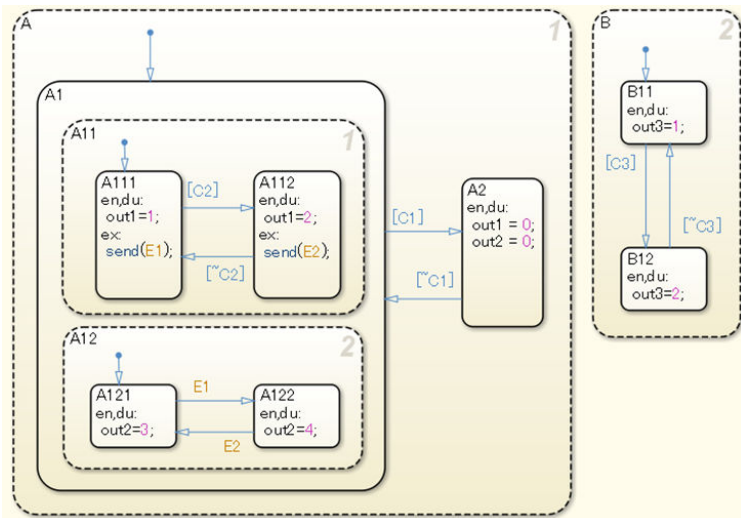
## MATLAB Versions

All

## Rule

### Sub ID a

Stateflow events shall be defined by the smallest scope level in the Stateflow block being used.



### Custom Parameter

Not Applicable

**Example — Correct**

The screenshot shows the Model Hierarchy on the left and the Stateflow Column View on the right. In the hierarchy, the event E1 and E2 are located under the state A1, which is highlighted with a red box. In the Column View, the events E1 and E2 are listed with a 'Local' scope, also highlighted with a red box.

| Name | Scope | Port |
|------|-------|------|
| A11  |       |      |
| A12  |       |      |
| E1   | Local |      |
| E2   | Local |      |

**Example — Incorrect**

The screenshot shows the Model Hierarchy on the left and the Stateflow Column View on the right. In the hierarchy, the event E1 and E2 are located under the state Chart1, which is highlighted with a red box. In the Column View, the events E1 and E2 are listed with a 'Local' scope, also highlighted with a red box.

| Name | Scope  | Port | Resolv                   |
|------|--------|------|--------------------------|
| A    |        |      |                          |
| B    |        |      |                          |
| C1   | Input  | 1    |                          |
| C2   | Input  | 2    |                          |
| C3   | Input  | 3    |                          |
| E1   | Local  |      |                          |
| E2   | Local  |      |                          |
| out1 | Output | 1    | <input type="checkbox"/> |

**Rationale**

Sub ID a:

- Limiting use locations increases reliability.

**Verification**

Model Advisor check: “Check definition of Stateflow events” (Simulink Check)



## Last Changed

R2020a

## See Also

- JMAAB guideline db\_0126, which is available in *Control Algorithm Modeling Guidelines Using MATLAB, Simulink, and Stateflow* on the MathWorks website.
- “Synchronize Model Components by Broadcasting Events” (Stateflow)
- “Use the Model Explorer with Stateflow Objects” (Stateflow)

## Introduced in R2020a

## jc\_0701: Usable number for first index

### Sub ID Recommendations

- NA-MAAB — a1/a2
- JMAAB — a1/a2

### MATLAB Versions

All

### Rule

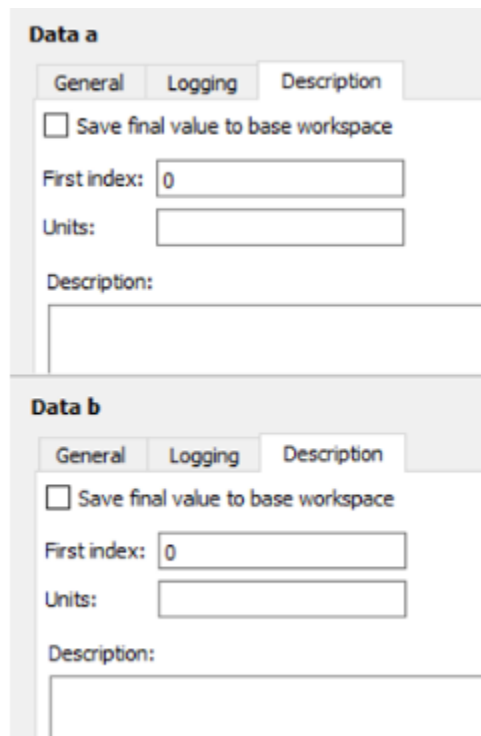
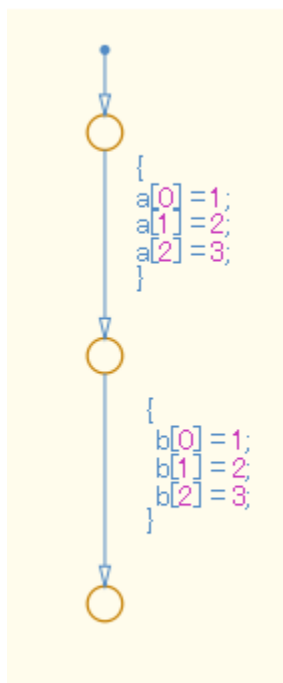
#### Sub ID a1

When Stateflow Chart property **Action Language** is set to C, Stateflow data property **First Index** shall be set to 0.

#### Custom Parameter

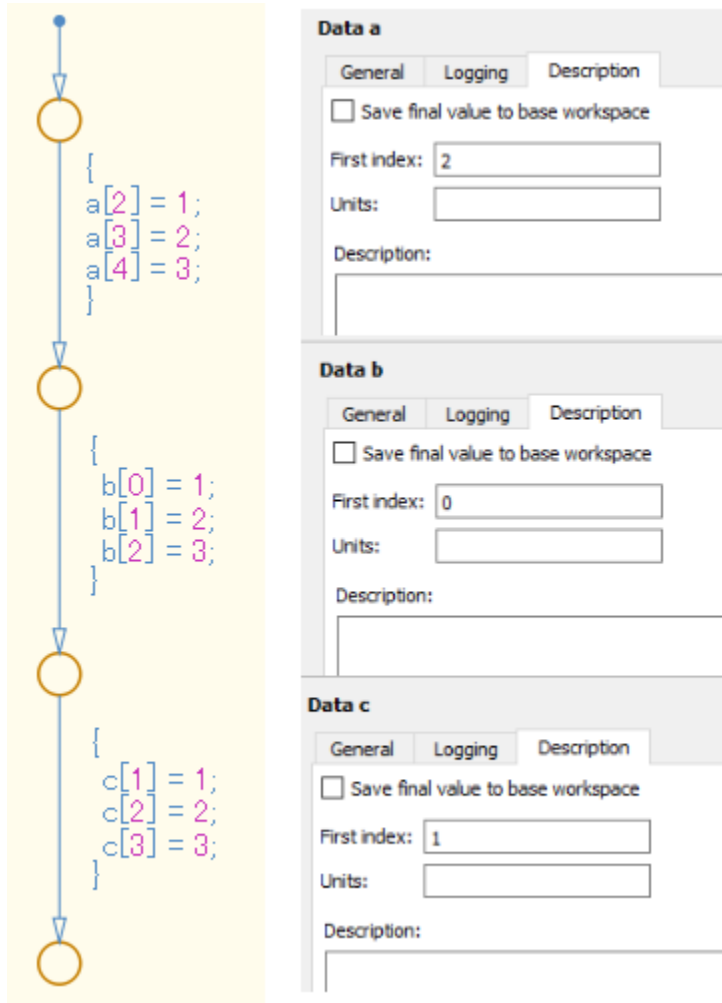
Not Applicable

#### Example — Correct



**Example — Incorrect**

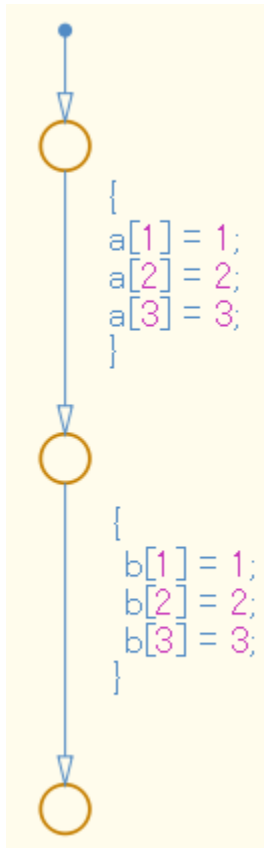
**First Index** is set to a combination of 0, 1, and 2.

**Sub ID a2**

When Stateflow Chart property **Action Language** is set to C, Stateflow data property **First Index** shall be set to 1.

**Custom Parameter**

Not Applicable

**Example — Correct**

| Data a  |                                |             |
|---|--------------------------------|-------------|
| General   | Logging                        | Description |
| <input type="checkbox"/> Save final value to base workspace |                                |             |
| First index:  | <input type="text" value="1"/> |             |
| Units:  | <input type="text"/>           |             |
| Description:  | <input type="text"/>           |             |

| Data b  |                                |             |
|---|--------------------------------|-------------|
| General   | Logging                        | Description |
| <input type="checkbox"/> Save final value to base workspace |                                |             |
| First index:  | <input type="text" value="1"/> |             |
| Units:  | <input type="text"/>           |             |
| Description:  | <input type="text"/>           |             |

**Example — Incorrect**

**First Index** is set to a combination of 0, 1, and 2.

The diagram illustrates three data blocks, each with a configuration panel and a code snippet. The code snippets are highlighted in yellow.

**Data a**

```

{
  a[2] = 1;
  a[3] = 2;
  a[4] = 3;
}

```

Configuration panel for Data a:

- General:  Save final value to base workspace
- First index: 2
- Units: [Empty]
- Description: [Empty]

**Data b**

```

{
  b[0] = 1;
  b[1] = 2;
  b[2] = 3;
}

```

Configuration panel for Data b:

- General:  Save final value to base workspace
- First index: 0
- Units: [Empty]
- Description: [Empty]

**Data c**

```

{
  c[1] = 1;
  c[2] = 2;
  c[3] = 3;
}

```

Configuration panel for Data c:

- General:  Save final value to base workspace
- First index: 1
- Units: [Empty]
- Description: [Empty]

## Rationale

Sub ID a1:

- Logic becomes easier to understand when **First Index** is uniform.

Sub ID a2:

- Logic becomes easier to understand when **First Index** is uniform. However, C language is 0-based, which decreases the readability of the code as the index calculation process is 1-based. This is reflected in the generated code.

## Verification

Model Advisor check: "Check usable number for first index" (Simulink Check)

## **Last Changed**

R2020a

## **See Also**

- JMAAB guideline jc\_0701, which is available in *Control Algorithm Modeling Guidelines Using MATLAB, Simulink, and Stateflow* on the MathWorks website.
- “Differences Between MATLAB and C as Action Language Syntax” (Stateflow)
- “Set Data Properties” (Stateflow)

## **Introduced in R2020a**

# jc\_0712: Execution timing for default transition path

## Sub ID Recommendations

- NA-MAAB — a
- JMAAB — a

## MATLAB Versions

All

## Rule

### Sub ID a

Stateflow Chart property **Execute (Enter) Chart at Initialization** shall not be selected.

### Custom Parameter

Not Applicable

## Rationale

Sub ID a:

- Using the same settings for each Stateflow Chart prevents the model from being misinterpreted.
- Use caution when referencing an input signal using the default transition line when property **Execute (Enter) Chart at Initialization** is selected.

## Verification

Model Advisor check: “Check execution timing for default transition path” (Simulink Check)

## Last Changed

R2020a

## See Also

- JMAAB guideline jc\_0712, which is available in *Control Algorithm Modeling Guidelines Using MATLAB, Simulink, and Stateflow* on the MathWorks website.
- “Transitions” (Stateflow)
- “Execution of a Stateflow Chart” (Stateflow)

**Introduced in R2020a**



# jc\_0722: Local data definition in parallel states

## Sub ID Recommendations

- NA-MAAB — a
- JMAAB — a

## MATLAB Versions

All

## Rule

### Sub ID a

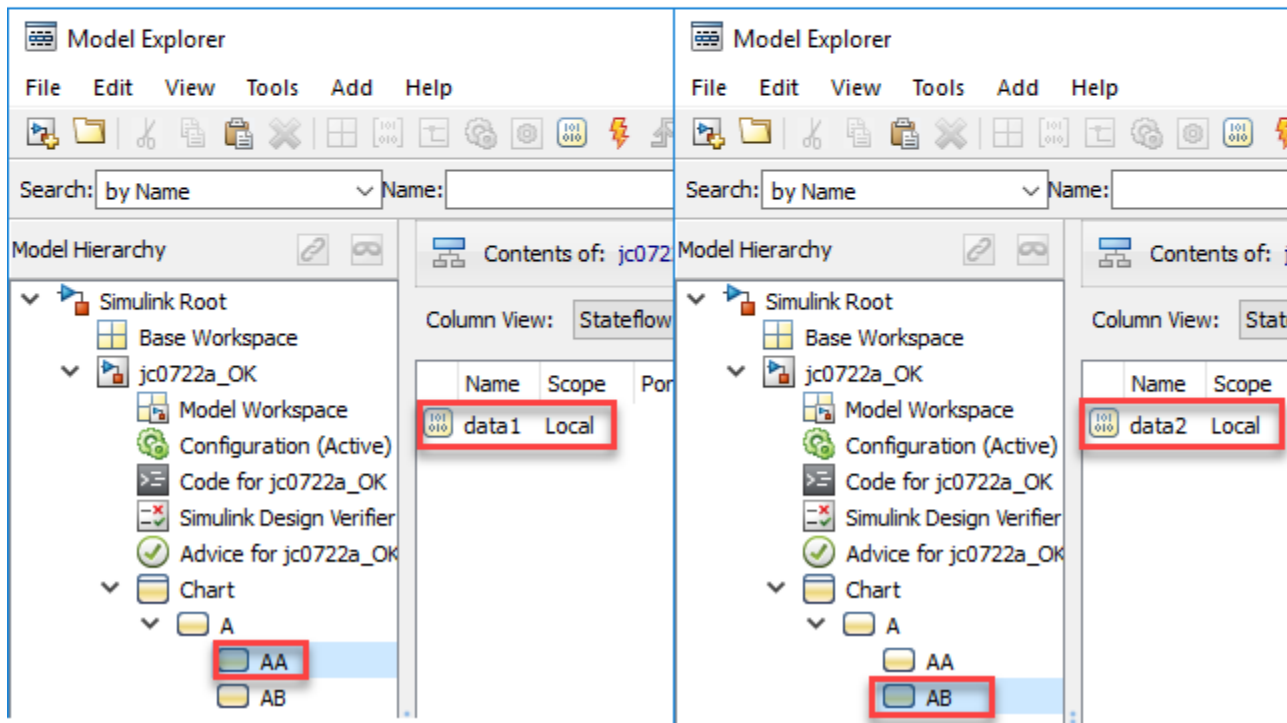
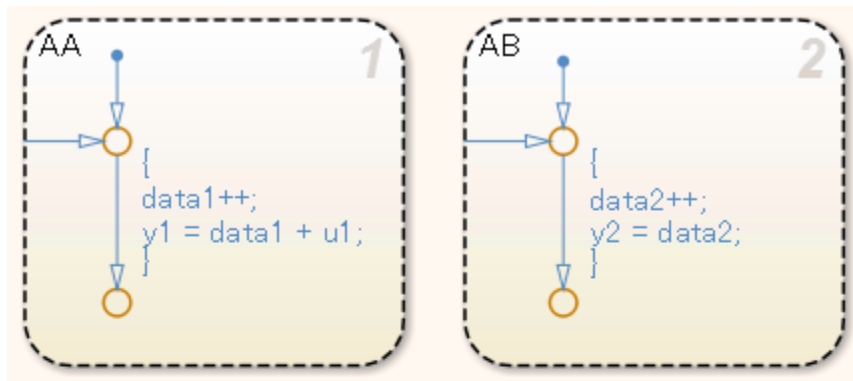
Local variables that are completed in one state shall be defined in that state.

### Custom Parameter

Not Applicable

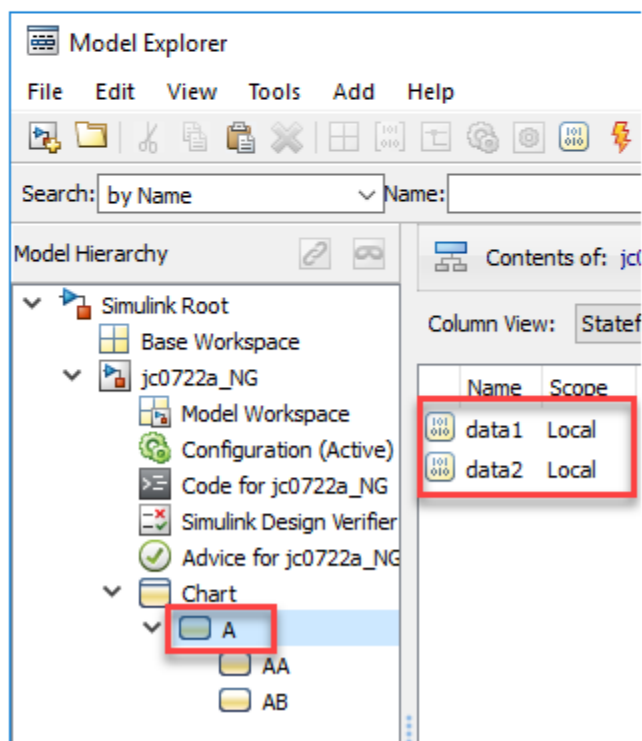
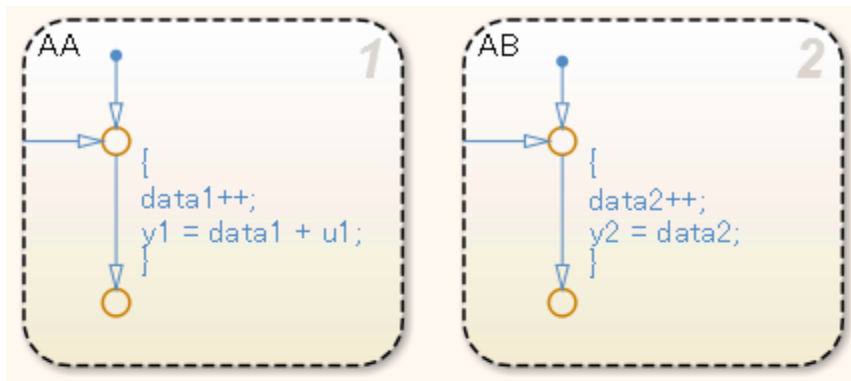
### Example — Correct

Local variables are defined in the state being used.



**Example – Incorrect**

Local variables are not defined in the state being used.



## Rationale

Sub ID a:

- Readability and maintainability can be improved by explicitly limiting the valid range of the variables, thereby avoiding unintended references and changes.

## Verification

Model Advisor check: “Check scope of data in parallel states” (Simulink Check)

## Last Changed

R2020a

### See Also

- JMAAB guideline jc\_0722, which is available in *Control Algorithm Modeling Guidelines Using MATLAB, Simulink, and Stateflow* on the MathWorks website.
- “States” (Stateflow)
- “Parallel and Exclusive States” (Stateflow)

### Introduced in R2020a

## Stateflow Diagram

# jc\_0797: Unconnected transitions / states / connective junctions

## Sub ID Recommendations

- NA-MAAB — a, b
- JMAAB — a, b

## MATLAB Versions

All

## Rule

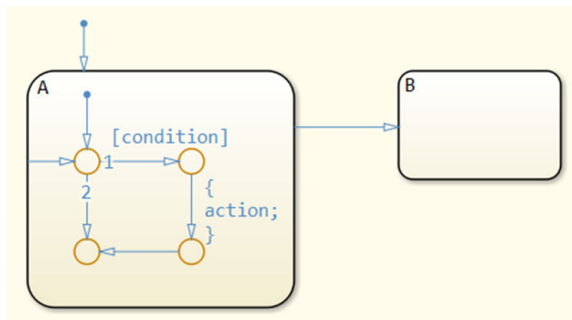
### Sub ID a

Stateflow Chart shall not have unconnected transitions.

### Custom Parameter

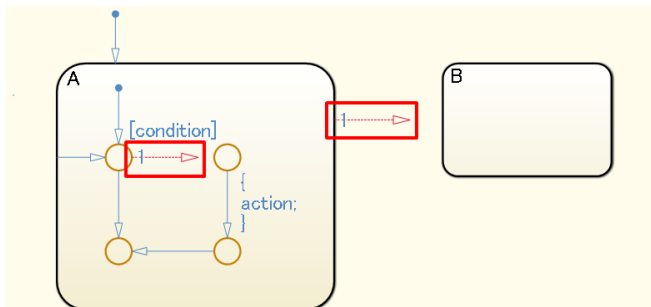
Not Applicable

### Example — Correct



### Example — Incorrect

There are unconnected transitions.



**Sub ID b**

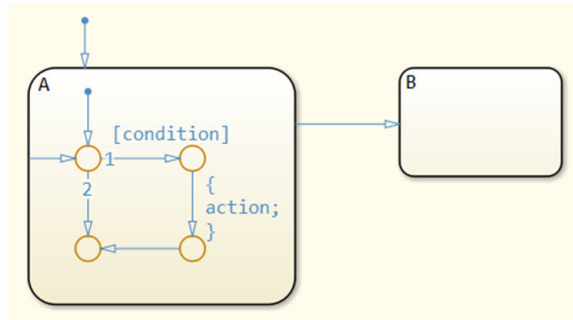
Stateflow Chart shall not have unconnected exclusive (OR) states and connective junctions without a transition source.

**Custom Parameter**

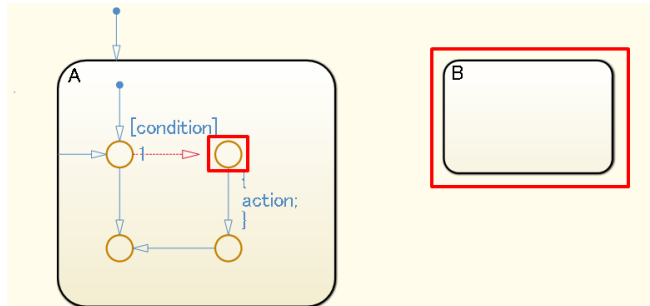
Not Applicable

**Example — Correct**

Does not have unconnected exclusive (OR) states or connective junctions without a transition source.

**Example — Incorrect**

There are unconnected exclusive (OR) states and connective junctions without a transition source.

**Rationale**

Sub IDs a, b:

- Unconnected transitions can result in adverse effects, such as misinterpretation of simulation results or failure to generate code.

**Verification**

Model Advisor check: “Check for unconnected objects in Stateflow Charts” (Simulink Check)

**Last Changed**

R2020a

## See Also

- JMAAB guideline jc\_0797, which is available in *Control Algorithm Modeling Guidelines Using MATLAB, Simulink, and Stateflow* on the MathWorks website.
- “Transitions” (Stateflow)
- “Exclusive (OR) State Decomposition” (Stateflow)
- “Transition Between Exclusive States” (Stateflow)
- “Transition Between Operating Modes” (Stateflow)
- “Represent Multiple Paths by Using Connective Junctions” (Stateflow)
- “Transitions to and from Junctions” (Stateflow)

## Introduced in R2020a



## db\_0137: States in state machines

### Sub ID Recommendations

- NA-MAAB — a
- JMAAB — a

### MATLAB Versions

All

### Rule

#### Sub ID a

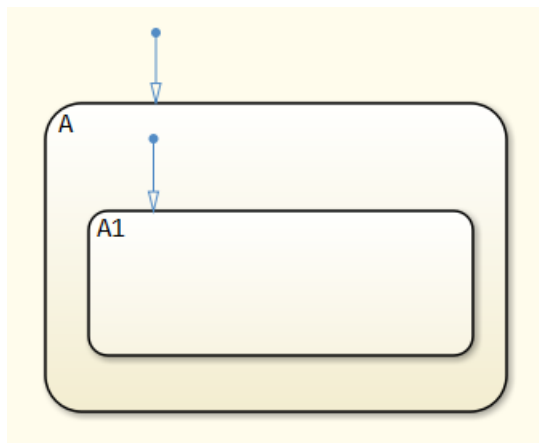
When the **Decomposition** for the Chart block or State is set to OR (Exclusive), there shall be at least two states in the hierarchy.

#### Custom Parameter

Not Applicable

#### Example — Incorrect

The hierarchy contains only one state when the **Decomposition** option is set to OR (Exclusive)



### Rationale

Sub ID a:

- Redundant descriptions impair readability.
- Generated code includes unnecessary state variables.

### Verification

Model Advisor check: “Check for state in state machines” (Simulink Check)

### Last Changed

R2020a

### See Also

- JMAAB guideline db\_0137, which is available in *Control Algorithm Modeling Guidelines Using MATLAB, Simulink, and Stateflow* on the MathWorks website.
- “States” (Stateflow)
- “State Decomposition” (Stateflow)

### Introduced in R2020a

# jc\_0721: Usage of parallel states

## Sub ID Recommendations

- NA-MAAB — a
- JMAAB — a

## MATLAB Versions

All

## Rule

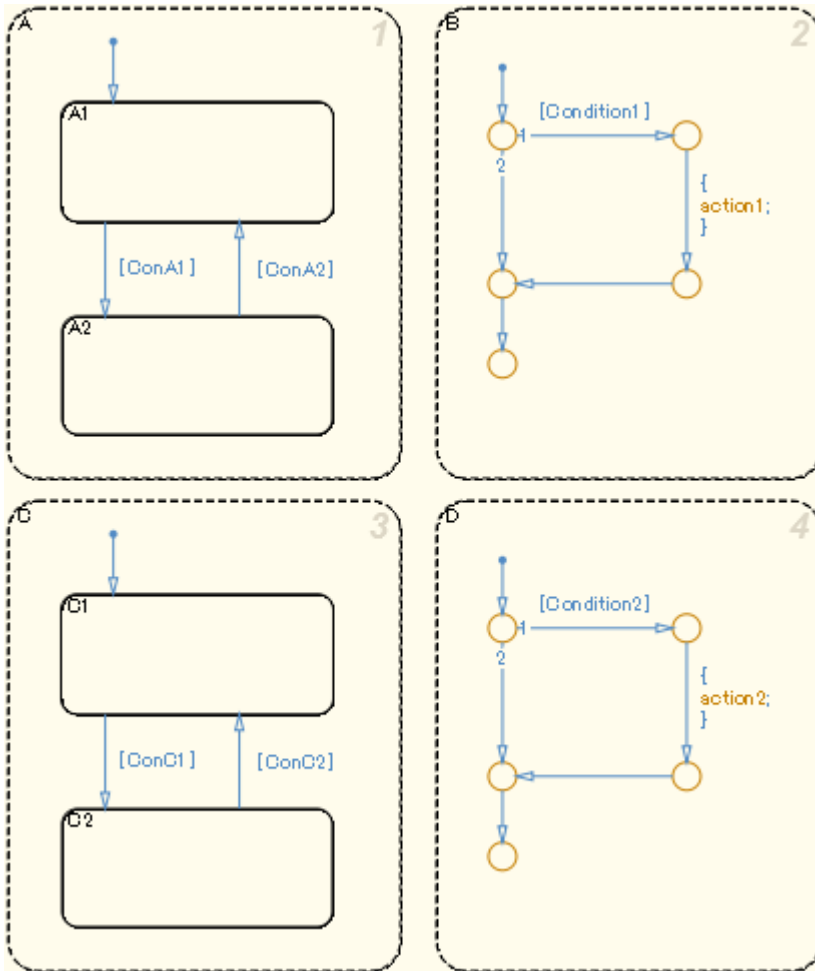
### Sub ID a

Substates of parallel states shall not be parallel states.

### Custom Parameter

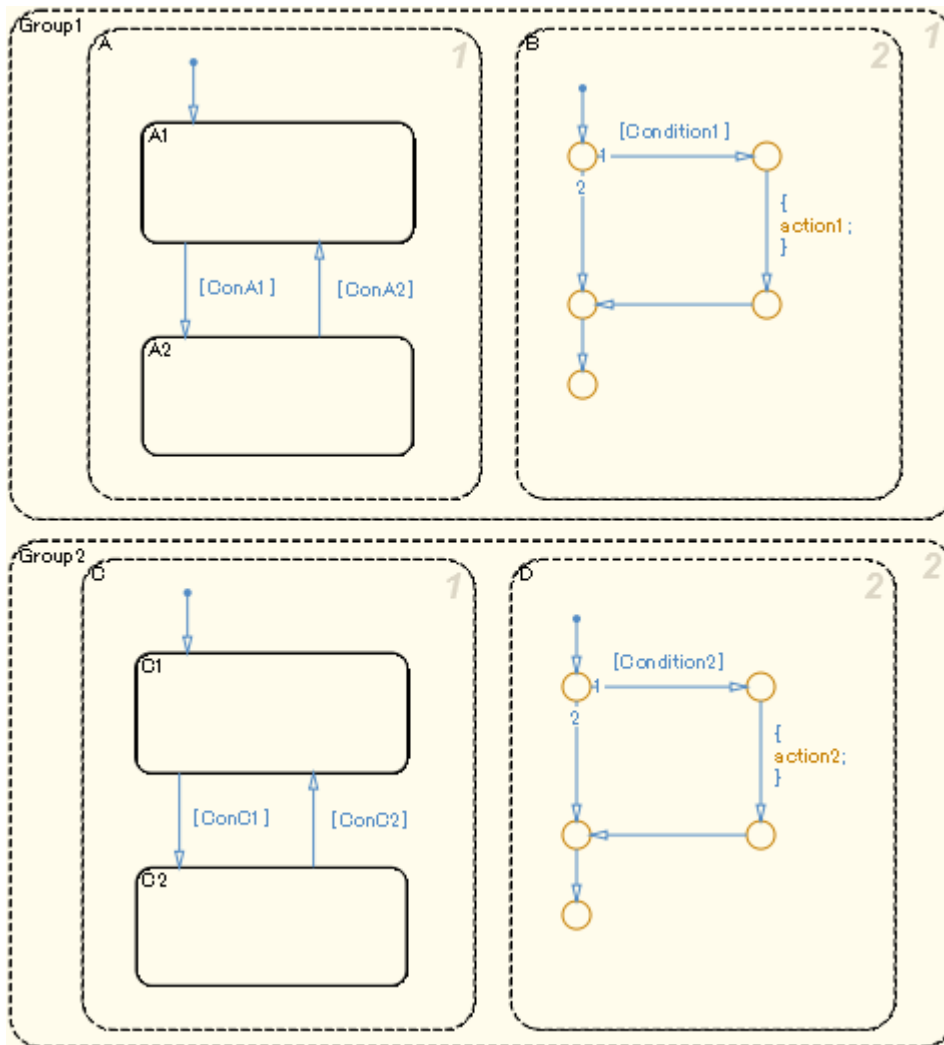
Not Applicable

**Example — Correct**



**Example — Incorrect**

Substates of parallel states are parallel states.



## Rationale

Sub ID a:

- Behavior is not affected by nesting parallel states in a parent superstate.
- Hierarchization of the parallel state decreases readability.

## Verification

Model Advisor check: "Check usage of parallel states" (Simulink Check)

## Last Changed

R2020a

### See Also

- JMAAB guideline jc\_0721, which is available in *Control Algorithm Modeling Guidelines Using MATLAB, Simulink, and Stateflow* on the MathWorks website.
- “States” (Stateflow)
- “Parallel and Exclusive States” (Stateflow)
- “State Hierarchy” (Stateflow)

### Introduced in R2020a

# db\_0129: Stateflow transition appearance

## Sub ID Recommendations

- NA-MAAB — a, b, c, d, e
- JMAAB — a, b, c, d, e

## MATLAB Versions

All

## Rule

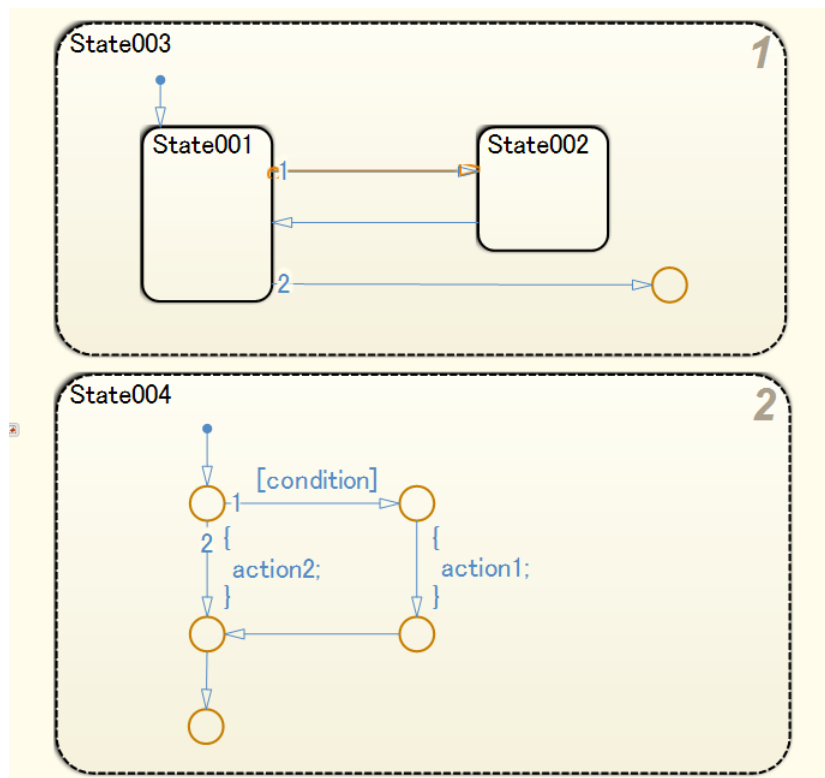
### Sub ID a

Transition lines shall not cross over one another.

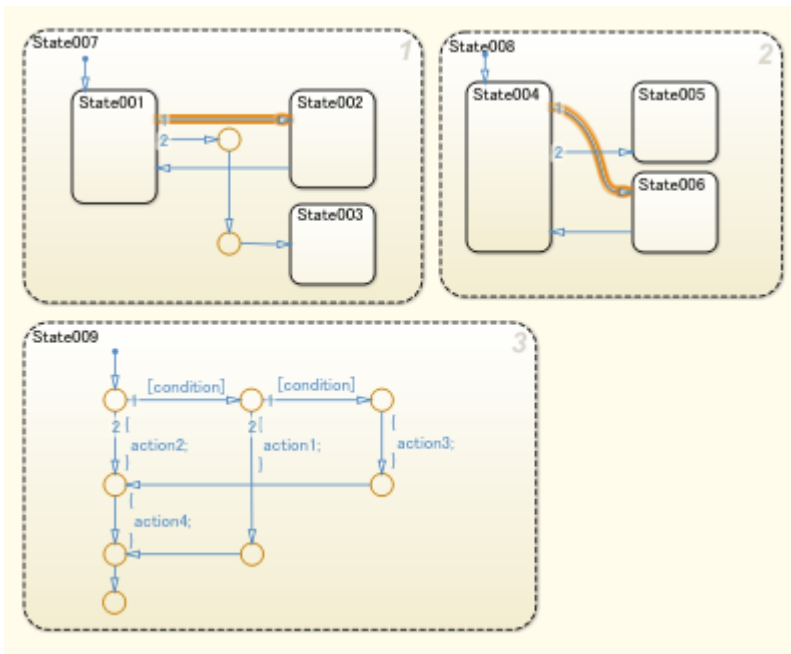
### Custom Parameter

Not Applicable

### Example — Correct



**Example — Incorrect**



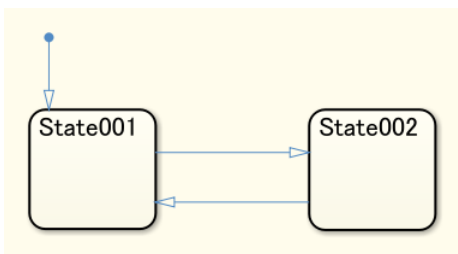
**Sub ID b**

Transition lines shall not overlap other transition lines.

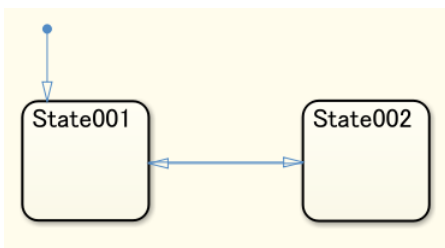
**Custom Parameter**

Not Applicable

**Example — Correct**



**Example — Incorrect**



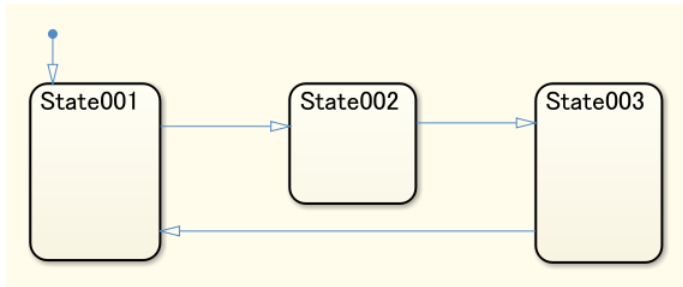
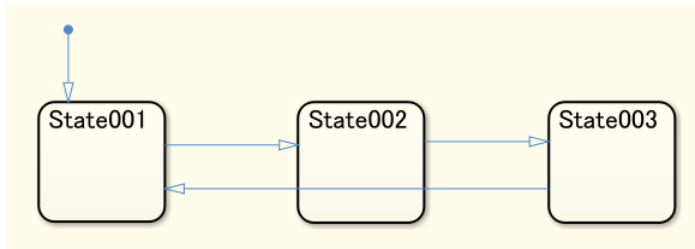


**Sub ID c**

Transition lines shall not cross over states.

**Custom Parameter**

Not Applicable

**Example — Correct****Example — Incorrect****Sub ID d**

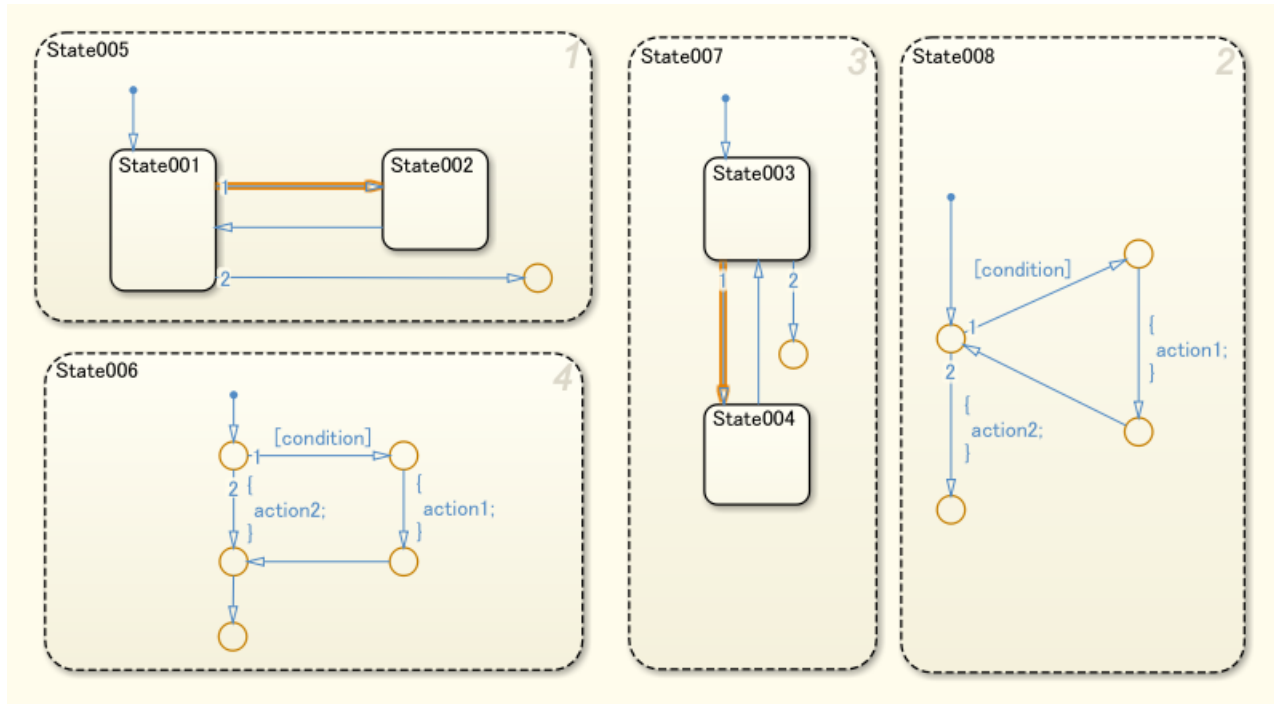
Transition lines shall be drawn vertically or horizontally.

Diagonal lines can be used for flow charts.

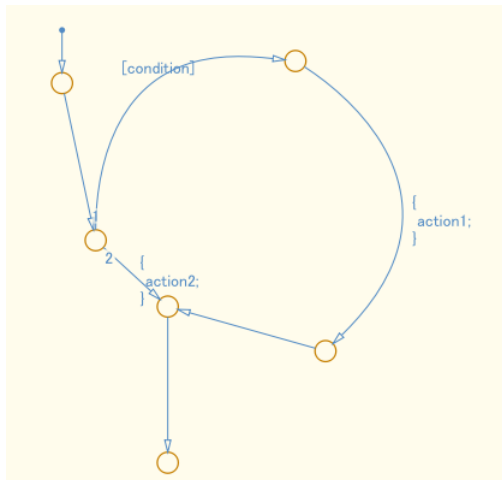
**Custom Parameter**

Not Applicable

**Example — Correct**



**Example — Incorrect**

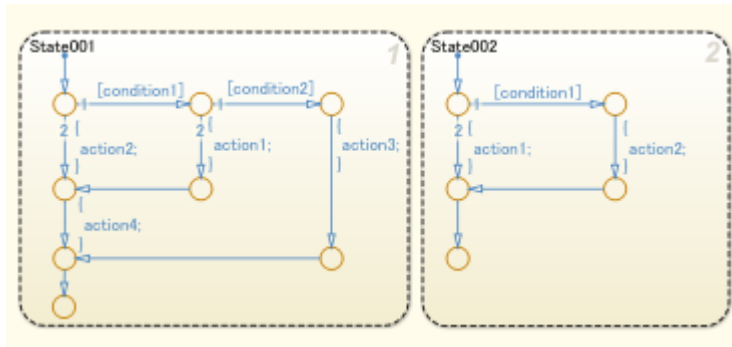
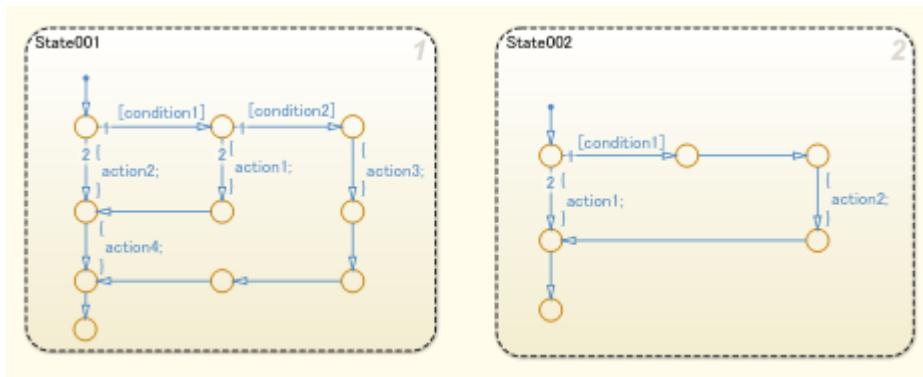


**Sub ID e**

Unnecessary connective junctions shall not be used.

**Custom Parameter**

Not Applicable

**Example — Correct****Example — Incorrect****Rationale**

Sub ID a:

- Difficult to understand the relationship between states when transition lines cross.

Sub ID b:

- Difficult to understand the relationship between states when transition lines overlap.

Sub ID c:

- Difficult to understand the relationship between states when transition lines cross over states.

Sub ID d:

- Consistent application of transition lines improves readability.

Sub ID e:

- Transitions can be difficult to understand when unnecessary connective junctions are used.

**Verification**

Model Advisor check: “Check for Stateflow transition appearance” (Simulink Check)

## **Last Changed**

R2020a

## **See Also**

- JMAAB guideline db\_0129, which is available in *Control Algorithm Modeling Guidelines Using MATLAB, Simulink, and Stateflow* on the MathWorks website.
- “Transitions” (Stateflow)
- “Transition Between Operating Modes” (Stateflow)

## **Introduced in R2020a**

# jc\_0531: Default transition

## Sub ID Recommendations

- NA-MAAB — a, b, c, d, e, f, g
- JMAAB — a, b, c, d, e, f, g

## MATLAB Versions

All

## Rule

### Sub ID a

When **Decomposition** of a Stateflow Chart is **Exclusive (OR)**, the default transition shall connect at the top of the Chart block.

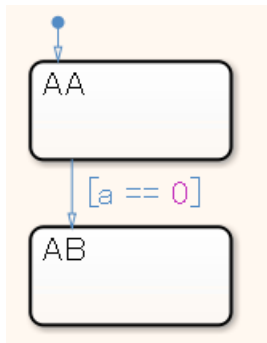
When **Decomposition** of the state is **Exclusive (OR)**, the default transition shall connect immediately beneath the state.

### Custom Parameter

Not Applicable

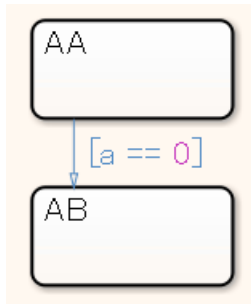
### Example — Correct

The default transition line is connected at the top.



### Example — Incorrect

The default transition line is not connected.

**Sub ID b**

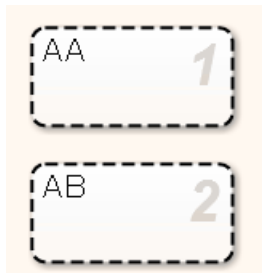
When **Decomposition** is set to “Parallel (AND)”, the default transition line shall not be connected.

**Custom Parameter**

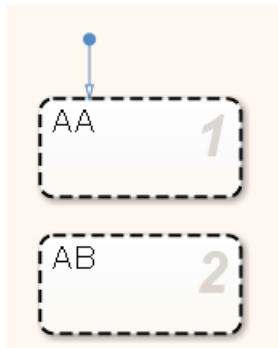
Not Applicable

**Example — Correct**

**Decomposition** of the parent object for states AA and AB is set to `Parallel (AND)`, which makes states AA and AB parallel states. The default transition line is not connected for these parallel states.

**Example — Incorrect**

A default transition line is connected for parallel state AA.

**Sub ID c**

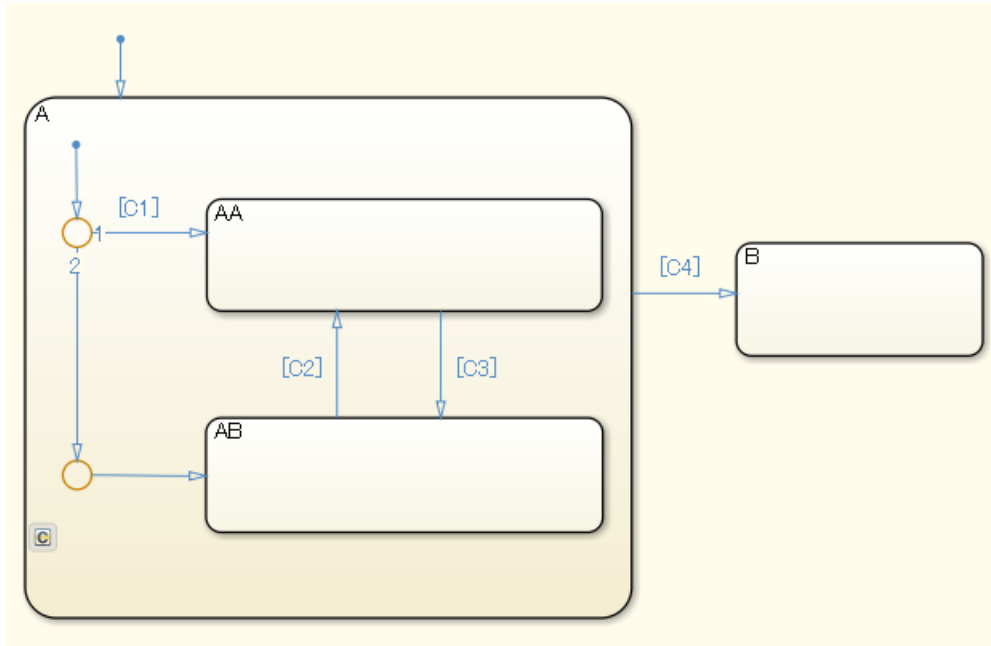
A level shall not have multiple default transitions.

**Custom Parameter**

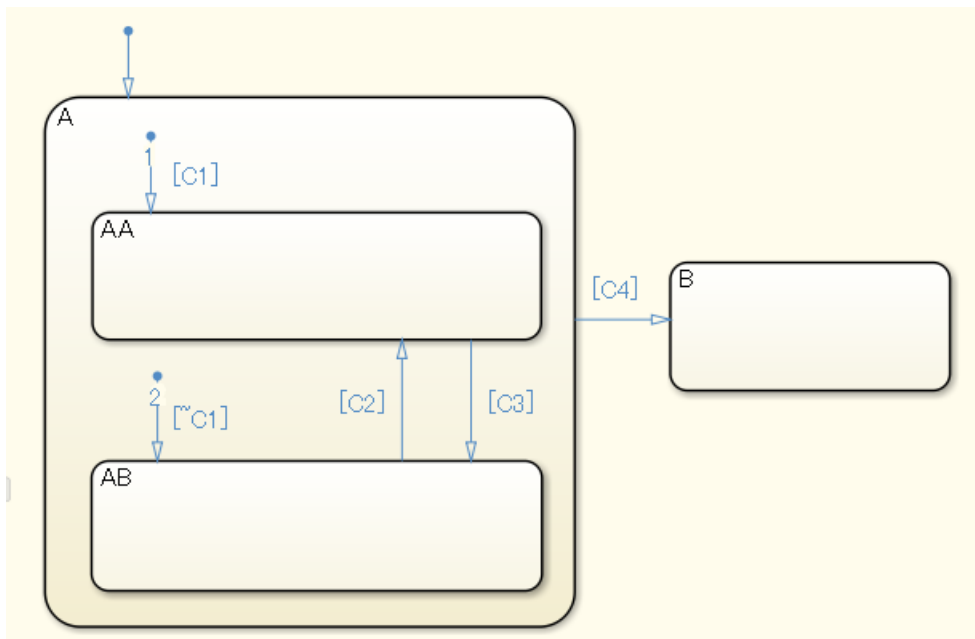
Not Applicable

**Example — Correct**

The level does not have multiple default transitions

**Example — Incorrect**

Multiple default transitions are included in the same level of state A.



**Sub ID d**

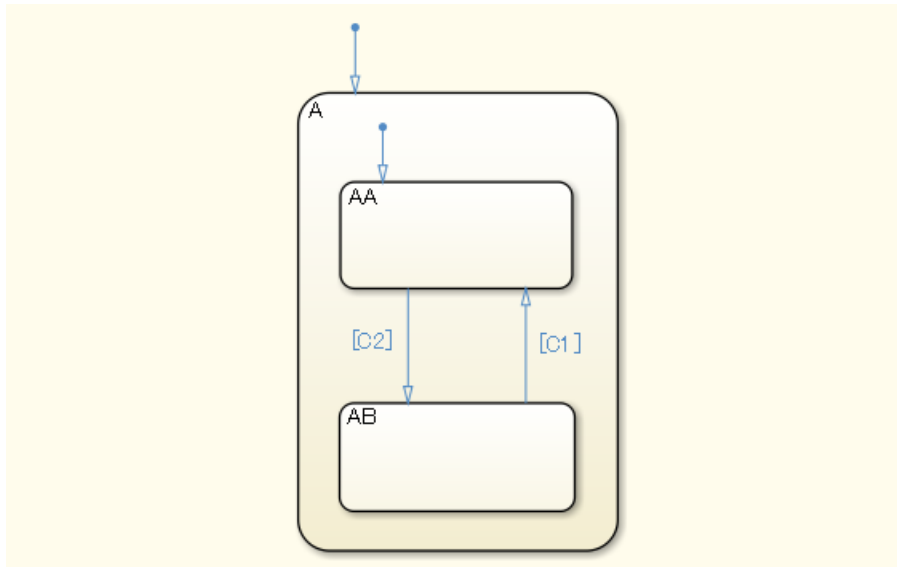
Default transitions shall be connected directly and positioned vertically to the upper part of the state or connective junction.

**Custom Parameter**

Not Applicable

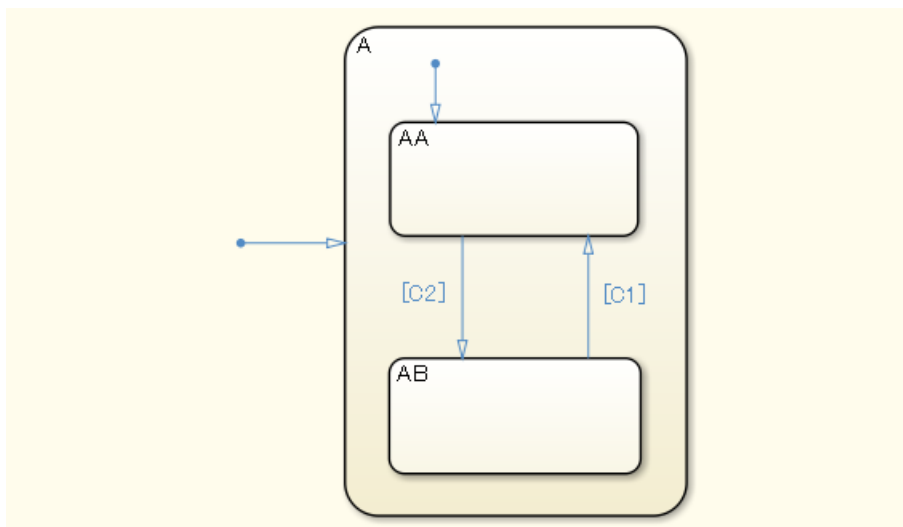
**Example – Correct**

The default transition is connected vertically to the upper part of the state.



**Example – Incorrect**

The default transition of state A is not connected vertically to the upper part of the state.





**Sub ID e**

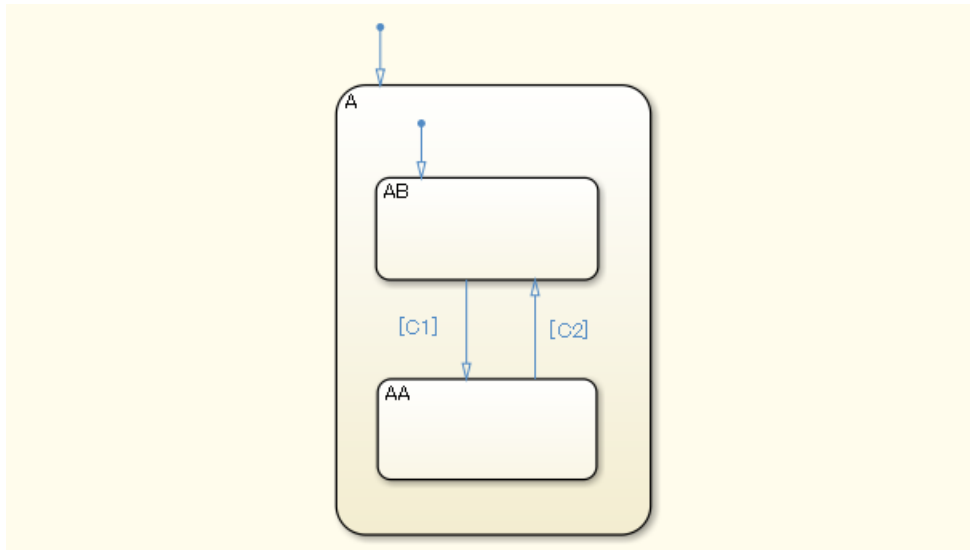
The destination state or destination connective junction for the default transition shall be positioned to the top left in the same level.

**Custom Parameter**

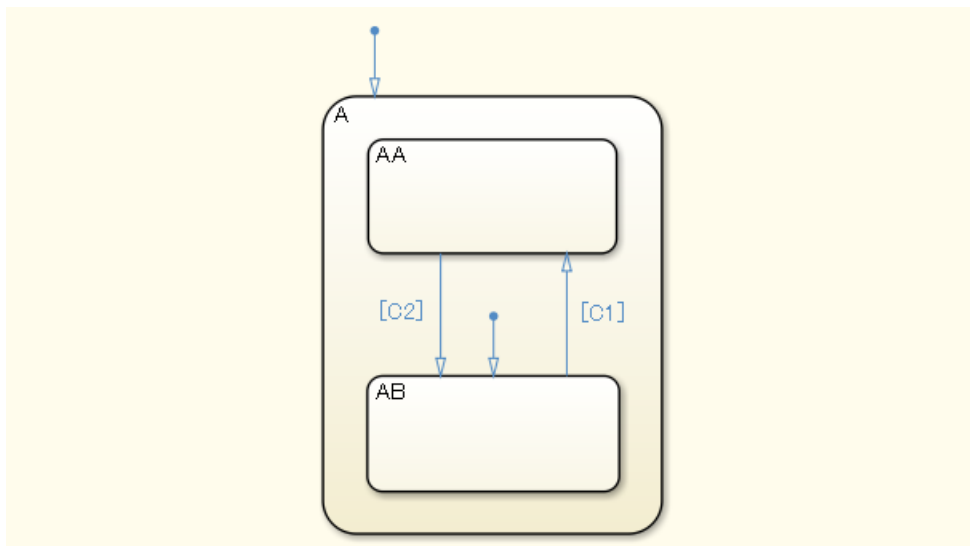
Not Applicable

**Example — Correct**

The default transition is positioned to the top left in the same level.

**Example — Incorrect**

The default transition of state AB is not positioned to the top left in the same level.



**Sub ID f**

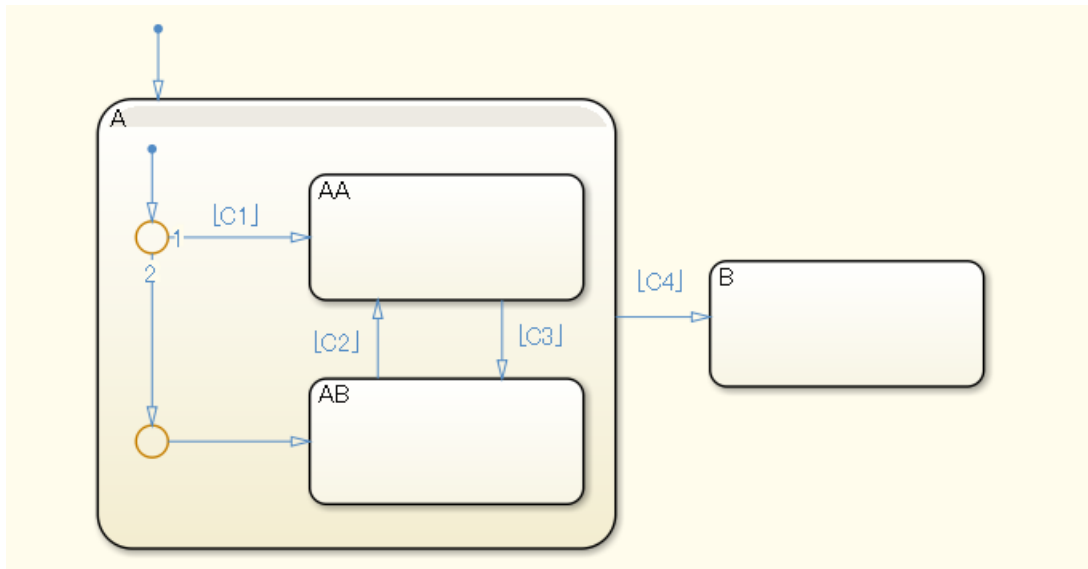
Default transitions shall not extend beyond the boundaries of the state.

**Custom Parameter**

Not Applicable

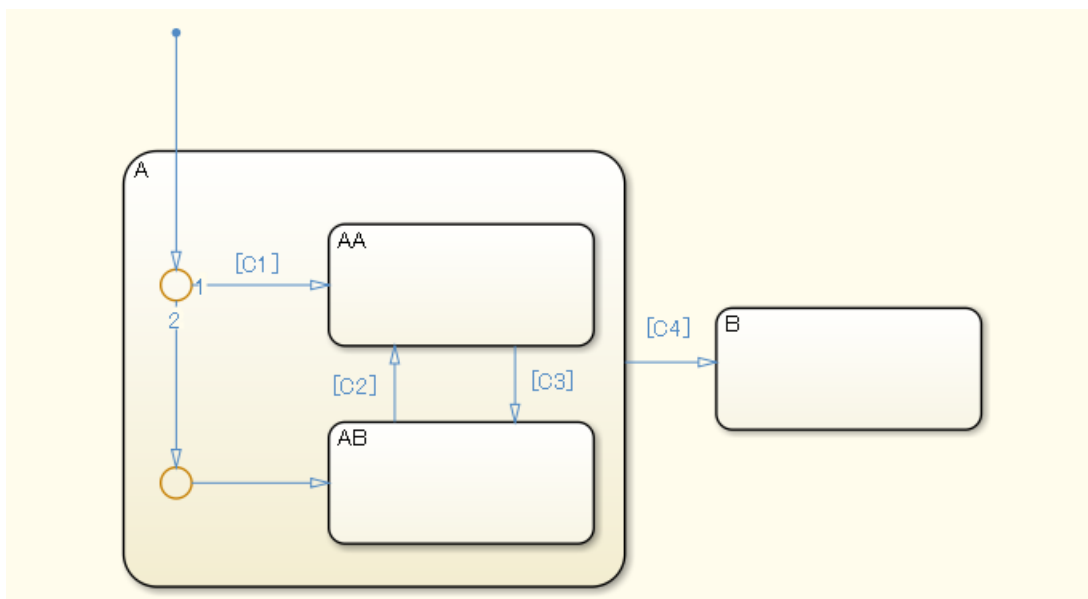
**Example – Correct**

The default transition is within the boundaries of the state.



**Example – Incorrect**

The default transition extends beyond the boundaries of the state.



**Sub ID g**

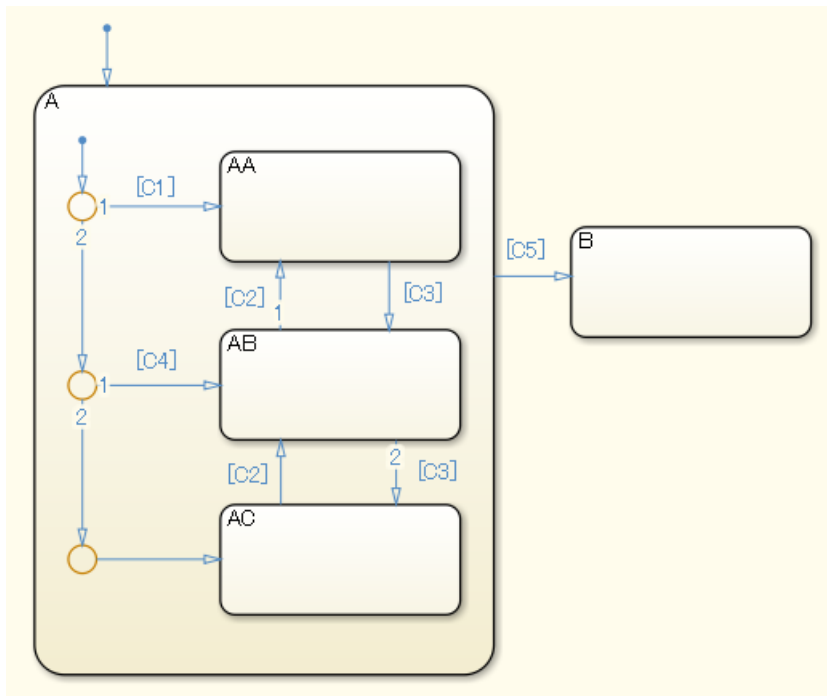
Configuration parameter **No unconditional default transitions** shall be set to Error to ensure that in the transition path for the default transition, the path with the lowest priority is an unconditional transition.

**Custom Parameter**

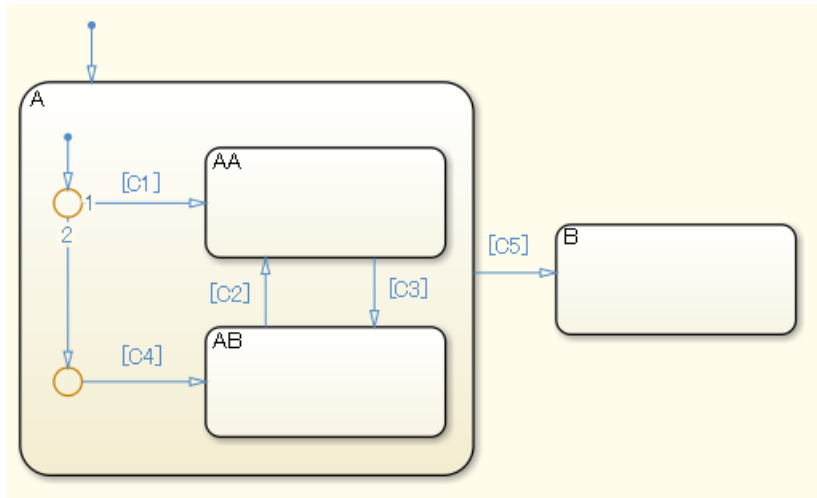
Not Applicable

**Example — Correct**

The path with the lowest priority in the transition path for the default transition is an unconditional transition.

**Example — Incorrect**

The path with the lowest priority in the transition path for the default transition is not an unconditional transition.



## Rationale

Sub ID a:

- Simulation errors can occur when a state chart does not include default transition lines.
- When default transitions are included in a flow chart, it is impossible to determine whether this is intentional or through failure to insert them.

Sub ID b:

- Readability improves when there are no unnecessary default transitions.

Sub ID c:

- The state may not function as intended and produce a warning when multiple default transitions are included in the same level.

Sub ID d:

- Readability decreases when there are curves or variations in the angle or position of default transitions.

Sub ID e:

- Readability decreases when there are variations in the position of the transition destination state or transition destination connective junction for the default transition.

Sub ID f

- Readability decreases when a default transition extends beyond the boundary of a state and intersects with state boundaries and expressions.

Sub ID g:

- When there is not an unconditional transition in the transition path of the default transition, the transition destination disappears if all conditions of the transition path are not met. This can result in unintended behavior.

## Verification

Model Advisor check: “Check default transition placement in Stateflow charts” (Simulink Check)

## Last Changed

R2020a

## See Also

- JMAAB guideline jc\_0531, which is available in *Control Algorithm Modeling Guidelines Using MATLAB, Simulink, and Stateflow* on the MathWorks website.
- “State Decomposition” (Stateflow)
- “Transitions” (Stateflow)
- “How Stateflow Objects Interact During Execution” (Stateflow)

## Introduced in R2020a

## jc\_0723: Prohibited direct transition from external state to child state

### Sub ID Recommendations

- NA-MAAB — No recommendations
- JMAAB — a

### MATLAB Versions

All

### Rule

#### Sub ID a

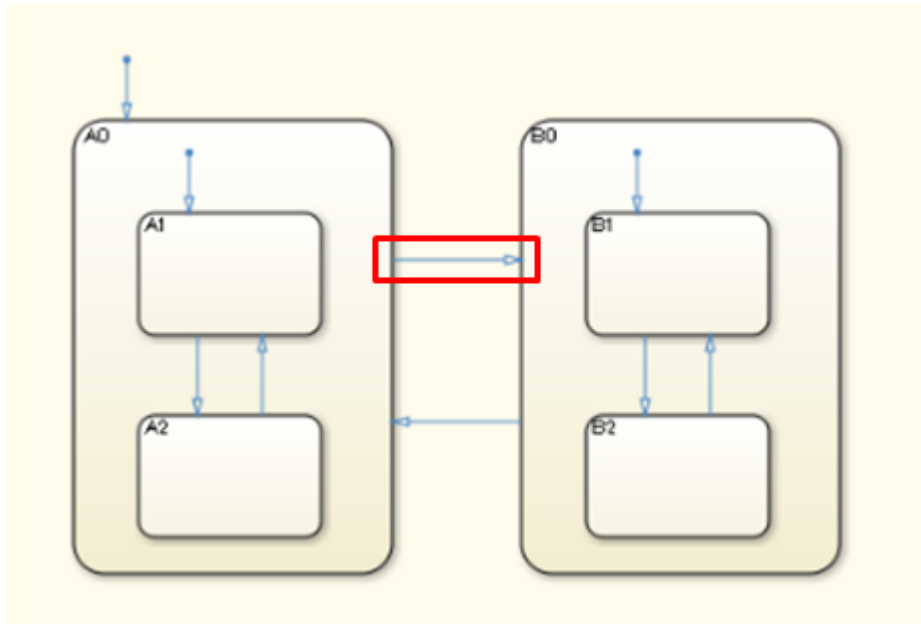
Transitions from one state directly to an external child state shall be prohibited.

#### Custom Parameter

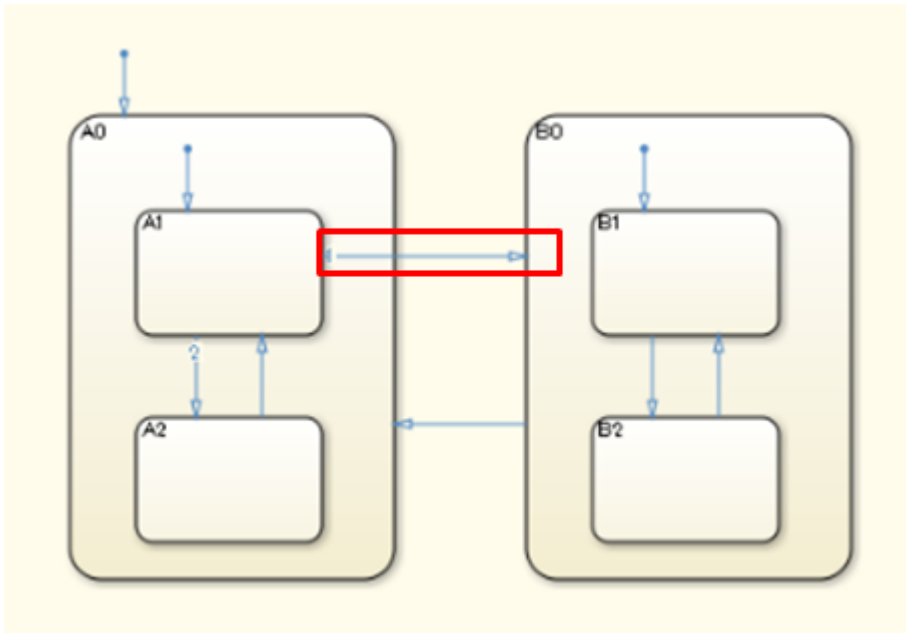
Not Applicable

#### Example — Correct

Transition from parent state to parent state.

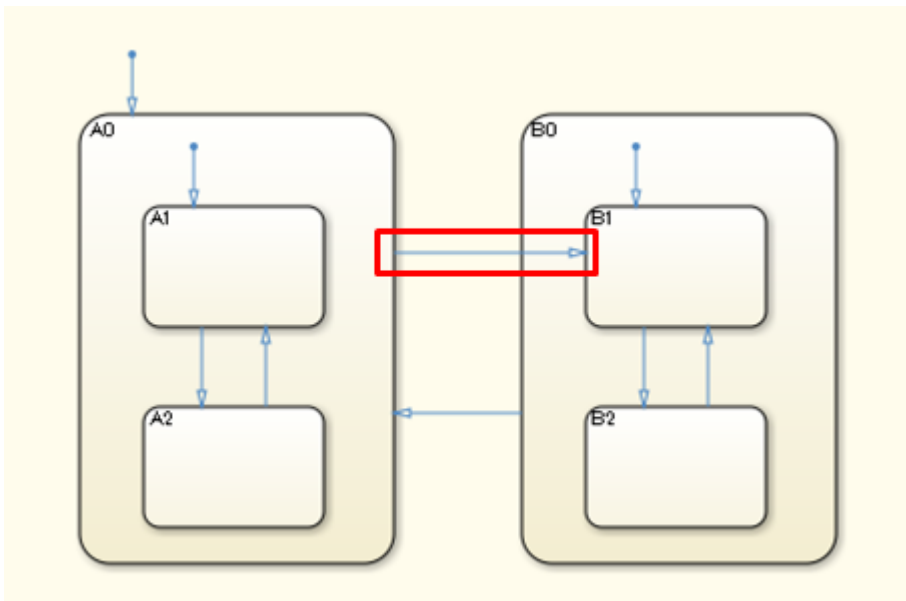


Transition from child state to another parent state.

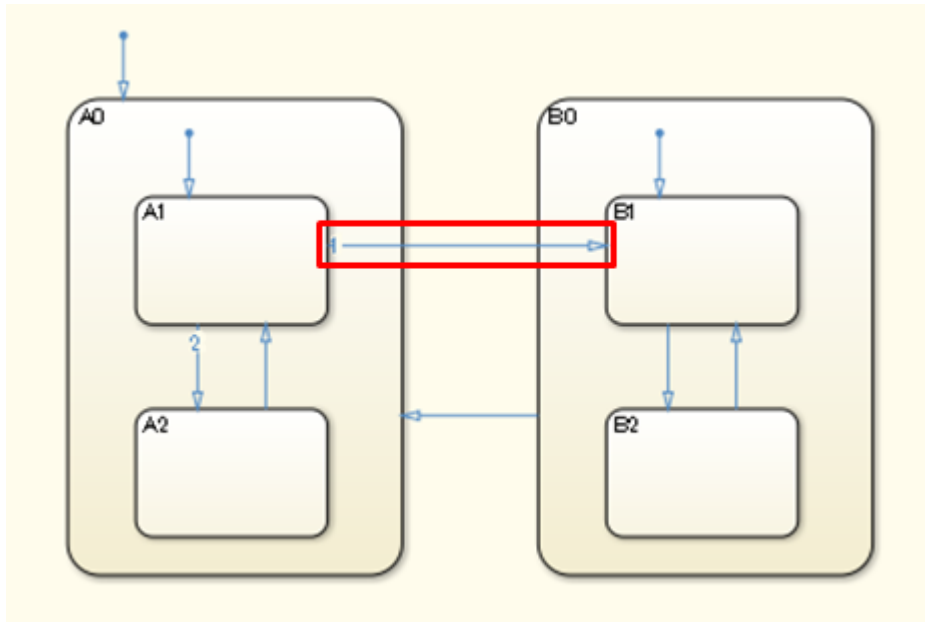


**Example — Incorrect**

Direct transition from an external state to a child state in a different state.



Direct transition from an external child state to a child state in a different state.



### Rationale

Sub ID a:

- Direct transitions between child states can complicate the states and decrease readability.

### Verification

Model Advisor check: “Check usage of transitions to external states” (Simulink Check)

### Last Changed

R2020a

### See Also

- JMAAB guideline jc\_0723, which is available in *Control Algorithm Modeling Guidelines Using MATLAB, Simulink, and Stateflow* on the MathWorks website.
- “Transitions” (Stateflow)

**Introduced in R2020a**



# jc\_0751: Backtracking prevention in state transition

## Sub ID Recommendations

- NA-MAAB — a
- JMAAB — a

## MATLAB Versions

All

## Rule

### Sub ID a

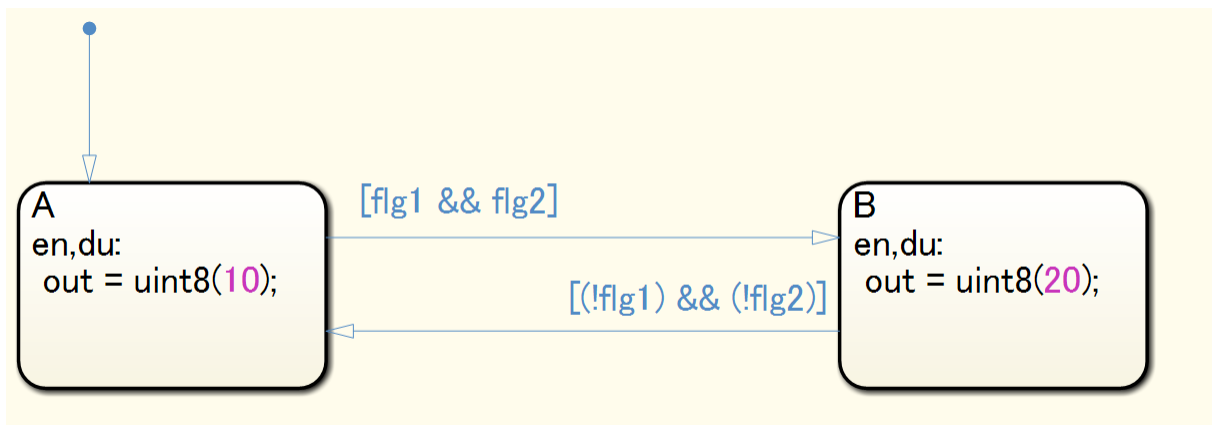
Connective junctions shall not be used to separate complex conditions.

### Custom Parameter

Not Applicable

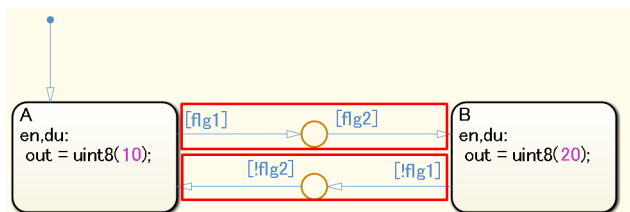
### Example — Correct

Connective junctions are not used to separate complex conditions.



### Example — Incorrect

Connective junctions are used to separate complex conditions.



### Rationale

Sub ID a:

- Deviation from the rule can cause backtracking, which results in unintended behavior.

### Verification

Model Advisor check: “Check for unexpected backtracking in state transitions” (Simulink Check)

### Last Changed

R2020a

### See Also

- JMAAB guideline jc\_0751, which is available in *Control Algorithm Modeling Guidelines Using MATLAB, Simulink, and Stateflow* on the MathWorks website.
- “Transitions” (Stateflow)
- “Evaluate Transitions” (Stateflow)
- “Transitions to and from Junctions” (Stateflow)

### Introduced in R2020a

# jc\_0760: Starting point of internal transition

## Sub ID Recommendations

- NA-MAAB — a
- JMAAB — a

## MATLAB Versions

All

## Rule

### Sub ID a

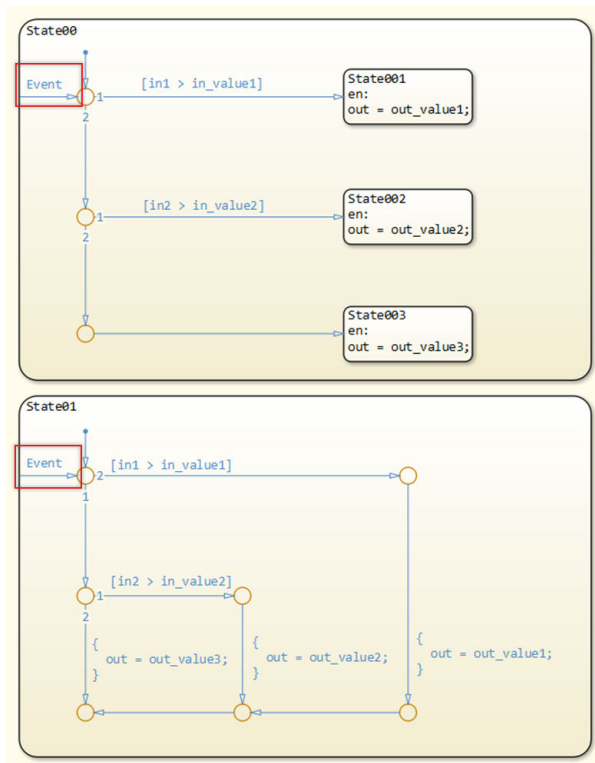
Internal transition lines shall start from the left edge of the state.

### Custom Parameter

Not Applicable

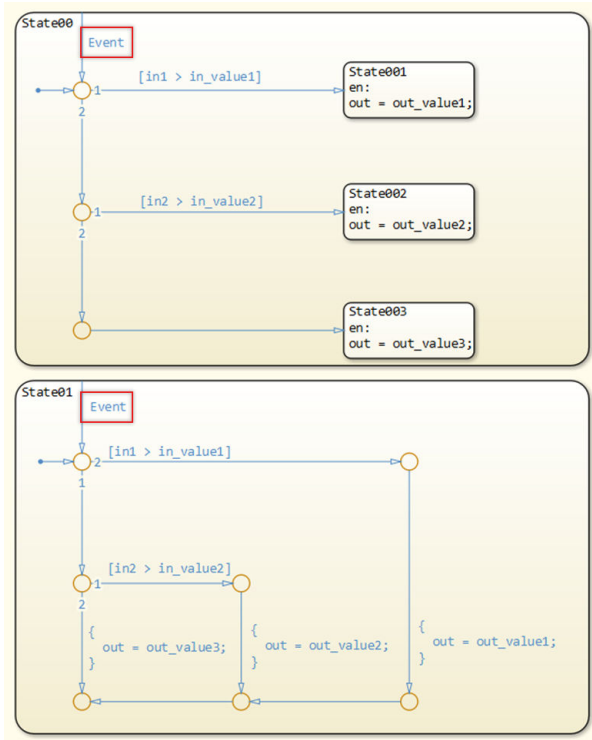
### Example — Correct

The inner transition line begins at the left edge of the state.



**Example — Incorrect**

The inner transition line does not begin at the left edge of the state.

**Rationale**

Sub ID a:

- Adherence to the rule improves readability.

**Verification**

Model Advisor check: “Check starting point of internal transition in Stateflow” (Simulink Check)

**Last Changed**

R2020a

**See Also**

- JMAAB guideline jc\_0760, which is available in *Control Algorithm Modeling Guidelines Using MATLAB, Simulink, and Stateflow* on the MathWorks website.
- “Inner Transitions” (Stateflow)

**Introduced in R2020a**

# jc\_0763: Usage of multiple internal transitions

## Sub ID Recommendations

- NA-MAAB — a1/a2
- JMAAB — a1/a2

## MATLAB Versions

All

## Rule

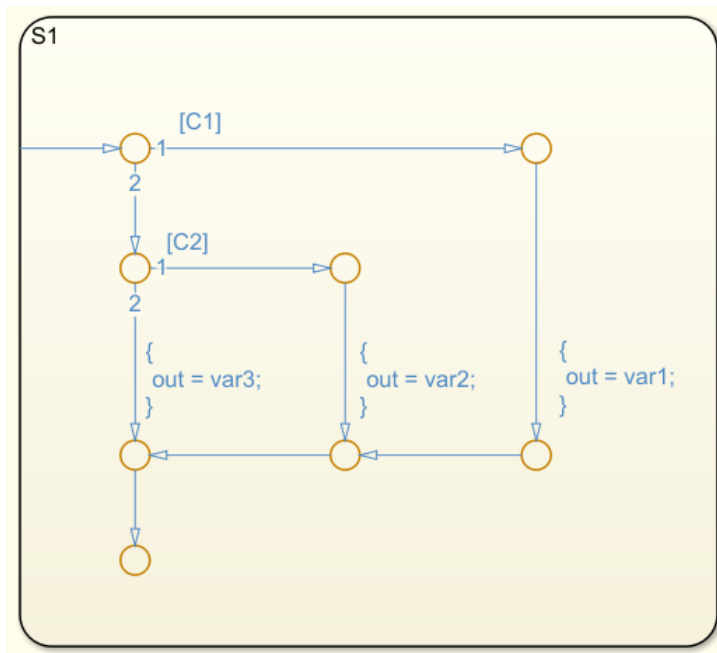
### Sub ID a1

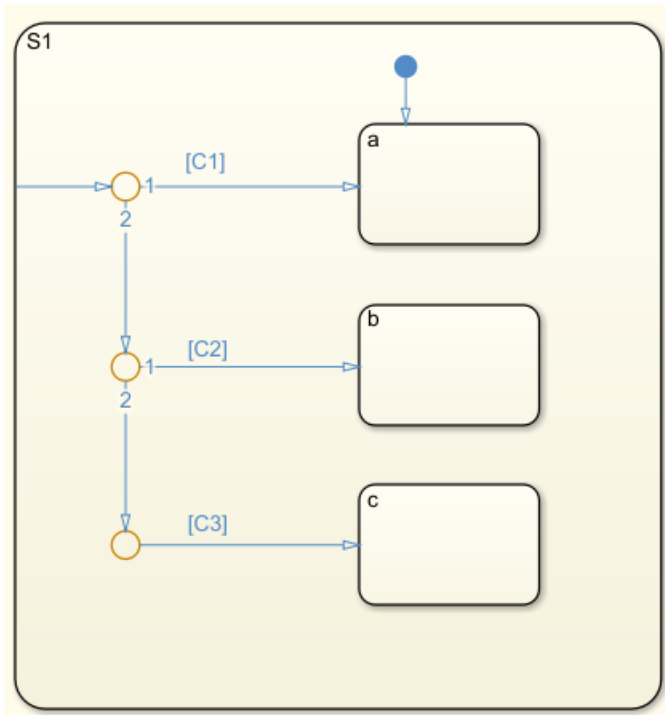
Multiple internal transitions shall not be used in a single state.

### Custom Parameter

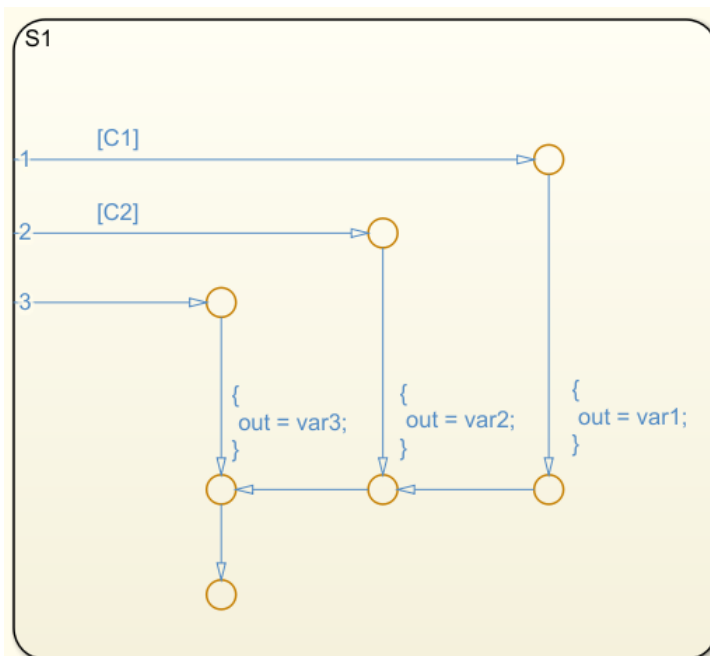
Not Applicable

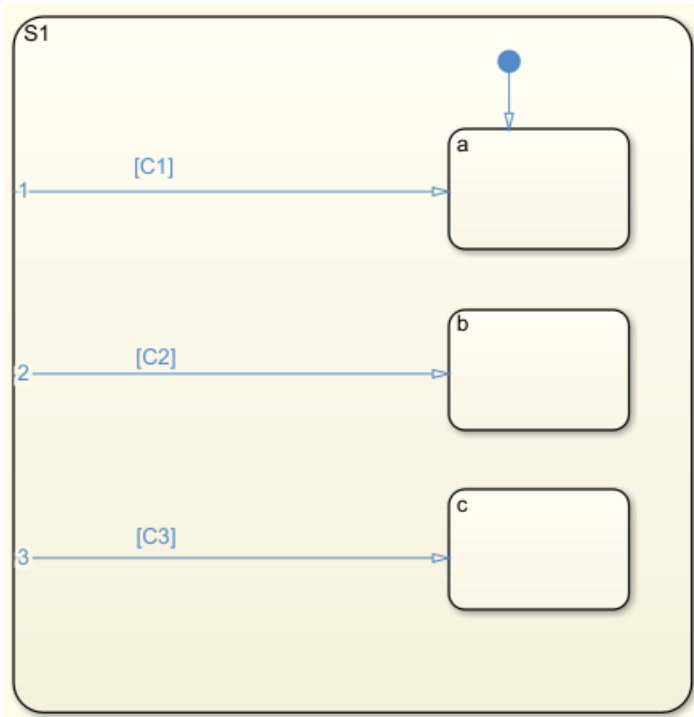
### Example — Correct





Example — Incorrect





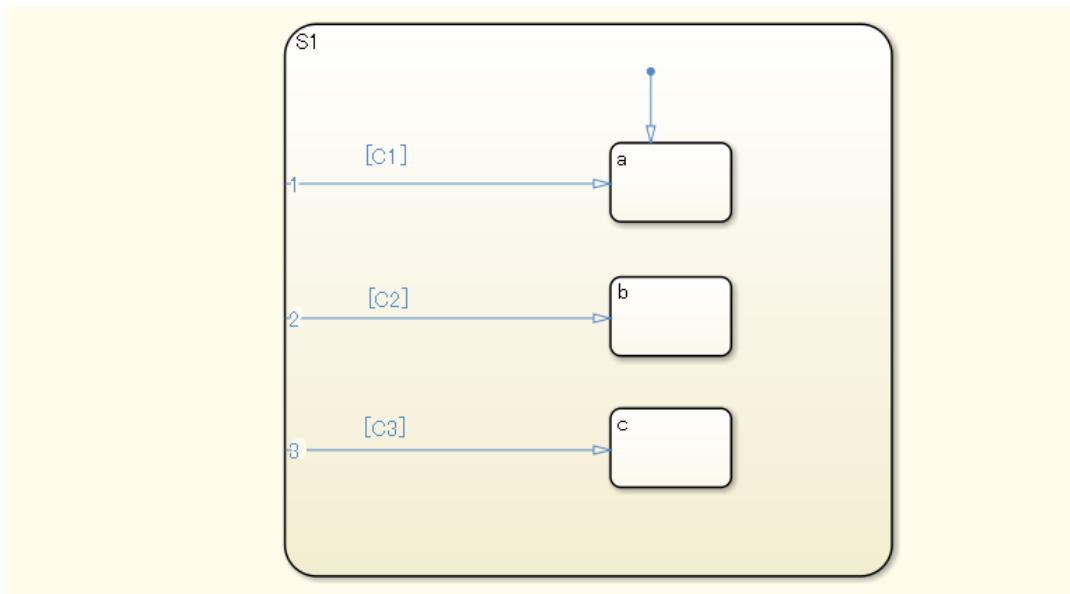
**Sub ID a2**

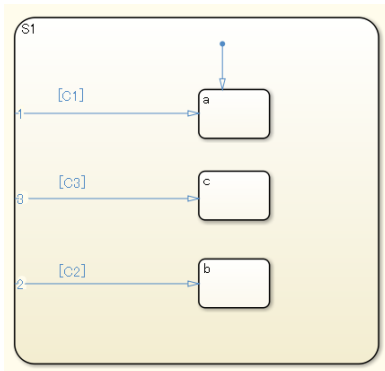
When multiple internal transitions are used in a single state, they shall be listed from top to bottom in the order of execution.

**Custom Parameter**

Not Applicable

**Example — Correct**



**Example — Incorrect****Rationale**

Sub ID a1:

- The number of transition conditions is unclear when multiple internal transitions are used. By limiting the use of internal transitions to a single use, transitions are clearer and readability improves.

Sub ID a1:

- Using multiple internal transitions can prevent transition lines from crossing and simplifies state transitions.
- Arranging internal transitions in execution order improves readability.

**Verification**

Model Advisor check: “Check usage of internal transitions in Stateflow states” (Simulink Check)

**Last Changed**

R2020a

**See Also**

- JMAAB guideline jc\_0763, which is available in *Control Algorithm Modeling Guidelines Using MATLAB, Simulink, and Stateflow* on the MathWorks website.
- “Hierarchy of Stateflow Objects” (Stateflow)
- “Transitions” (Stateflow)
- “Types of Chart Execution” (Stateflow)

**Introduced in R2020a**



# jc\_0762: Prohibition of state action and flow chart combination

## Sub ID Recommendations

- NA-MAAB — a
- JMAAB — a

## MATLAB Versions

All

## Rule

### Sub ID a

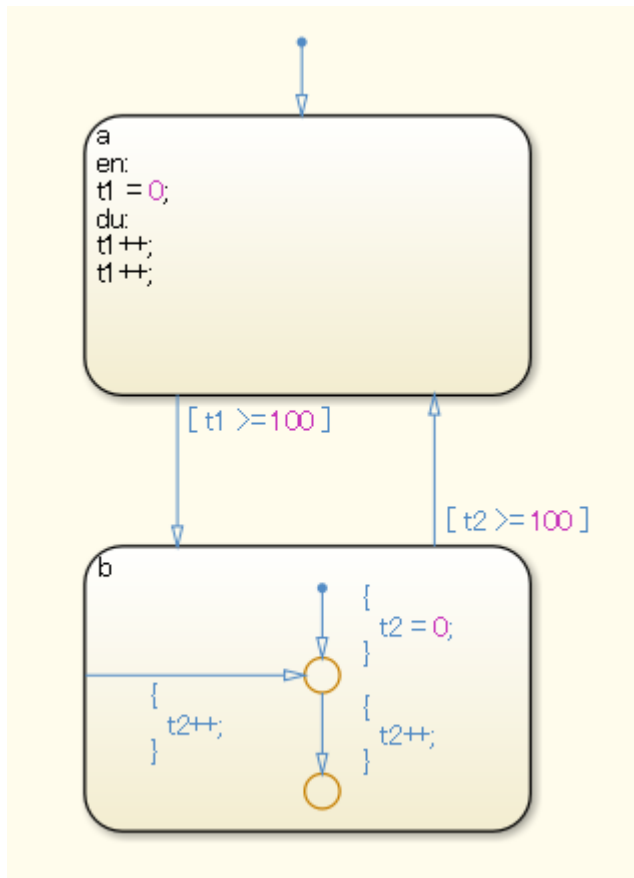
A state shall not include state actions (en, du, or ex) and flow charts.

### Custom Parameter

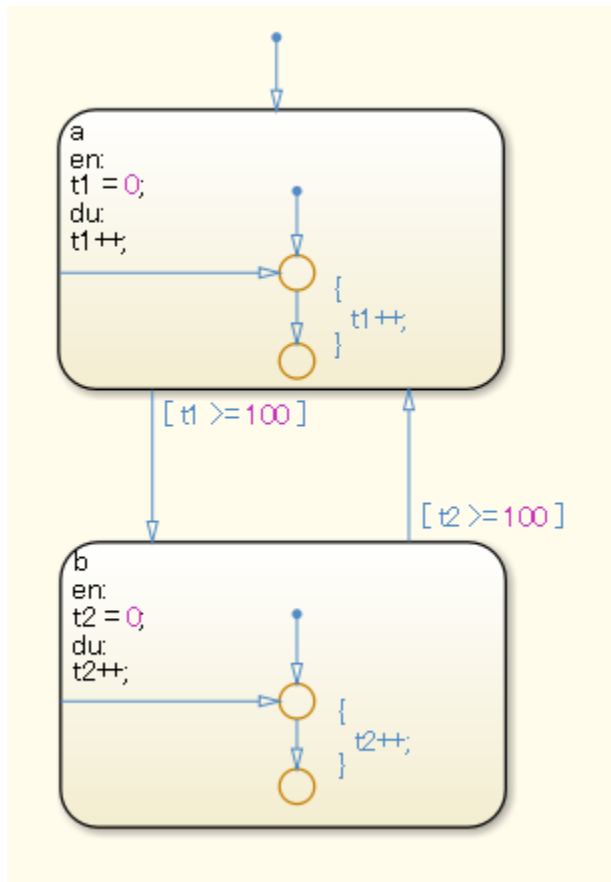
Not Applicable

### Example — Correct

Within the state, only a state action is described.

**Example — Incorrect**

The state includes state actions en and du and also a flow chart.



## Rationale

Sub ID a:

- The execution order becomes difficult to understand, which decreases readability.

## Verification

Model Advisor check: "Check prohibited combination of state action and flow chart" (Simulink Check)

## Last Changed

R2020a

## See Also

- JMAAB guideline jc\_0762, which is available in *Control Algorithm Modeling Guidelines Using MATLAB, Simulink, and Stateflow* on the MathWorks website.
- "Flow Charts in Stateflow" (Stateflow)
- "States" (Stateflow)

**Introduced in R2020a**

# db\_0132: Transitions in flow charts

## Sub ID Recommendations

- NA-MAAB — a, b
- JMAAB — a, b

## MATLAB Versions

All

## Rule

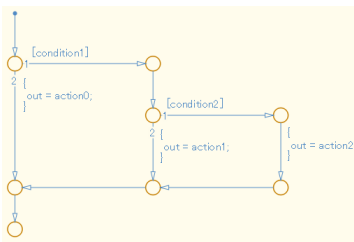
### Sub ID a

Transition actions shall not be used in flow charts.

### Custom Parameter

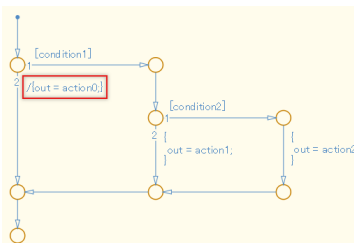
Not Applicable

### Example — Correct



### Example — Incorrect

Transition actions are used.



### Sub ID b

In a flow chart, the condition shall be positioned on a horizontal transition line and the condition action shall be positioned on a vertical transition line.

**Exception**

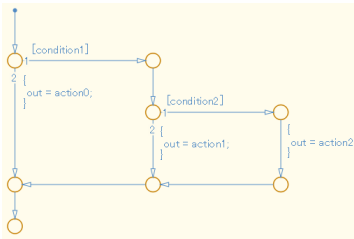
Diagonal transition lines in loop constructs.

**Custom Parameter**

Not Applicable

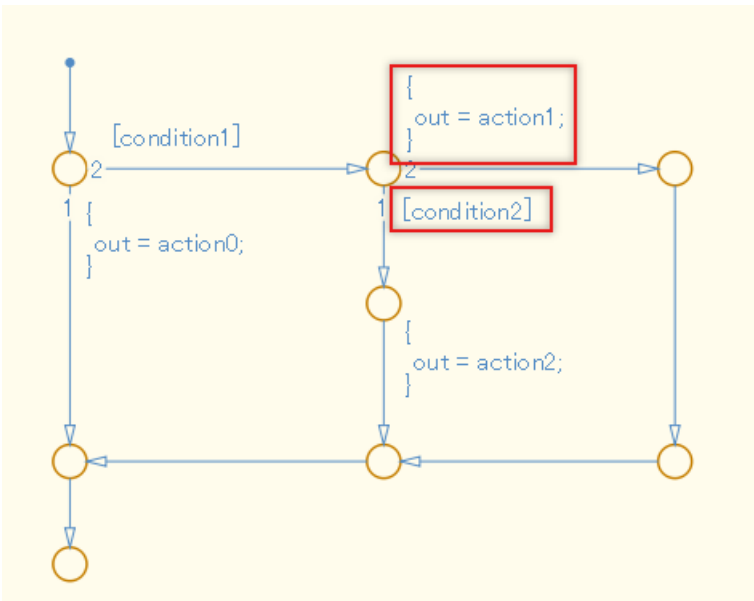
**Example — Correct**

The condition is positioned on a horizontal transition line and the condition action is on a vertical transition line.



**Example — Incorrect**

The condition is positioned on a vertical transition line and the condition action is on a horizontal transition line.



**Rationale**

Sub ID a:

- The transition action in a flow chart is not executed.

Sub ID b:

- Consistent positioning of conditions and condition actions improves readability.

## **Verification**

Model Advisor check: “Check transitions in Stateflow Flow charts” (Simulink Check)

## **Last Changed**

R2020a

## **See Also**

- JMAAB guideline db\_0132, which is available in *Control Algorithm Modeling Guidelines Using MATLAB, Simulink, and Stateflow* on the MathWorks website.
- “Transitions” (Stateflow)
- “Transition Between Operating Modes” (Stateflow)
- “Transitions” (Stateflow)

## **Introduced in R2020a**

## jc\_0773: Unconditional transition of a flow chart

### Sub ID Recommendations

- NA-MAAB — a, b
- JMAAB — a, b

### MATLAB Versions

All

### Rule

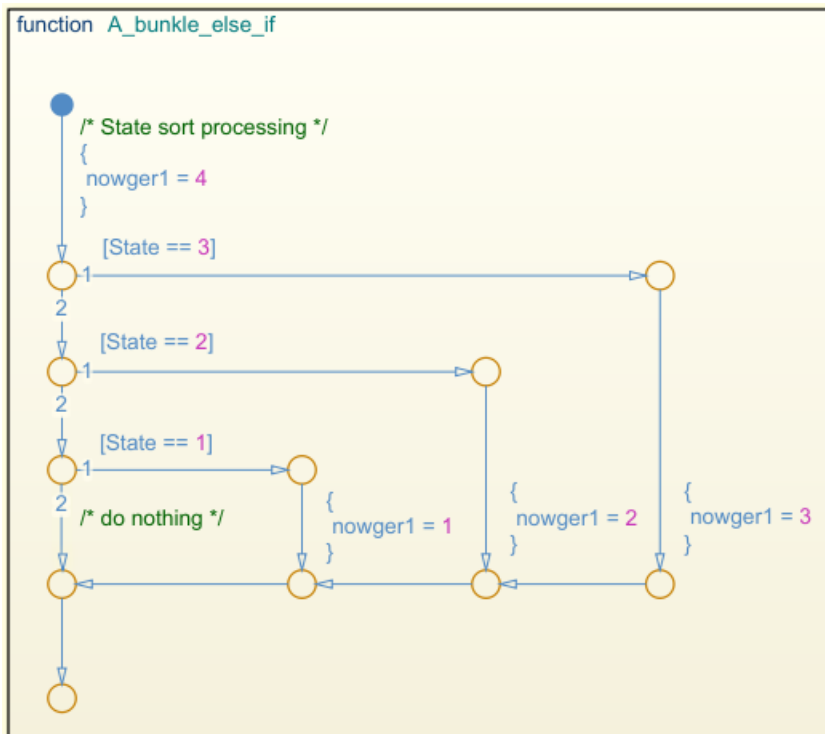
#### Sub ID a

When a transition line with a transition condition originates from a connective junction, the unconditional transition line shall also begin from that junction.

#### Custom Parameter

Not Applicable

#### Example — Correct









- “Transitions” (Stateflow)
- “Execution of a Stateflow Chart” (Stateflow)

**Introduced in R2020a**

## jc\_0775: Terminating junctions in flow charts

### Sub ID Recommendations

- NA-MAAB — a1/a2
- JMAAB — a1/a2

### MATLAB Versions

All

### Rule

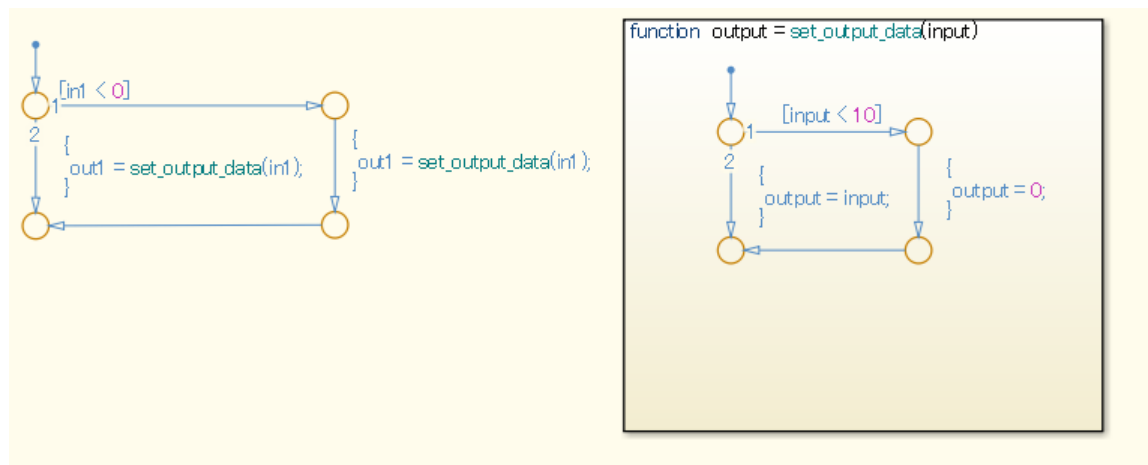
#### Sub ID a1

Only one terminating junction shall be used.

#### Custom Parameter

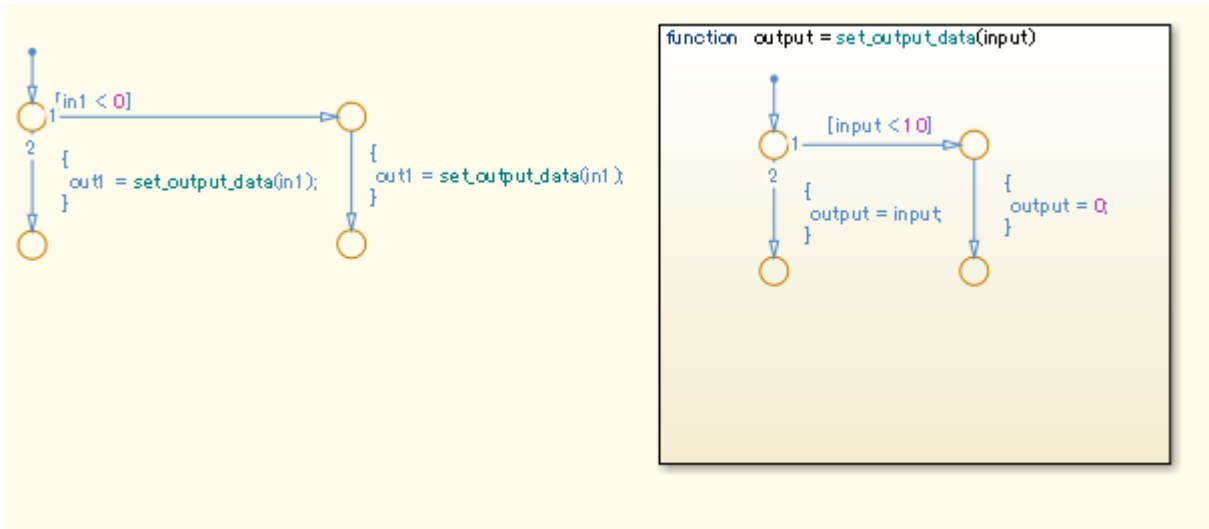
Not Applicable

#### Example — Correct



#### Example — Incorrect

There is more than one terminating junction.



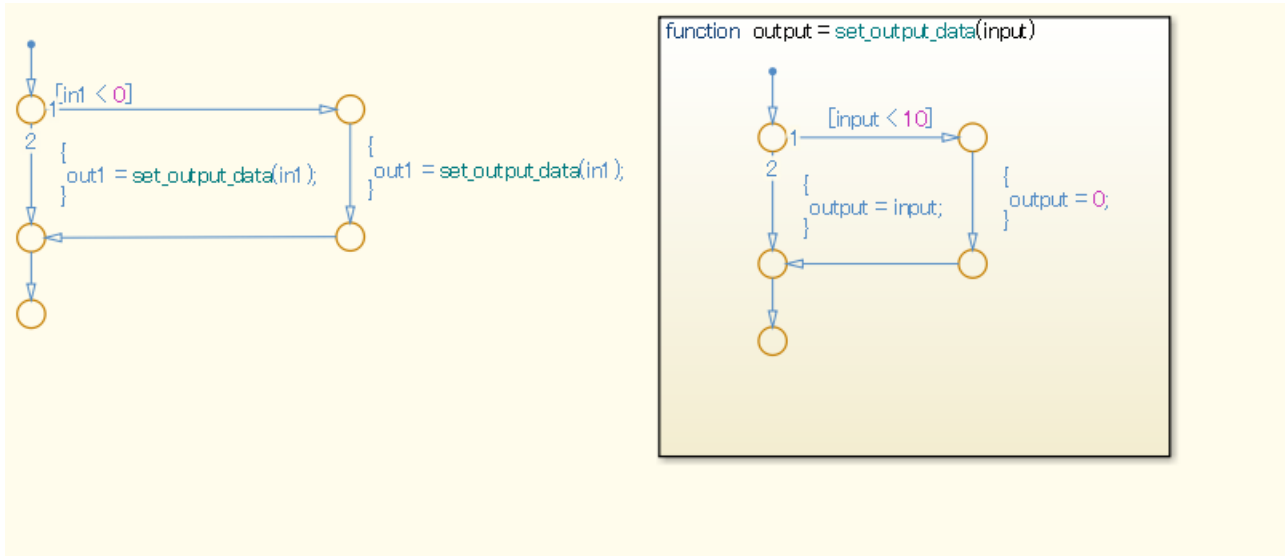
**Sub ID a2**

One terminating junction with a single unconditional transition as the input shall be used.

**Custom Parameter**

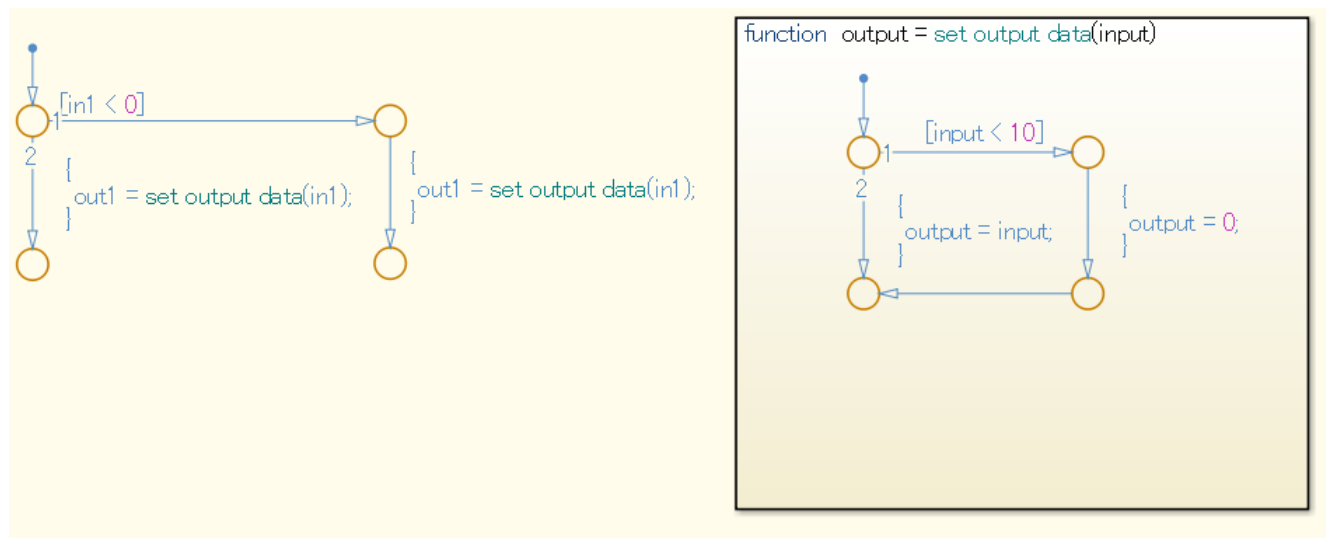
Not Applicable

**Example — Correct**



**Example — Incorrect**

There is more than one terminating junction and input.



## Rationale

Sub IDs a1, a2

- One terminating junction improves understanding of the logic end point.
- Using a consistent style for terminating junction improves readability.

## Verification

Model Advisor check: “Check terminal junctions in Stateflow” (Simulink Check)

## Last Changed

R2020a

## See Also

- JMAAB guideline: `jc_0775`, which is available in *Control Algorithm Modeling Guidelines Using MATLAB, Simulink, and Stateflow* on the MathWorks website.
- “Evaluate Transitions” (Stateflow)
- “Represent Multiple Paths by Using Connective Junctions” (Stateflow)

**Introduced in R2020a**

# jc\_0738: Usage of Stateflow comments

## Sub ID Recommendations

- NA-MAAB — a
- JMAAB — a, b

## MATLAB Versions

All

## Rule

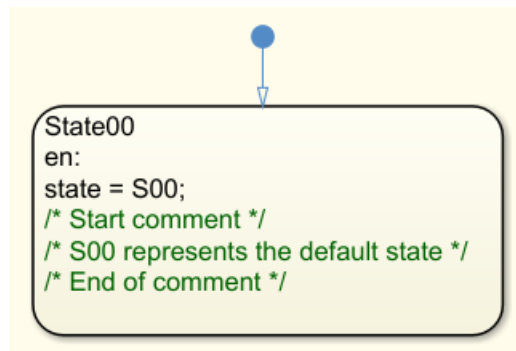
### Sub ID a

When Chart parameter **Action Language** is set to C, `/* . . . */` comment nesting shall not be used.

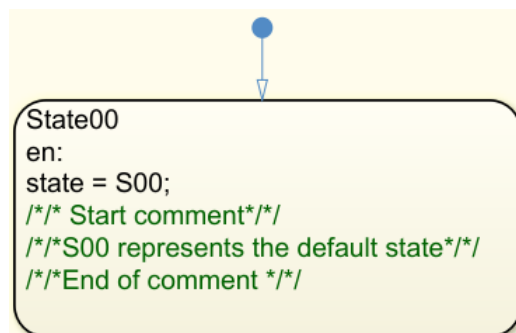
### Custom Parameter

Not Applicable

### Example — Correct



### Example — Incorrect

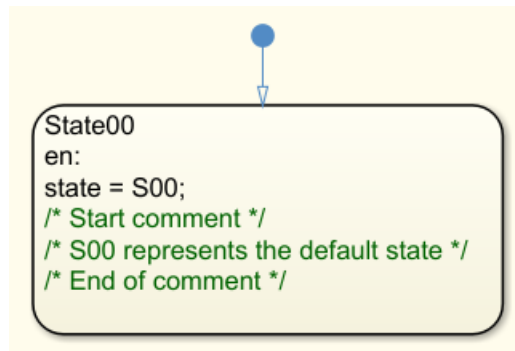
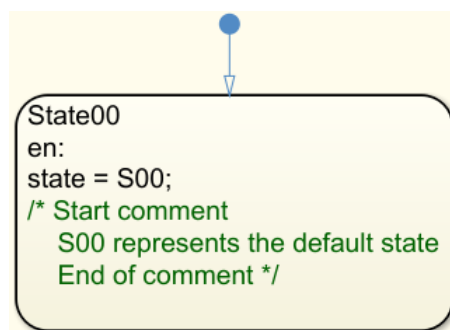


**Sub ID b**

When Chart parameter **Action Language** is set to C, new line characters for comments `/* */` shall not be used in the middle of a single comment.

**Custom Parameter**

Not Applicable

**Example — Correct****Example — Incorrect****Rationale**

Sub ID a:

- The compiler can misinterpret the comments as a program.

Sub ID b:

- A line break in the middle of a comment makes it difficult to determine whether the part being edited is in the comment. There is also a possibility that the comment is nested.
- When Chart parameter **Action Language** is set to MATLAB, comments must use %.

**Verification**

Model Advisor check: “Check usage of Stateflow comments” (Simulink Check)



## Last Changed

R2020a

## See Also

- JMAAB guideline jc\_0738, which is available in *Control Algorithm Modeling Guidelines Using MATLAB, Simulink, and Stateflow* on the MathWorks website.
- “Differences Between MATLAB and C as Action Language Syntax” (Stateflow)
- “Modify the Action Language for a Chart” (Stateflow)

## Introduced in R2020a

## **Conditional Transition / Action**

# jc\_0790: Action language of Chart block

## Sub ID Recommendations

- NA-MAAB — No recommendations
- JMAAB — a

## MATLAB Versions

All

## Rule

### Sub ID a

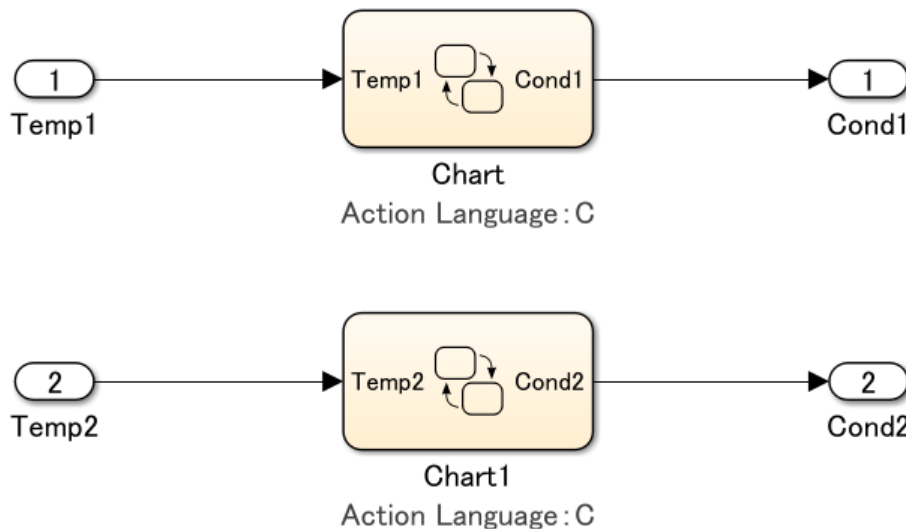
Stateflow Chart property **Action Language** shall be set to C.

### Custom Parameter

Not Applicable

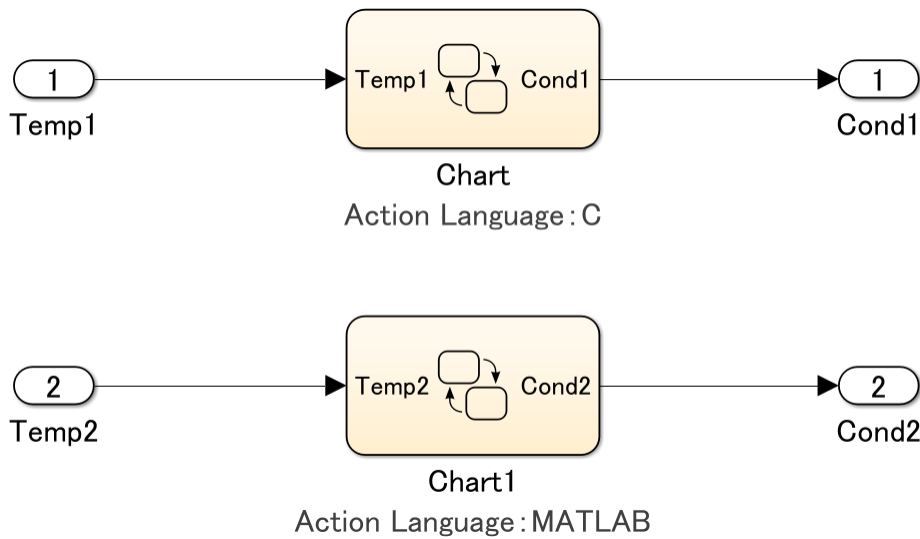
### Example — Correct

The **Action Language** is set to C.



### Example — Incorrect

The **Action Language** is set to MATLAB.



## Rationale

Sub ID a:

- Using a consistent action language improves readability because there is not a difference in syntax.
- Easier to maintain consistency between the model and the generated code when using C as the action language as compared to MATLAB.
- Easier to understand the model for users who are familiar with the C programming language.

## Verification

Model Advisor check: “Check Stateflow chart action language” (Simulink Check)

## Last Changed

R2020a

## See Also

- JMAAB guideline [jc\\_0790](#), which is available in *Control Algorithm Modeling Guidelines Using MATLAB, Simulink, and Stateflow* on the MathWorks website.
- “Modify the Action Language for a Chart” (Stateflow)
- “Differences Between MATLAB and C as Action Language Syntax” (Stateflow)

**Introduced in R2020a**

# jc\_0702: Use of named Stateflow parameters and constants

## Sub ID Recommendations

- NA-MAAB — a
- JMAAB — a

## MATLAB Versions

All

## Rule

### Sub ID a

Stateflow block shall not use numeric literal.

### Exceptions

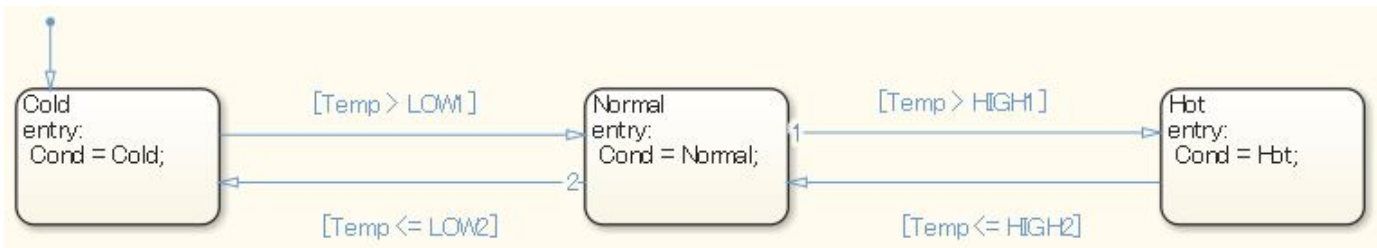
- Initial value is 0
- Increment, decrement 1

### Custom Parameter

Not Applicable

### Example — Correct

Numeric literals are not used.

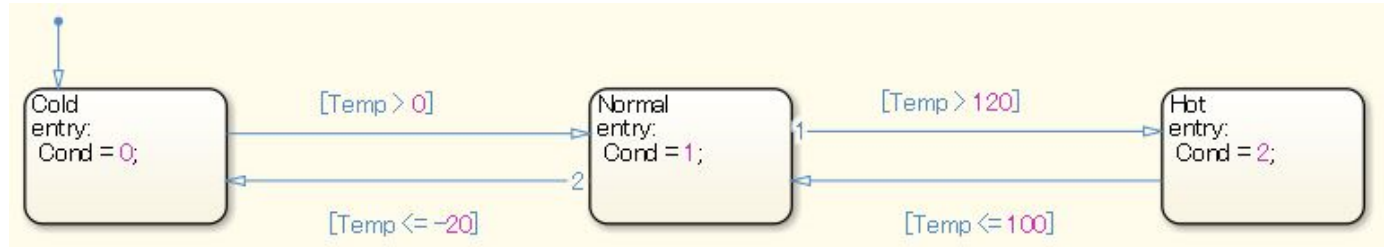


```

jc0702a_OK_parameter.m
1  %
2  -  HIGH1=100;
3  -  HIGH2=120;
4  -  LOW1=0;
5  -  LOW2=10;
  
```

**Example — Incorrect**

Numeric literals are used.

**Rationale**

Sub ID a:

- Only the modeler will understand the purpose of the value when numeric literals are used to write constants, which decreases readability.
- Constants that are intended for calibration are generated in the code using numeric literals.

**Verification**

Model Advisor check: “Check usage of numeric literals in Stateflow” (Simulink Check)

**Last Changed**

R2020a

**See Also**

- JMAAB guideline jc\_0702, which is available in *Control Algorithm Modeling Guidelines Using MATLAB, Simulink, and Stateflow* on the MathWorks website.
- “Guidelines for Naming Stateflow Objects” (Stateflow)

**Introduced in R2020a**

# jm\_0011: Pointers in Stateflow

## Sub ID Recommendations

- NA-MAAB — a
- JMAAB — a

## MATLAB Versions

All

## Rule

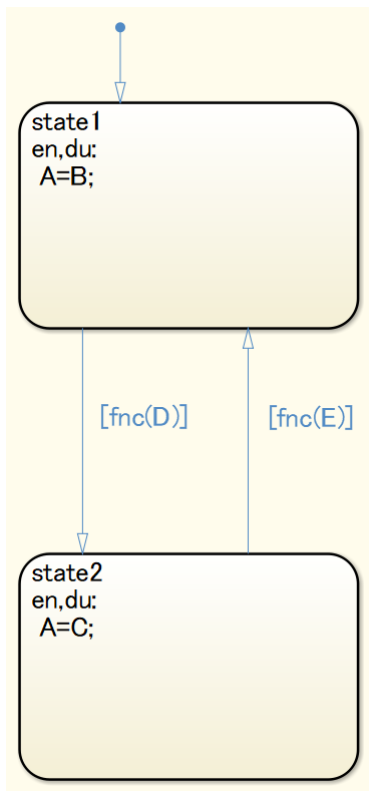
### Sub ID a

Stateflow Chart shall not use pointer variables.

### Custom Parameter

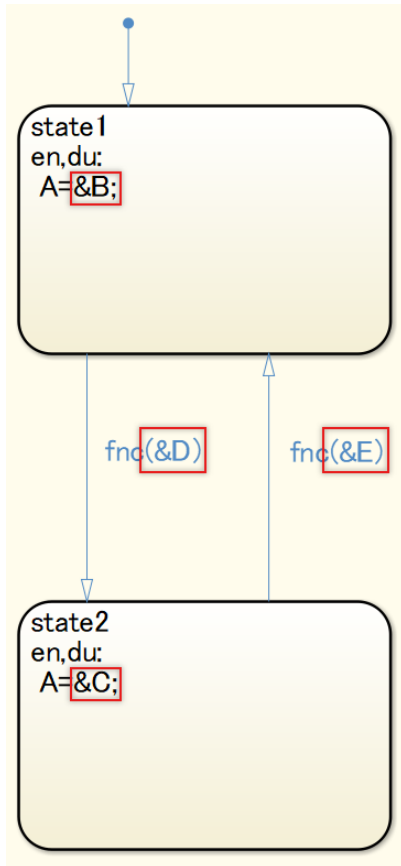
Not Applicable

### Example — Correct



**Example — Incorrect**

Pointer variables are used.

**Rationale**

Sub ID a:

- Readability is impaired when pointer variables are used.
- Code generation may not be possible.

**Verification**

Model Advisor check: “Check for pointers in Stateflow charts” (Simulink Check)

**Last Changed**

R2020a

**See Also**

- JMAAB guideline jm\_0011, which is available in *Control Algorithm Modeling Guidelines Using MATLAB, Simulink, and Stateflow* on the MathWorks website.



- “Pointer and Address Operations” (Stateflow)

**Introduced in R2020a**

## jc\_0491: Reuse of Stateflow data

### Sub ID Recommendations

- NA-MAAB — a
- JMAAB — a

### MATLAB Versions

All

### Rule

#### Sub ID a

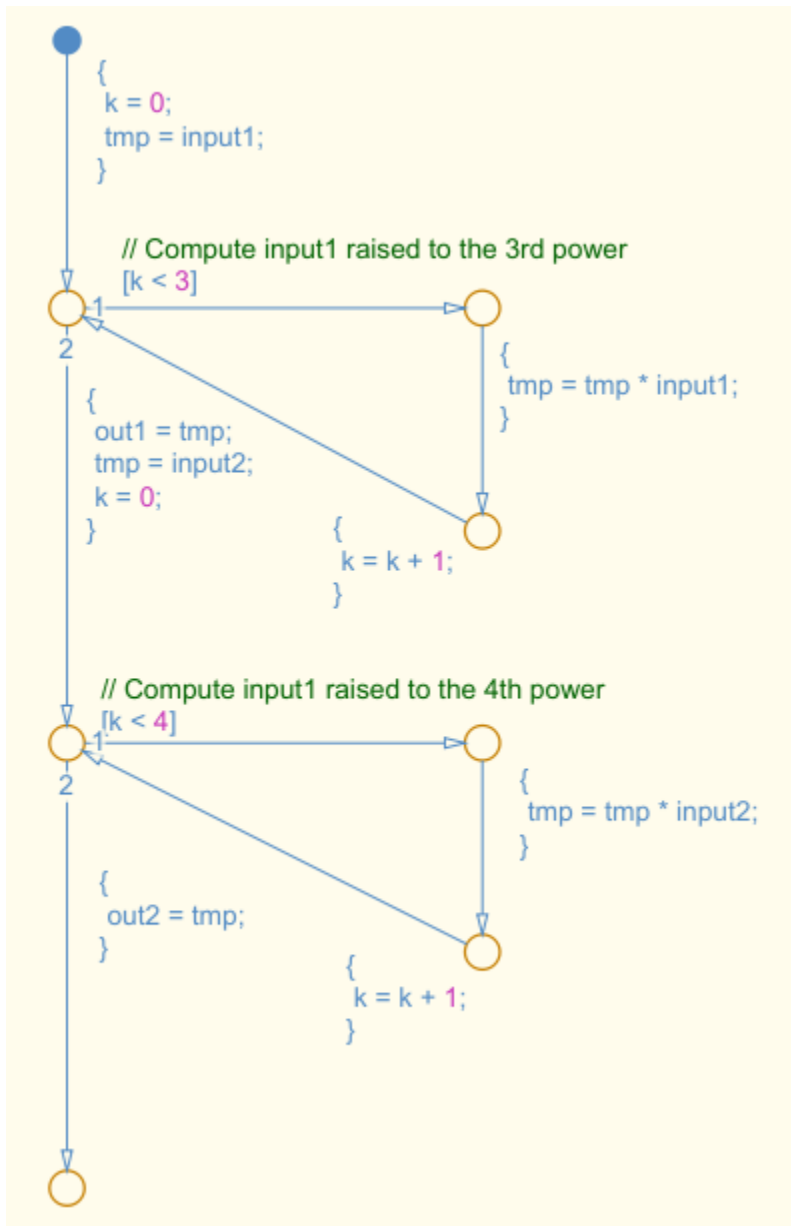
A variable shall not have multiple meanings (usages) in a single Stateflow Chart.

#### Custom Parameter

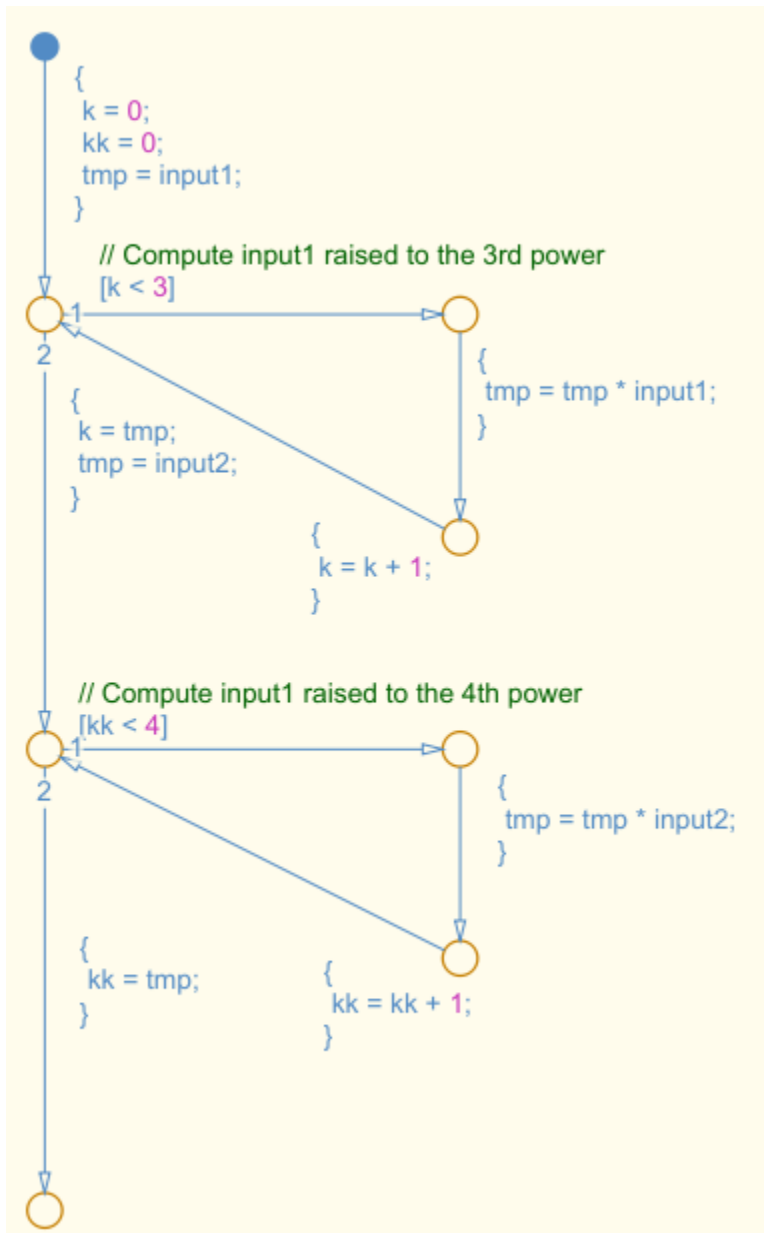
Not Applicable

#### Example — Correct

Variable does not have multiple usages.

**Example — Incorrect**

Variables  $k$  and  $kk$  have multiple usages in the Stateflow Chart.



## Rationale

Sub ID a:

- Variables can be misinterpreted when the variable name is different than the meaning of the numerical value that is assigned to the variable.

## Verification

Model Advisor check: Adherence to this modeling guideline cannot be verified by using a Model Advisor check.

## Last Changed

R2020a

## See Also

- JMAAB guideline jc\_0491, which is available in *Control Algorithm Modeling Guidelines Using MATLAB, Simulink, and Stateflow* on the MathWorks website.
- “Construct and Run a Stateflow Chart” (Stateflow)

## Introduced in R2020a

## jm\_0012: Usage restrictions of events and broadcasting events

### Sub ID Recommendations

- NA-MAAB — No recommendations
- JMAAB — a1/a2/a3

### MATLAB Versions

All

### Rule

#### Sub ID a1

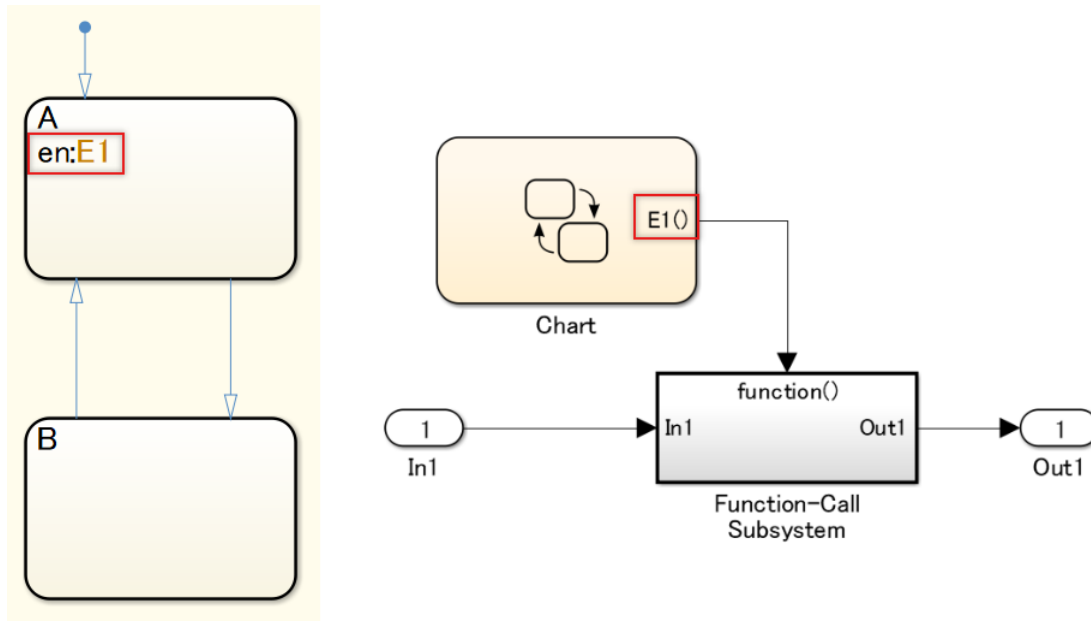
Stateflow events shall be used only in Stateflow Chart output.

#### Custom Parameter

Not Applicable

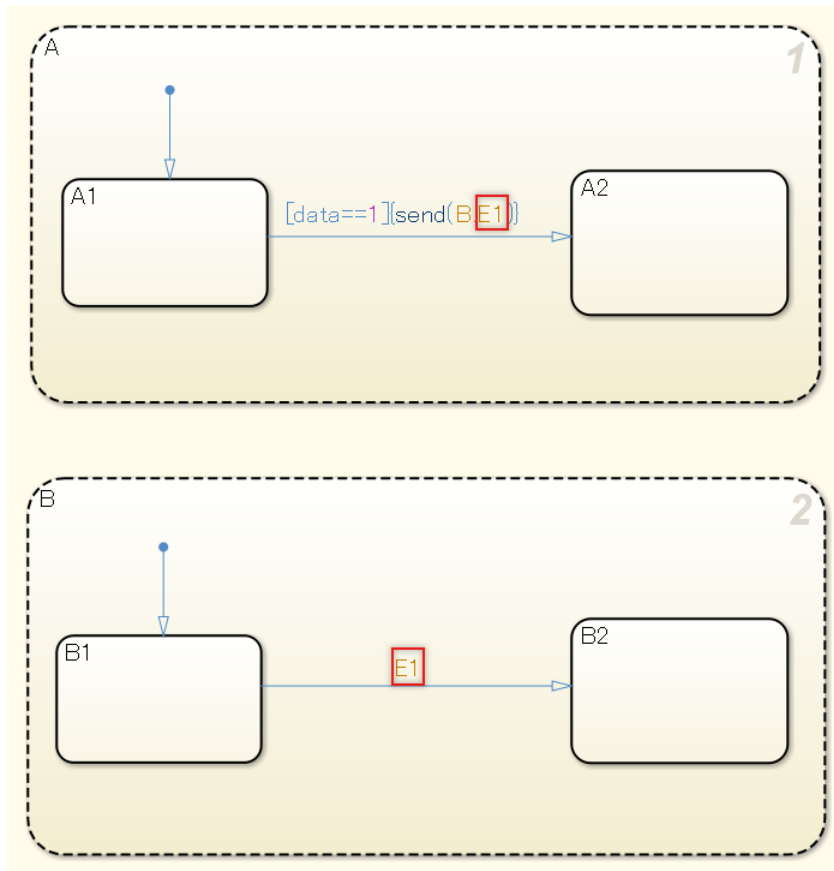
#### Example — Correct

Event is used only in the Stateflow Chart output.



#### Example — Incorrect

Event is used other than in the Stateflow Chart output.

**Sub ID a2**

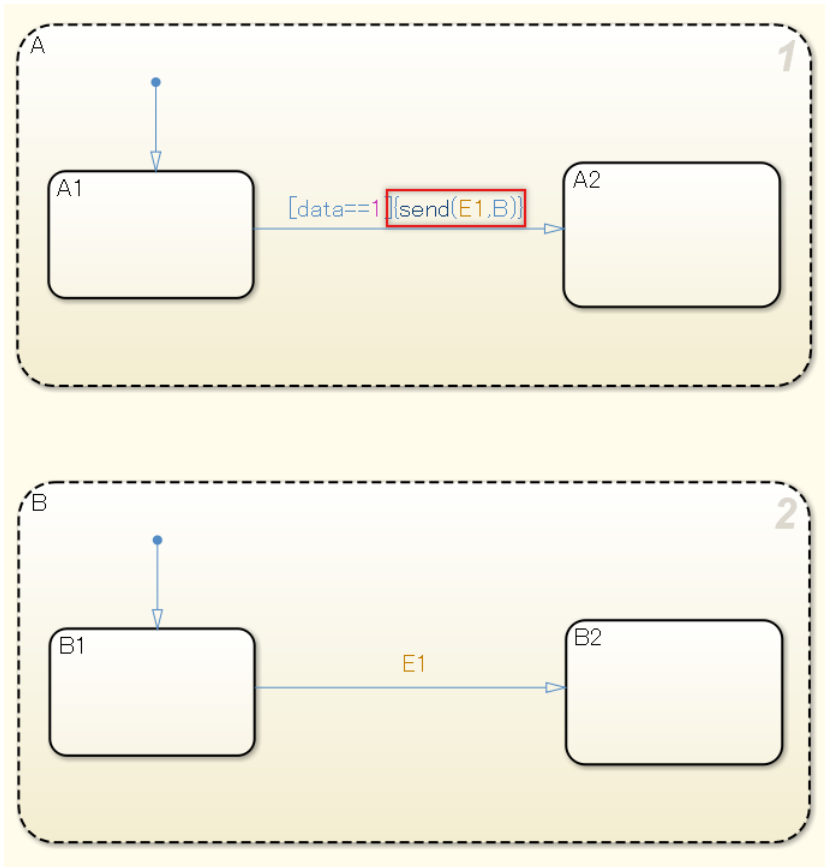
The send syntax `send(event_name, state_name)` shall be used to broadcast Stateflow events.

**Custom Parameter**

Not Applicable

**Example — Correct**

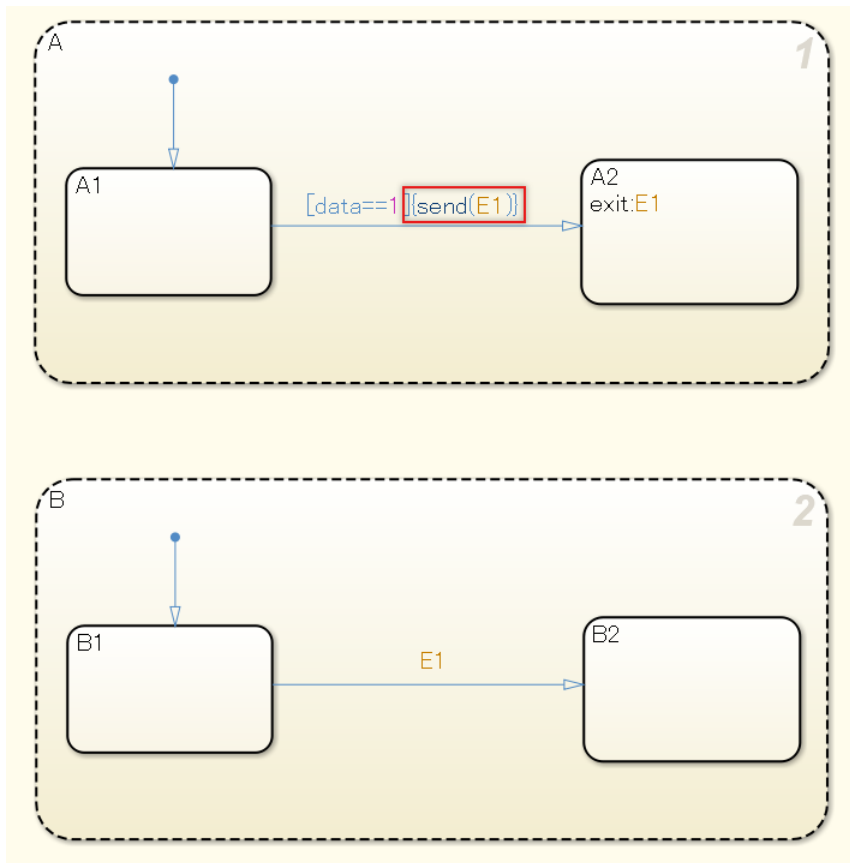
Event is broadcast using the `send` syntax.



**Example – Incorrect**

The state that receives the broadcast has not been defined in the send syntax.



**Sub ID a3**

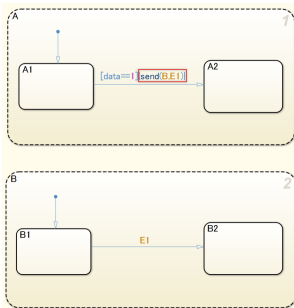
The send syntax `send(state_name.event_name)` with the qualified event name shall be used to broadcast Stateflow events.

**Custom Parameter**

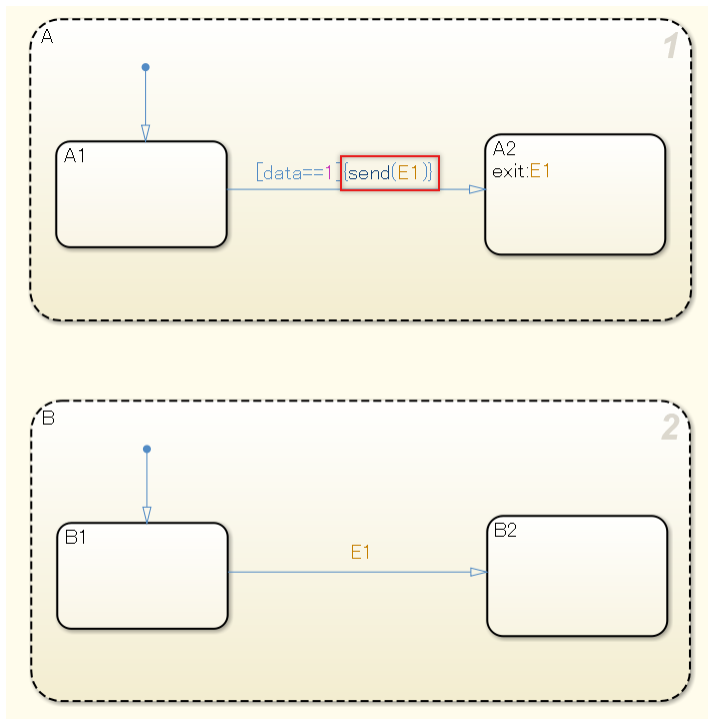
Not Applicable

**Example — Correct**

The qualified event name is used in the event being broadcast.

**Example — Incorrect**

The state that receives the broadcast has not been described in the send syntax.



## Rationale

Sub ID a1:

- Recursive processing in a chart is prevented by using Stateflow events in the Stateflow Chart output only.

Sub IDs a2, a3:

- Improves readability because transitions that are triggered by events are clearly identified.

## Verification

Model Advisor check: “Check for usage of events and broadcasting events in Stateflow charts” (Simulink Check)

## Last Changed

R2020a

## See Also

- JMAAB guideline `jm_0012`, which is available in *Control Algorithm Modeling Guidelines Using MATLAB, Simulink, and Stateflow* on the MathWorks website.
- “Events” (Stateflow)
- “Use Events to Execute Charts” (Stateflow)

- “Broadcast Local Events to Synchronize Parallel States” (Stateflow)

**Introduced in R2020a**

## jc\_0733: Order of state action types

### Sub ID Recommendations

- NA-MAAB — a, b
- JMAAB — a, b

### MATLAB Versions

All

### Rule

#### Sub ID a

Basic state action types shall be stated in this order:

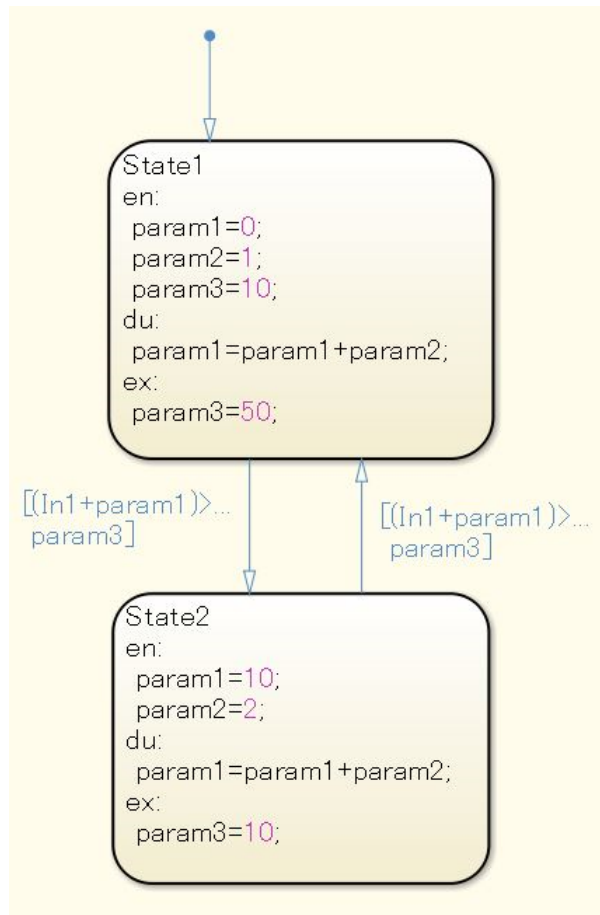
entry (en)

during (du)

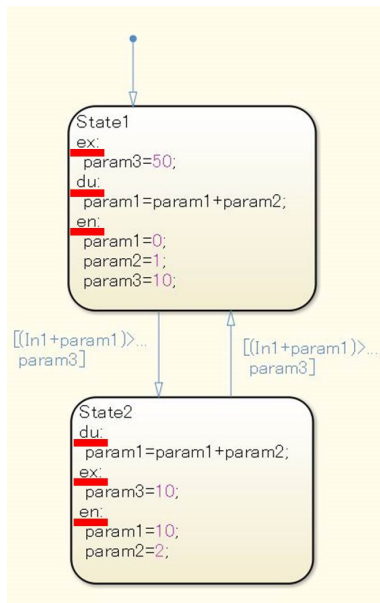
exit (ex)

#### Custom Parameter

Not Applicable

**Example — Correct****Example — Incorrect**

Action types are out of order.



### Sub ID b

Combined state action types shall be stated in this order:

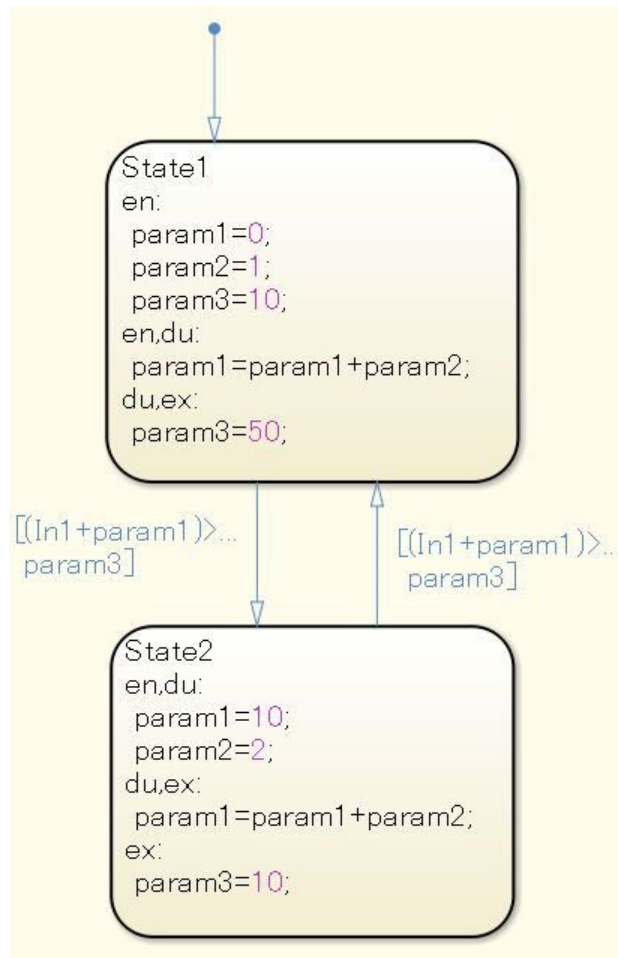
entry (en)

during (du)

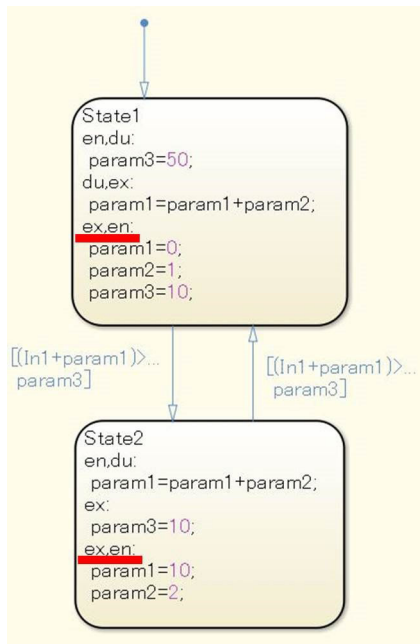
exit (ex)

### Custom Parameter

Not Applicable

**Example – Correct****Example – Incorrect**

Action types are out of order



## Rationale

Sub ID a:

- Consistent modelling improves readability and maintainability.

## Verification

Model Advisor check: “Check order of state action types” (Simulink Check)

## Last Changed

R2020a

## See Also

- JMAAB guideline jc\_0733, which is available in *Control Algorithm Modeling Guidelines Using MATLAB, Simulink, and Stateflow* on the MathWorks website.
- “States” (Stateflow)
- “During Actions” (Stateflow)
- “Exit a State” (Stateflow)

**Introduced in R2020a**



# jc\_0734: Number of state action types

## Sub ID Recommendations

- NA-MAAB — a
- JMAAB — a

## MATLAB Versions

All

## Rule

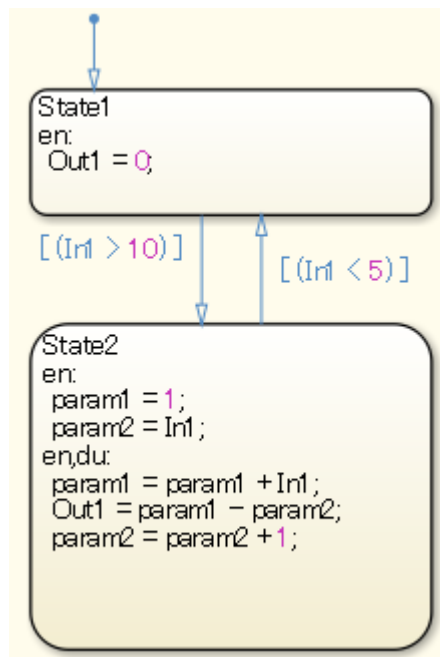
### Sub ID a

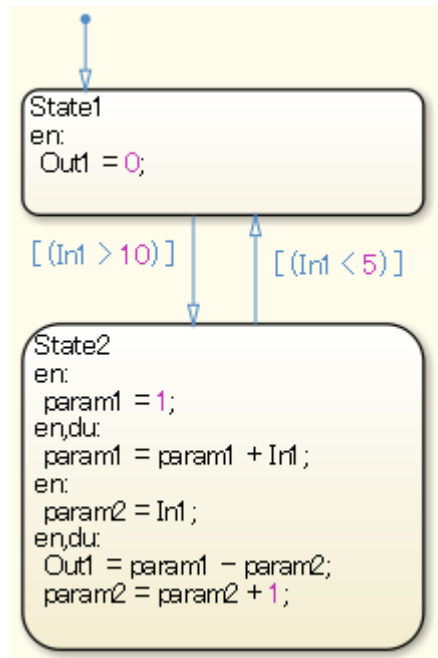
State action types shall not describe the same thing more than twice.

### Custom Parameter

Not Applicable

### Example — Correct



**Example — Incorrect****Rationale**

Sub ID a:

- The execution order will differ depending on the order in which they are described.
- Execution order can be difficult to understand when the action type is described multiple times.

**Verification**

Model Advisor check: “Check repetition of Action types” (Simulink Check)

**Last Changed**

R2020a

**See Also**

- JMAAB guideline [jc\\_0734](#), which is available in *Control Algorithm Modeling Guidelines Using MATLAB, Simulink, and Stateflow* on the MathWorks website.
- “States” (Stateflow)

**Introduced in R2020a**

## jc\_0740: Limitation on use of exit state action

### Sub ID Recommendations

- NA-MAAB — No recommendations
- JMAAB — a

### MATLAB Versions

All

### Rule

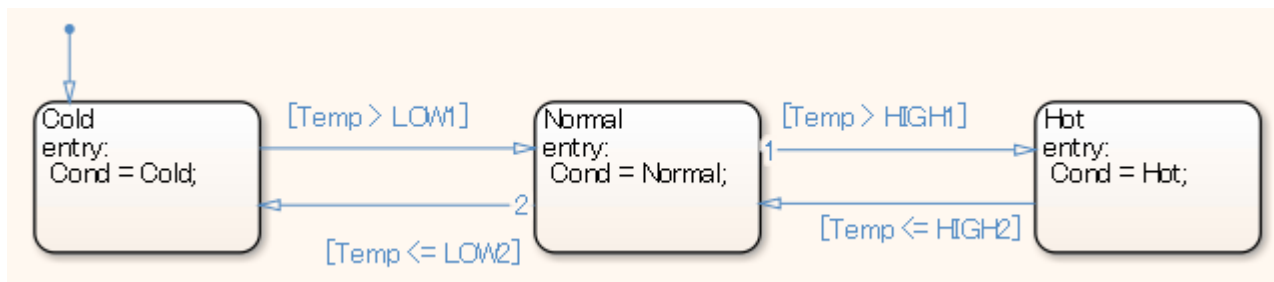
#### Sub ID a

State action type `exit(ex)` shall not be used.

#### Custom Parameter

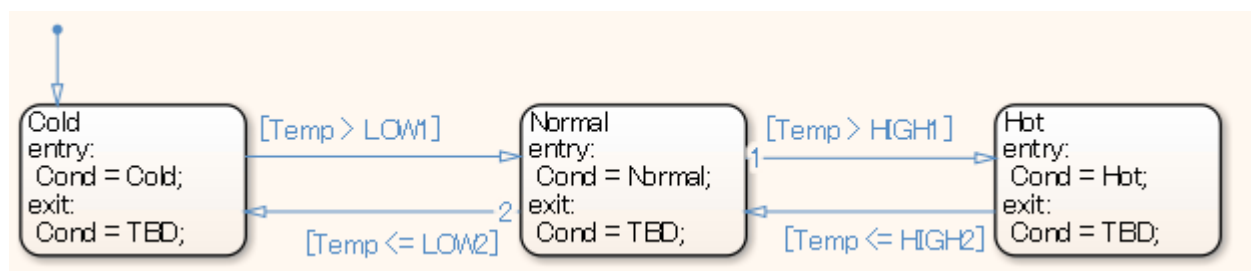
Not Applicable

#### Example — Correct



#### Example — Incorrect

This example illustrates how the model behavior in Stateflow Chart is misinterpreted. It appears that TBD is output when state action type `exit(ex)` is used, but it is in fact being overwritten by the state action type entry of the transition destination state. It is not outputted by the Stateflow Chart.



## Rationale

Sub ID a:

- Execution timing can be difficult to understand when state action type `exit(ex)` is used in combination with a conditional action, a transition action, or state action type `entry(en)`. This can result in misinterpretation of the model behavior.

## Verification

Model Advisor check: “Check if state action type 'exit' is used in the model” (Simulink Check)

## Last Changed

R2020a

## See Also

- JMAAB guideline `jc_0740`, which is available in *Control Algorithm Modeling Guidelines Using MATLAB, Simulink, and Stateflow* on the MathWorks website.
- “State Actions” (Stateflow)
- “Exit a State” (Stateflow)

**Introduced in R2020a**

# jc\_0741: Timing to update data used in state chart transition conditions

## Sub ID Recommendations

- NA-MAAB — No recommendations
- JMAAB — a

## MATLAB Versions

All

## Rule

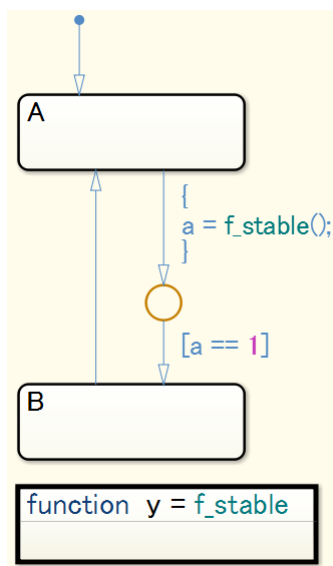
### Sub ID a

Variables that are used in a state transition condition shall not use state action du to perform an update.

### Custom Parameter

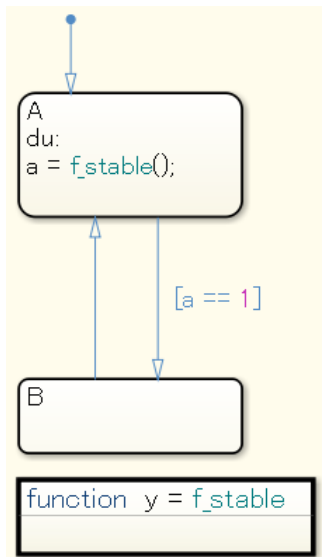
Not Applicable

### Example — Correct



### Example — Incorrect

State action du is used to perform an update.



### Rationale

Sub ID a:

- The execution order of the transition condition and implement of during can be difficult to understand, which increases the risk of errors.

### Verification

Model Advisor check: “Check updates to variables used in state transition conditions” (Simulink Check)

### Last Changed

R2020a

### See Also

- JMAAB guideline `jc_0741`, which is available in *Control Algorithm Modeling Guidelines Using MATLAB, Simulink, and Stateflow* on the MathWorks website.
- “Transitions” (Stateflow)
- “States” (Stateflow)
- “Execution of a Stateflow Chart” (Stateflow)

**Introduced in R2020a**

# jc\_0772: Execution order and transition conditions of transition lines

## Sub ID Recommendations

- NA-MAAB — a
- JMAAB — a

## MATLAB Versions

All

## Rule

### Sub ID a

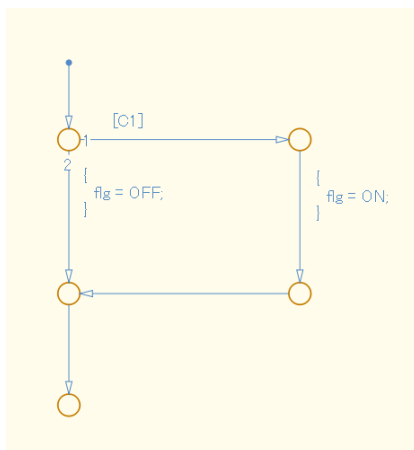
All transition paths shall be executable by setting configuration parameter:

- (R2011b to R2016a) Set **Transition shadowing** to error.
- (R2016b and later) Set **Unreachable execution path** to error.

### Custom Parameter

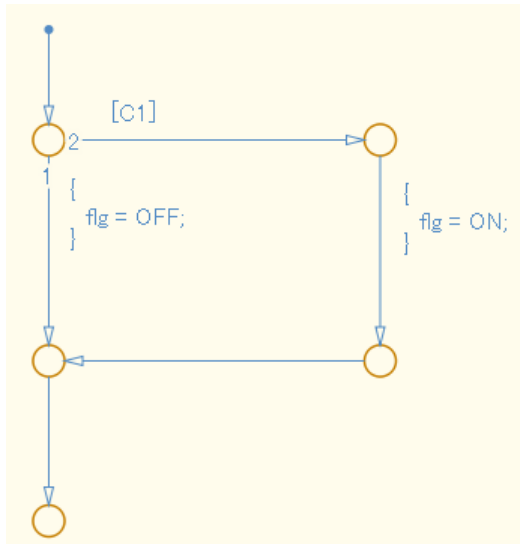
Not Applicable

### Example — Correct



### Example — Incorrect

Execution order 1 is an unconditional transition and conditional expression [C1] is described in execution condition 2.



## Rationale

Sub ID a:

- An unconditional transition that is in a position other than the last in the execution order causes the subsequent transition to be a dead path, which results in unintended simulation behavior.

## Verification

Model Advisor check: “Check usage of transition conditions in Stateflow transitions” (Simulink Check)

## Last Changed

R2020a

## See Also

- JMAAB guideline jc\_0772, which is available in *Control Algorithm Modeling Guidelines Using MATLAB, Simulink, and Stateflow* on the MathWorks website.
- “Transitions” (Stateflow)
- “Types of Chart Execution” (Stateflow)
- “Execution of a Stateflow Chart” (Stateflow)

**Introduced in R2020a**



# jc\_0753: Condition actions and transition actions in Stateflow

## Sub ID Recommendations

- NA-MAAB — a1/a2
- JMAAB — a1/a2

## MATLAB Versions

All

## Rule

### Sub ID a1

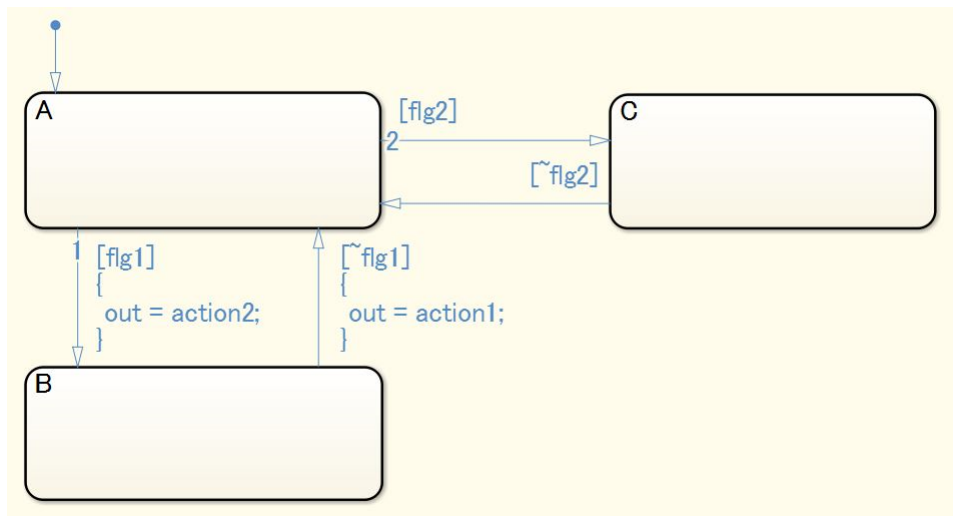
Transition actions shall not be used in a Stateflow Chart.

### Custom Parameter

Not Applicable

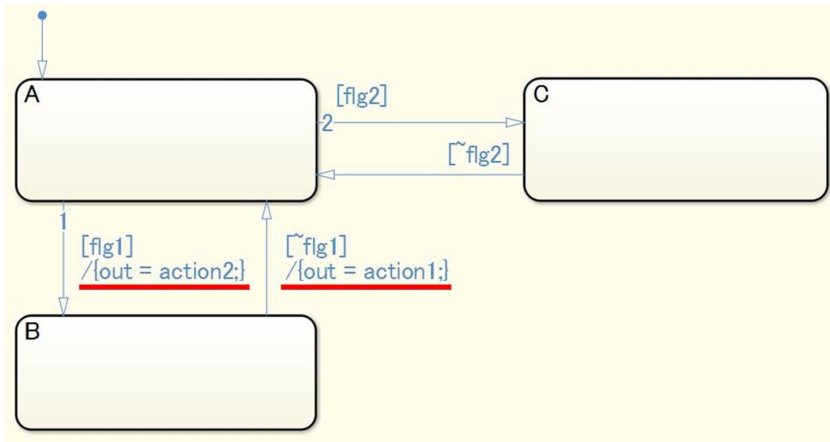
### Example — Correct

Only a condition action is used.



### Example — Incorrect

A transition action is used.



**Sub ID a2**

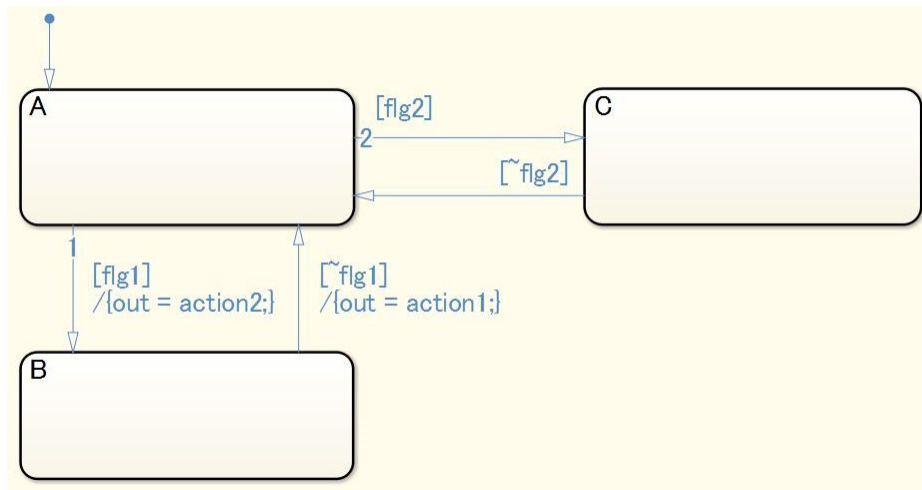
Condition actions and transition actions shall not be combined in the same Stateflow Chart.

**Custom Parameter**

Not Applicable

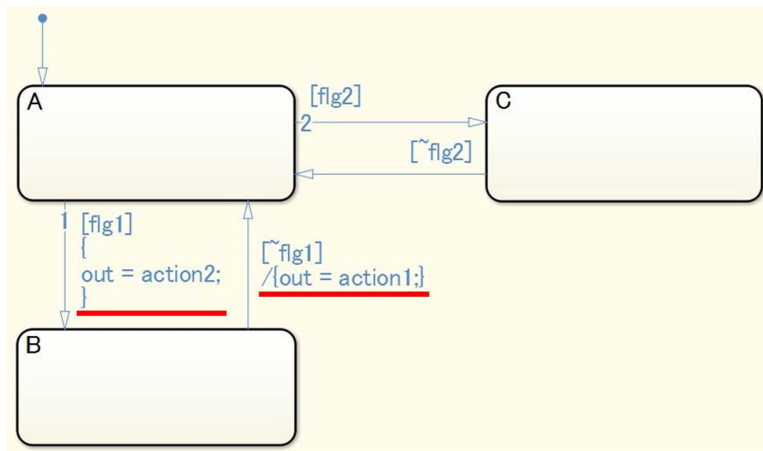
**Example – Correct**

Either a condition action or a transition action can be used. (The following diagram illustrates a transition action.)



**Example – Incorrect**

Includes both a condition action and a transition action.



## Rationale

Sub ID a1:

- Prevents confusion with a condition action, thus improving readability.

Sub ID a2:

- A condition action executes upon entering a transition. A transition action executes after determining whether it can transition to the next state. Adherence to the rule prevents confusion between a conditional action and a transition action.

## Verification

Model Advisor check: “Check condition actions and transition actions in Stateflow” (Simulink Check)

## Last Changed

R2020a

## See Also

- JMAAB guideline jc\_0753, which is available in *Control Algorithm Modeling Guidelines Using MATLAB, Simulink, and Stateflow* on the MathWorks website.
- “Condition and Transition Actions” (Stateflow)

**Introduced in R2020a**

## jc\_0711: Division in Stateflow

### Sub ID Recommendations

- NA-MAAB — a1/a2
- JMAAB — a1/a2

### MATLAB Versions

All

### Rule

#### Sub ID a1

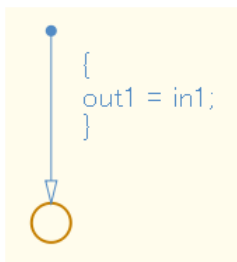
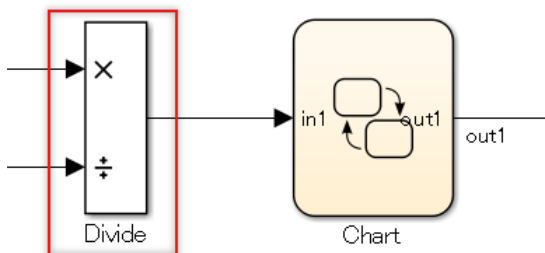
Variables, constants, or parameters in Stateflow Chart shall not be used to perform division operations.

#### Custom Parameter

Not Applicable

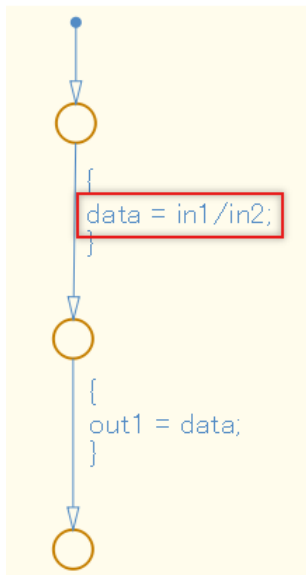
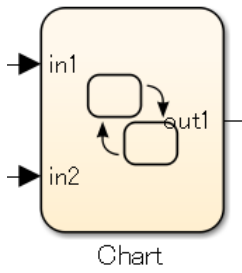
#### Example — Correct

Division is performed outside of the Stateflow Chart.



#### Example — Incorrect

Division occurs within the Stateflow Chart.

**Sub ID a2**

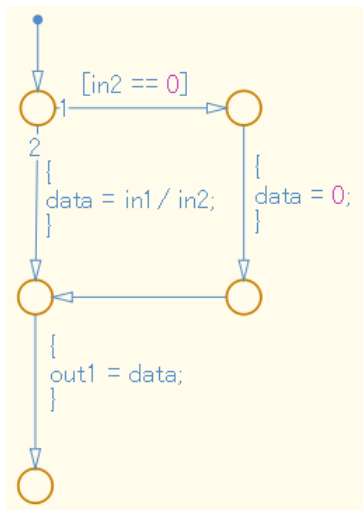
When division occurs in a Stateflow Chart, the process shall prevent division by zero.

**Custom Parameter**

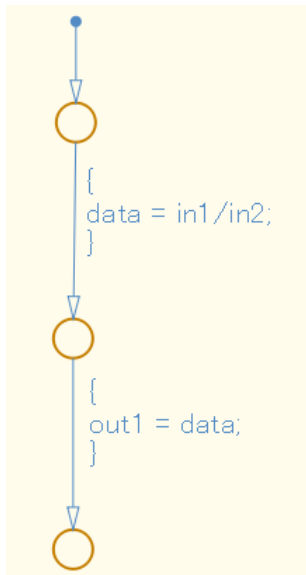
Not Applicable

**Example – Correct**

The process is defined to prevent division by zero.

**Example — Incorrect**

The process does not prevent division by zero.

**Rationale**

Sub ID a1, a2:

- Deviation from the rule can cause unintended operation and code generation results.

**Verification**

Model Advisor check: Adherence to this modeling guideline cannot be verified by using a Model Advisor check.

## Last Changed

R2020a

## See Also

- JMAAB guideline jc\_0711, which is available in *Control Algorithm Modeling Guidelines Using MATLAB, Simulink, and Stateflow* on the MathWorks website.
- “Fixed-Point Operations in Stateflow Charts” (Stateflow)

## Introduced in R2020a

## db\_0127: Limitation on MATLAB commands in Stateflow blocks

### Sub ID Recommendations

- NA-MAAB — a1/a2
- JMAAB — a1/a2

### MATLAB Versions

All

### Rule

#### Sub ID a1

MATLAB commands shall not be used in Stateflow blocks.

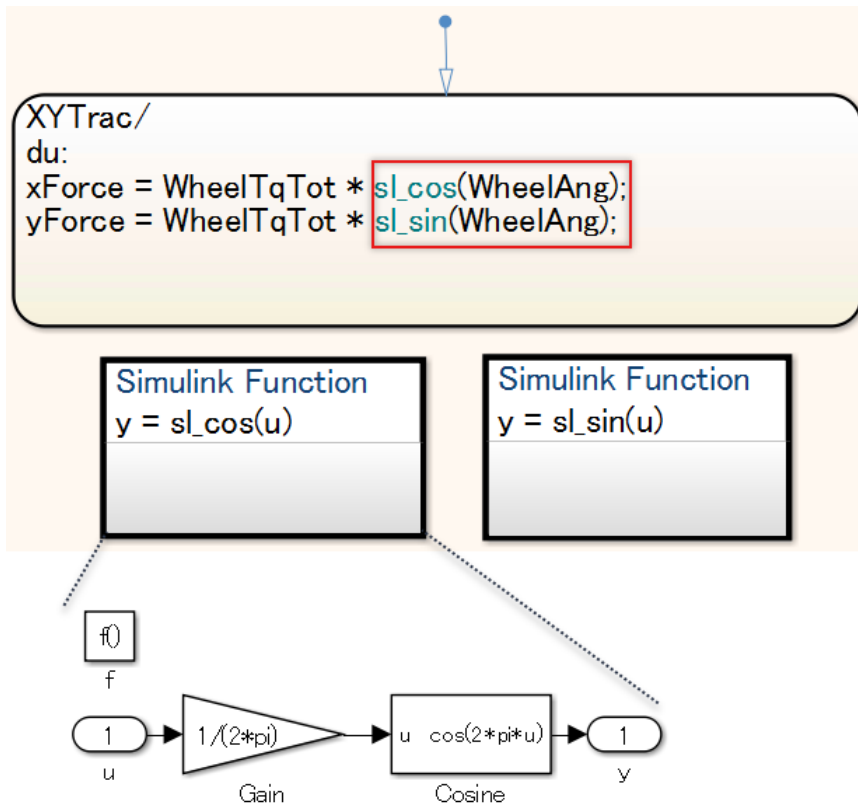
#### Custom Parameter

Not Applicable

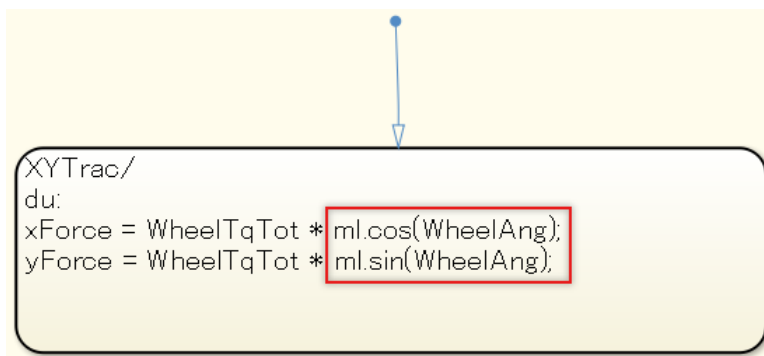
#### Example — Correct

MATLAB commands are not used in Stateflow blocks.



**Example – Incorrect**

A MATLAB command is used in the Stateflow block.

**Sub ID a2**

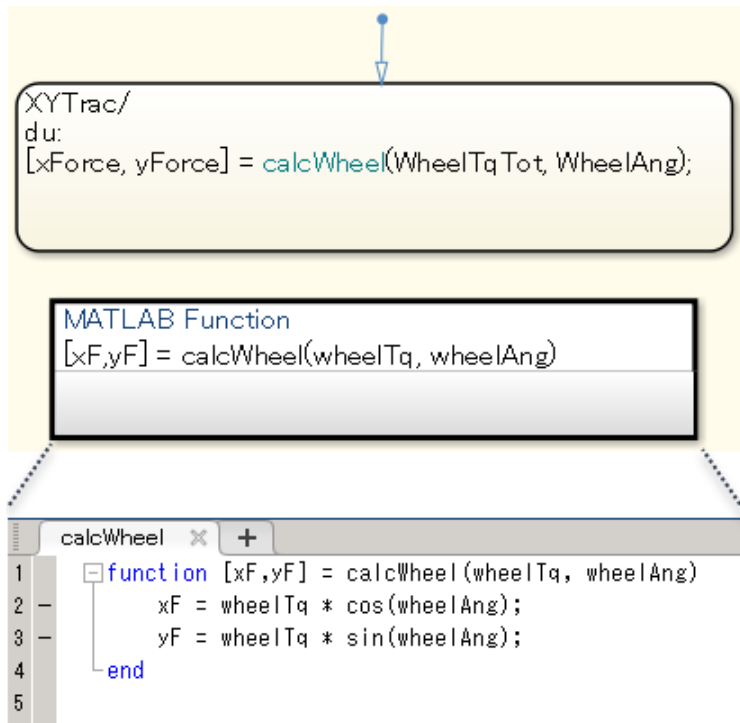
When a MATLAB command is used in Stateflow blocks, it shall be accessed only by using MATLAB Function block.

**Custom Parameter**

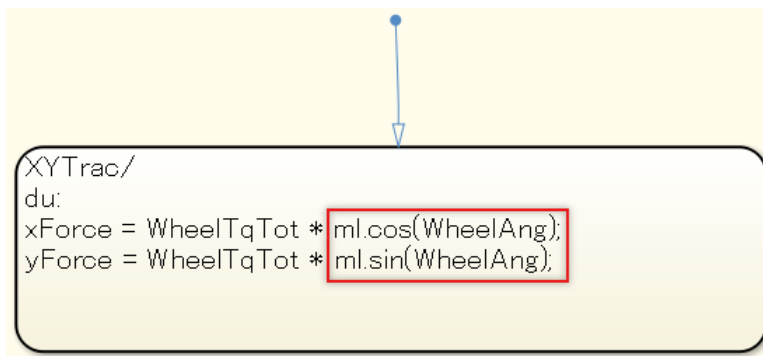
Not Applicable

**Example – Correct**

The MATLAB command is accessed by using the MATLAB Function block.

**Example — Incorrect**

A MATLAB Function block is not used for a MATLAB command.

**Rationale**

Sub ID a1:

- Not all MATLAB commands are supported for code generation. As a result, code may not be generated for these unsupported MATLAB commands.

Sub ID a2:

- Not all MATLAB commands are supported for code generation. As a result, code may not be generated for these unsupported MATLAB commands.
- Readability improves when C and MATLAB action languages are described separately.

## Verification

Model Advisor check: “Check for MATLAB expressions in Stateflow charts” (Simulink Check)

## Last Changed

R2020a

## See Also

- JMAAB guideline db\_0127, which is available in *Control Algorithm Modeling Guidelines Using MATLAB, Simulink, and Stateflow* on the MathWorks website.
- MATLAB Function
- “Stateflow Programmatic Interface” (Stateflow)
- “Differences Between MATLAB and C as Action Language Syntax” (Stateflow)

## Introduced in R2020a

## jc\_0481: Use of hard equality comparisons for floating point numbers in Stateflow

### Sub ID Recommendations

- NA-MAAB — a
- JMAAB — a

### MATLAB Versions

All

### Rule

#### Sub ID a

These equality comparison operators shall not be used in floating-point operands:

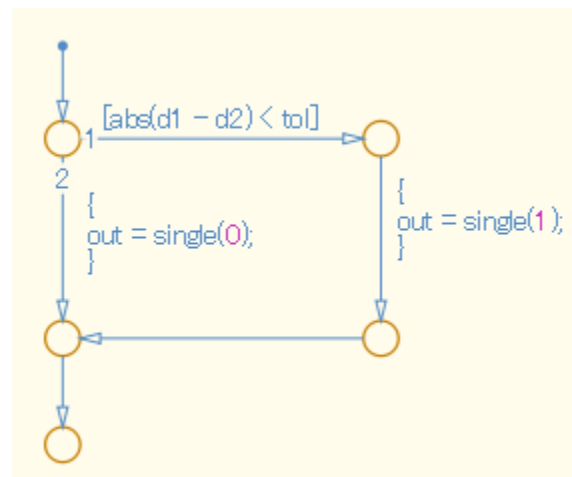
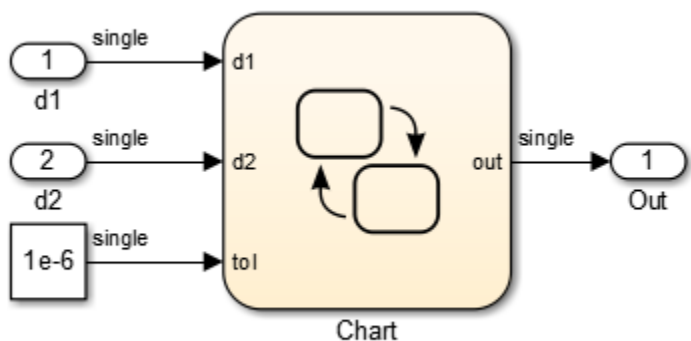
- ==
- !=
- ~=

#### Custom Parameter

Not Applicable

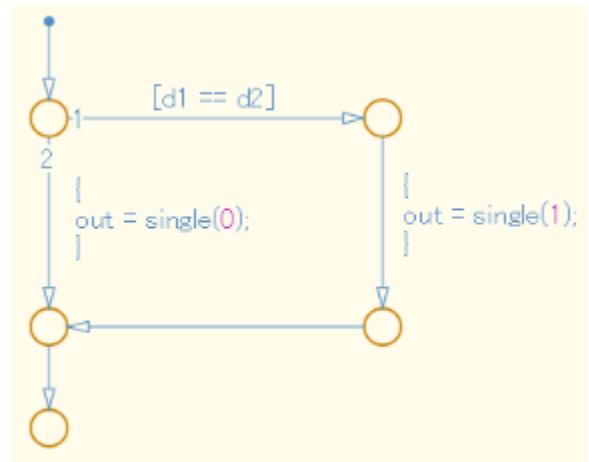
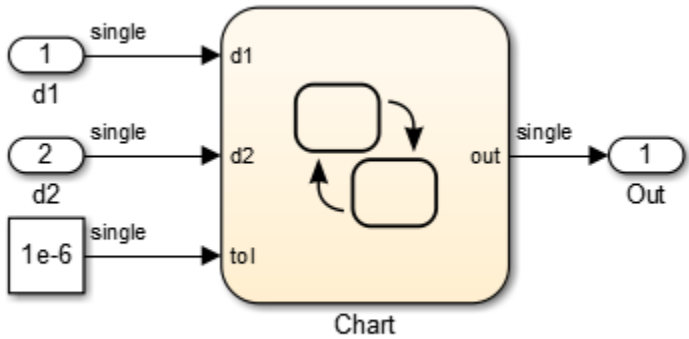
#### Example — Correct

Equality comparison operators are not used in floating-point operands.



#### Example — Incorrect

Equality comparison operator == is used in floating-point operands.



## Rationale

Sub ID a:

- Due to the nature of the floating-point data type, as it contains an error, the result of the equivalence comparison operation may be false when it was expected to be true.

## Verification

Model Advisor check: “Check usage of floating-point expressions in Stateflow charts” (Simulink Check)

## Last Changed

R2020a

## See Also

- JMAAB guideline jc\_0481, which is available in *Control Algorithm Modeling Guidelines Using MATLAB, Simulink, and Stateflow* on the MathWorks website.
- “Fixed-Point Data in Stateflow Charts” (Stateflow)
- “Relational Operations”

**Introduced in R2020a**

## na\_0001: Standard usage of Stateflow operators

### Sub ID Recommendations

- NA-MAAB — No recommendations
- JMAAB — a, b1/b2/b3, c

### MATLAB Versions

All

### Rule

#### Sub ID a

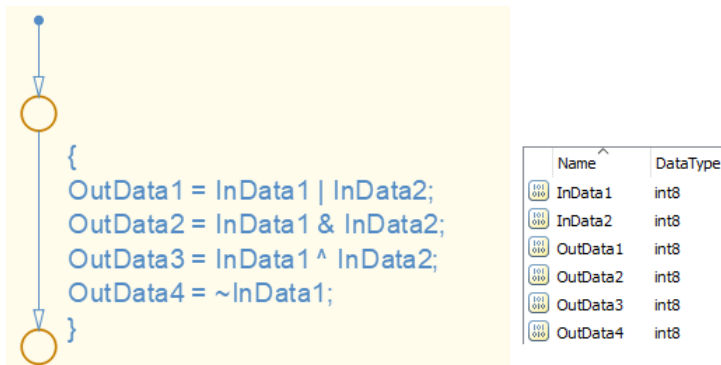
When Stateflow Chart property **Action Language** is set to C, operators (&, |, ^, ~) shall be used only for bit operations.

#### Custom Parameter

Not Applicable

#### Example — Correct

Operators (&, |, ^, ~) are used for bit operations.



#### Example — Incorrect

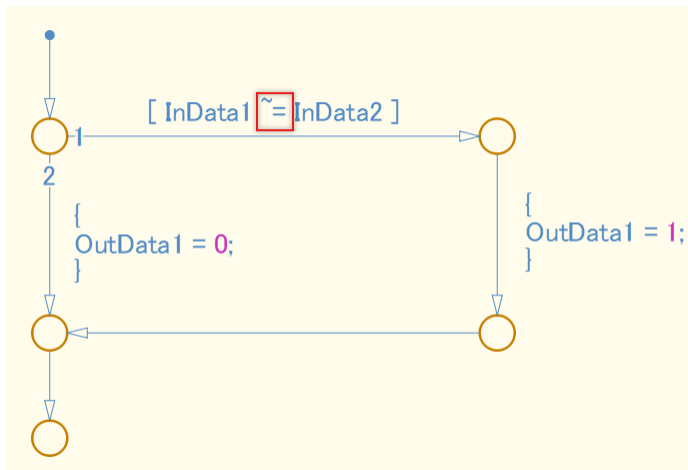
Operators (&, |, ^, ~) are not used for bit operations.

**Sub ID b1**

When Stateflow Chart property **Action Language** is set to C, operator  $\sim=$  shall be used for inequality operations.

**Custom Parameter**

Not Applicable

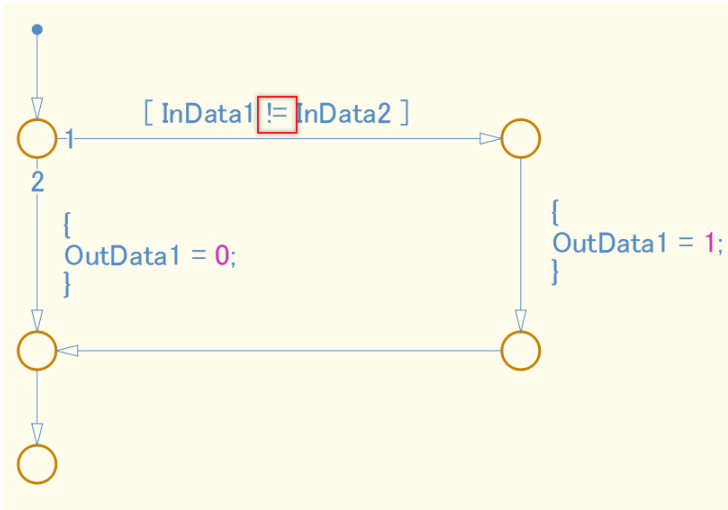
**Example — Correct****Sub ID b2**

When Stateflow Chart property **Action Language** is set to C, operator  $!=$  shall be used for inequality operations.

**Custom Parameter**

Not Applicable

**Example — Correct**



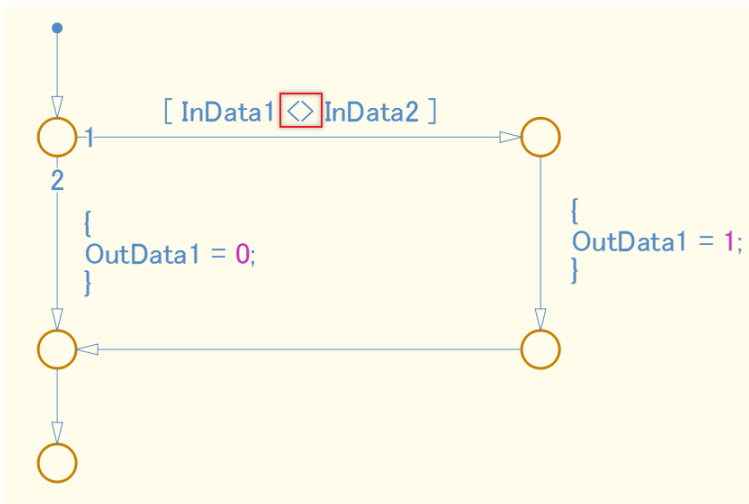
**Sub ID b3**

When Stateflow Chart property **Action Language** is set to C, operator `<>` shall be used for inequality operations.

**Custom Parameter**

Not Applicable

**Example — Correct**



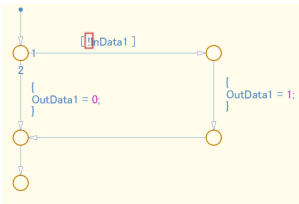
**Sub ID c**

When Stateflow Chart property **Action Language** is set to C, operation `!` shall be used for logical negation.

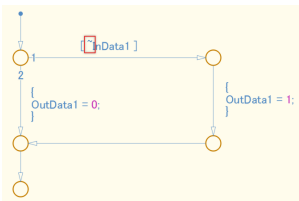
**Custom Parameter**

Not Applicable



**Example — Correct****Example — Incorrect**

An operator other than ! should be used for logical negation.

**Rationale**

Sub ID a:

- When either of these Stateflow Chart properties are set as follows:
  - **Action Language** is set to MATLAB
  - **Action Language** is set to C and **Enable C-Bit Operations** is selected

&& and &, || and |, have the same calculation function. However, when && and & or || and | are combined in the same chart, it can be difficult to determine whether these are separate calculation functions or the same calculation function.

Sub IDs b1, b2, b3:

- Consistent use of equality operators improves readability.

Sub ID c:

- Consistent use of logical negation operators improves readability.
- When **C-bit operations are enabled** is selected, the function of the ! operator remains the same and is not affected by logic changes that result from changing the setting.

**Verification**

Model Advisor check: “Check Stateflow operators” (Simulink Check)

**Last Changed**

R2020a

### See Also

- JMAAB guideline na\_0001, which is available in *Control Algorithm Modeling Guidelines Using MATLAB, Simulink, and Stateflow* on the MathWorks website.
- “Modify the Action Language for a Chart” (Stateflow)
- “Differences Between MATLAB and C as Action Language Syntax” (Stateflow)

### Introduced in R2020a

# jc\_0655: Prohibition of logical value comparison in Stateflow

## Sub ID Recommendations

- NA-MAAB — No recommendations
- JMAAB — a

## MATLAB Versions

All

## Rule

### Sub ID a

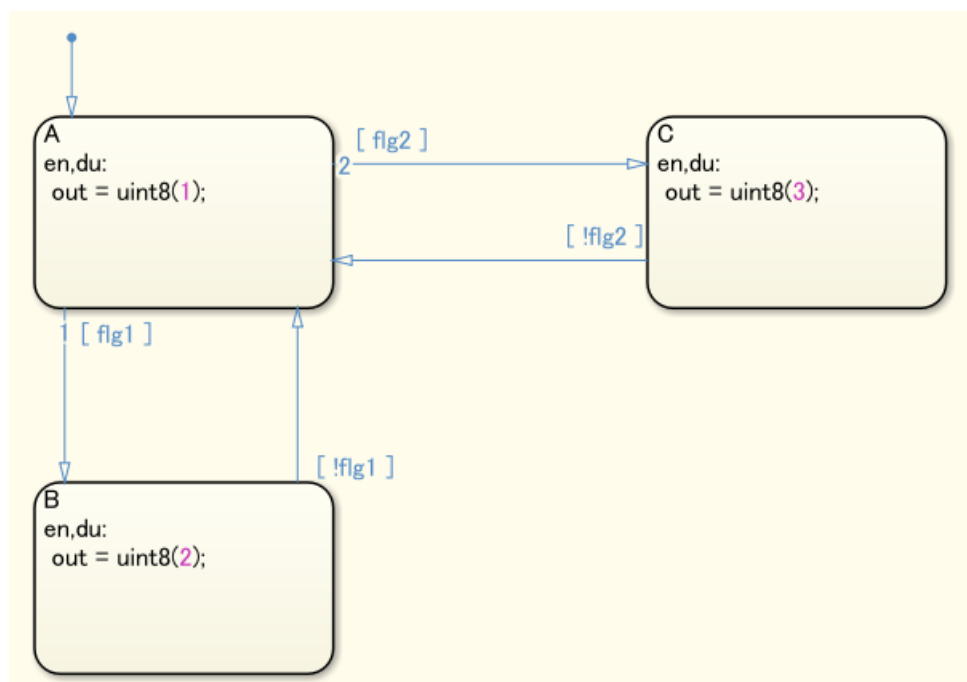
Logical constants shall not be compared to each other.

### Custom Parameter

Not Applicable

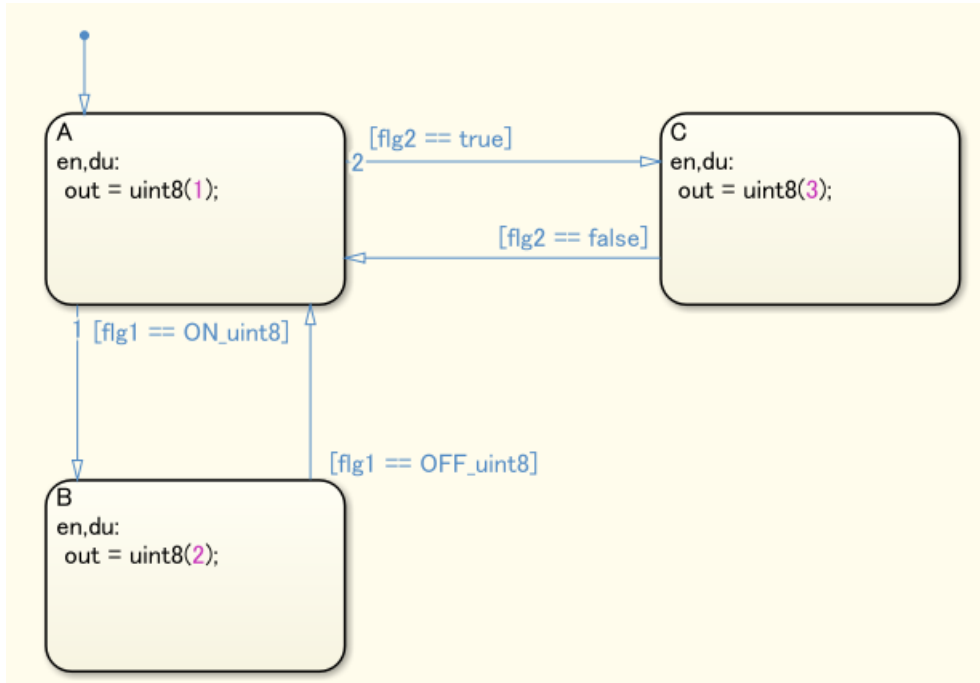
### Example — Correct

Logical constants are not compared to each other.



**Example — Incorrect**

Logical constants are compared to each other.

**Rationale**

Sub ID a:

- Readability improves with consistent use of `boolean-valued signal==true` (boolean type constant) or `(boolean-valued signal)` for logical signal condition expressions.
- Prevents redundancy in the model.
- Deviation from the rule can cause unexpected issues.

**Verification**

Model Advisor check: “Check prohibited comparison operation of logical type signals” (Simulink Check)

**Last Changed**

R2020a

**See Also**

- JMAAB guideline `jc_0655`, which is available in *Control Algorithm Modeling Guidelines Using MATLAB, Simulink, and Stateflow* on the MathWorks website.

**Introduced in R2020a**

## jc\_0451: Use of unary minus on unsigned integers

### Sub ID Recommendations

- NA-MAAB — a
- JMAAB — a

### MATLAB Versions

All

### Rule

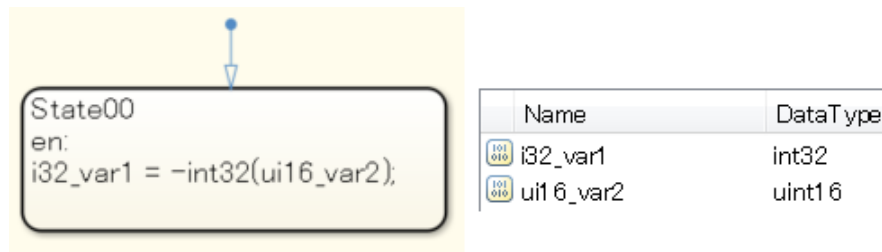
#### Sub ID a

Unary minus shall not be used on unsigned integers.

#### Custom Parameter

Not Applicable

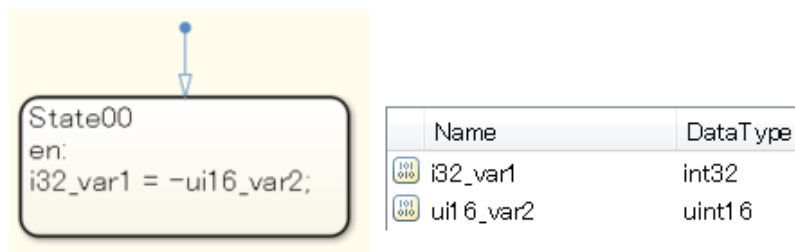
#### Example — Correct



| Name      | Data Type |
|-----------|-----------|
| i32_var1  | int32     |
| ui16_var2 | uint16    |

#### Example — Incorrect

Negative values cannot be input into 16-bit environments. (Negative values can be input into 32-bit environments.)



| Name      | Data Type |
|-----------|-----------|
| i32_var1  | int32     |
| ui16_var2 | uint16    |

### Rationale

Sub ID a:

- As the results are depend on the execution environment, unintended results can occur.

## Verification

Model Advisor check: “Check usage of unary minus operations in Stateflow charts” (Simulink Check)

## Last Changed

R2020a

## See Also

- JMAAB guideline jc\_0451, which is available in *Control Algorithm Modeling Guidelines Using MATLAB, Simulink, and Stateflow* on the MathWorks website.
- “Data Types Supported by Simulink”
- “Unary Minus of Matrix Input”

## Introduced in R2020a

## jc\_0802: Prohibited use of implicit type casting in Stateflow

### Sub ID Recommendations

- NA-MAAB — a
- JMAAB — a

### MATLAB Versions

All

### Rule

#### Sub ID a

All operations, including substitution, comparison, arithmetic, etc., shall be performed between variables of the same data type.

The data type of the actual arguments and the formal arguments in a function call shall be the same.

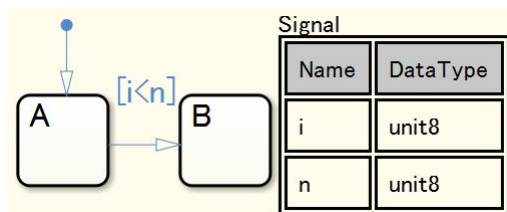
#### Custom Parameter

Not Applicable

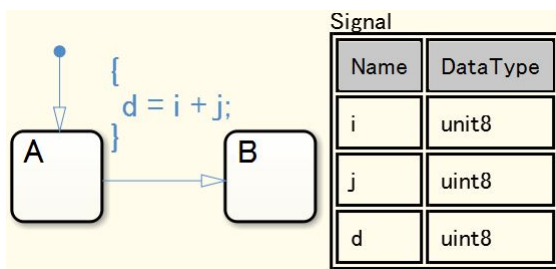
#### Example — Correct

Variables use the same data type for calculations.

Example: Comparison operation



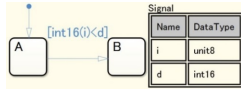
Example: Arithmetic operations and assignment operations (compound expressions)



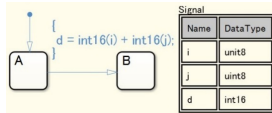


Variables have different data types but are explicitly typecast before calculation.

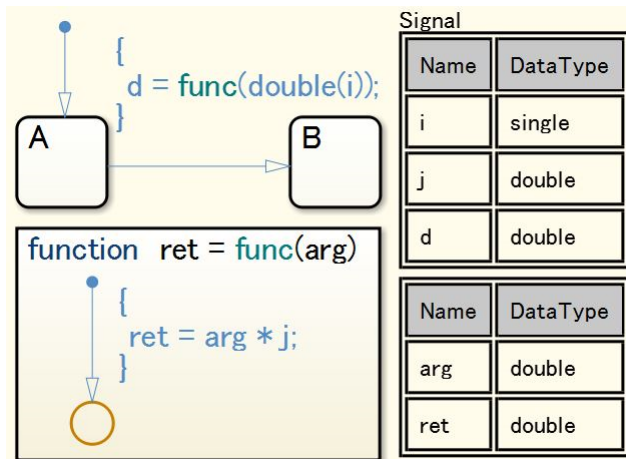
Example: Comparison operation



Example: Arithmetic operations and assignment operations (compound expressions)



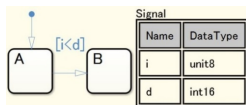
The data type of actual arguments and formal arguments in the function call are the same.



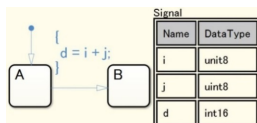
**Example – Incorrect**

Variables use different data types for calculations.

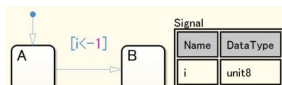
Example: Comparison operation



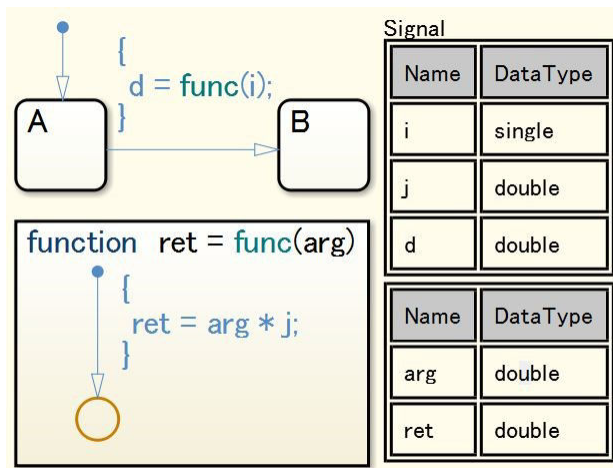
Example: Arithmetic operations and assignment operations (compound expressions)



Calculations are performed between unsigned integer type variables and signed integers.



The data type of actual arguments and formal arguments in the function call are different.



## Rationale

Sub ID a:

- Implicit data type conversion can produce unexpected results.

## Verification

Model Advisor check: “Check for implicit type casting in Stateflow” (Simulink Check)

## Last Changed

R2020a

## See Also

- JMAAB guideline `jc_0802`, which is available in *Control Algorithm Modeling Guidelines Using MATLAB, Simulink, and Stateflow* on the MathWorks website.
- “Type Cast Operations” (Stateflow)
- “Differences Between MATLAB and C as Action Language Syntax” (Stateflow)

**Introduced in R2020a**

# jc\_0803: Passing values to library functions

## Sub ID Recommendations

- NA-MAAB — a1/a2, b1/b2, c1/c2,
- JMAAB — a1/a2, b1/b2, c1/c2, d1/d2

## MATLAB Versions

All

## Rule

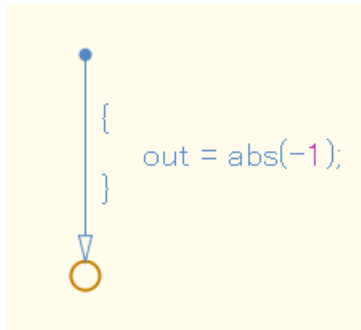
### Sub ID a1

A minimum value for the signed integer type shall not be provided when using the `abs` library function.

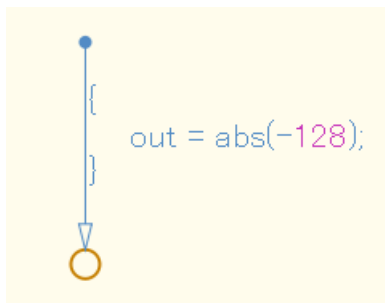
#### Custom Parameter

Not Applicable

#### Example — Correct



#### Example — Incorrect



### Sub ID a2

The `abs` library function shall not be used.

**Custom Parameter**

Not Applicable

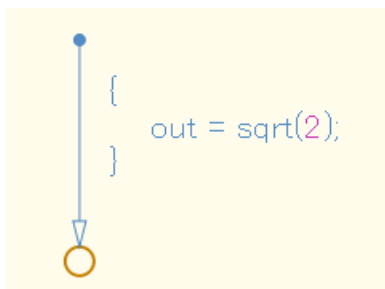
**Sub ID b1**

A negative number shall not be entered when using the `sqrt` library function.

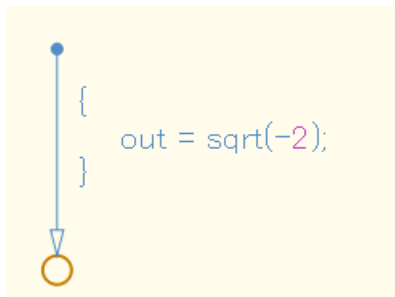
**Custom Parameter**

Not Applicable

**Example — Correct**



**Example — Incorrect**



**Sub ID b2**

The `sqrt` library function shall not be used.

**Custom Parameter**

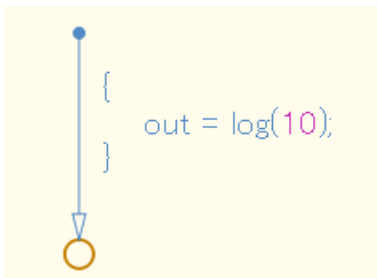
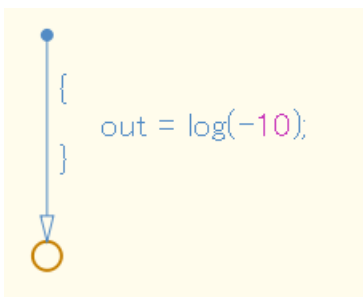
Not Applicable

**Sub ID c1**

A negative number shall not be entered when using the `log` and `log10` library functions.

**Custom Parameter**

Not Applicable

**Example — Correct****Example — Incorrect****Sub ID c2**

The `log` and `log10` library functions shall not be used.

**Custom Parameter**

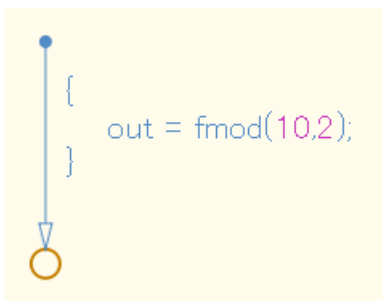
Not Applicable

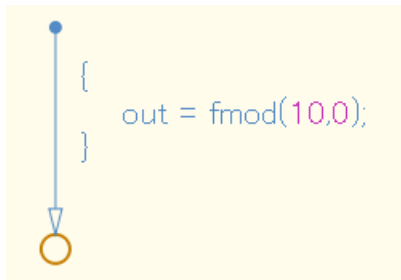
**Sub ID d1**

Zero shall not be entered for the second argument when using the `fmod` library function.

**Custom Parameter**

Not Applicable

**Example — Correct**

**Example — Incorrect****Sub ID d2**

The `fmod` library function shall not be used.

**Custom Parameter**

Not Applicable

**Rationale**

Sub IDs a1, b1, c1, d1

- The behavior of a library function when an invalid value has been passed is dependent on the processing system and may result in unintended behavior.

Sub IDs a2, b2, c2, d2

- To avoid duplicate modelling of the same guard process in Simulink and Stateflow, use Simulink to perform arithmetic operations

**Verification**

Model Advisor check: Adherence to this modeling guideline cannot be verified by using a Model Advisor check.

**Last Changed**

R2020a

**See Also**

- JMAAB guideline `jc_0803`, which is available in *Control Algorithm Modeling Guidelines Using MATLAB, Simulink, and Stateflow* on the MathWorks website.
- “Extrinsic Functions”
- “Library Development” (Embedded Coder)

**Introduced in R2020a**

# Label Description

## jc\_0732: Distinction between state names, data names, and event names

### Sub ID Recommendations

- NA-MAAB — a
- JMAAB — a

### MATLAB Versions

All

### Rule

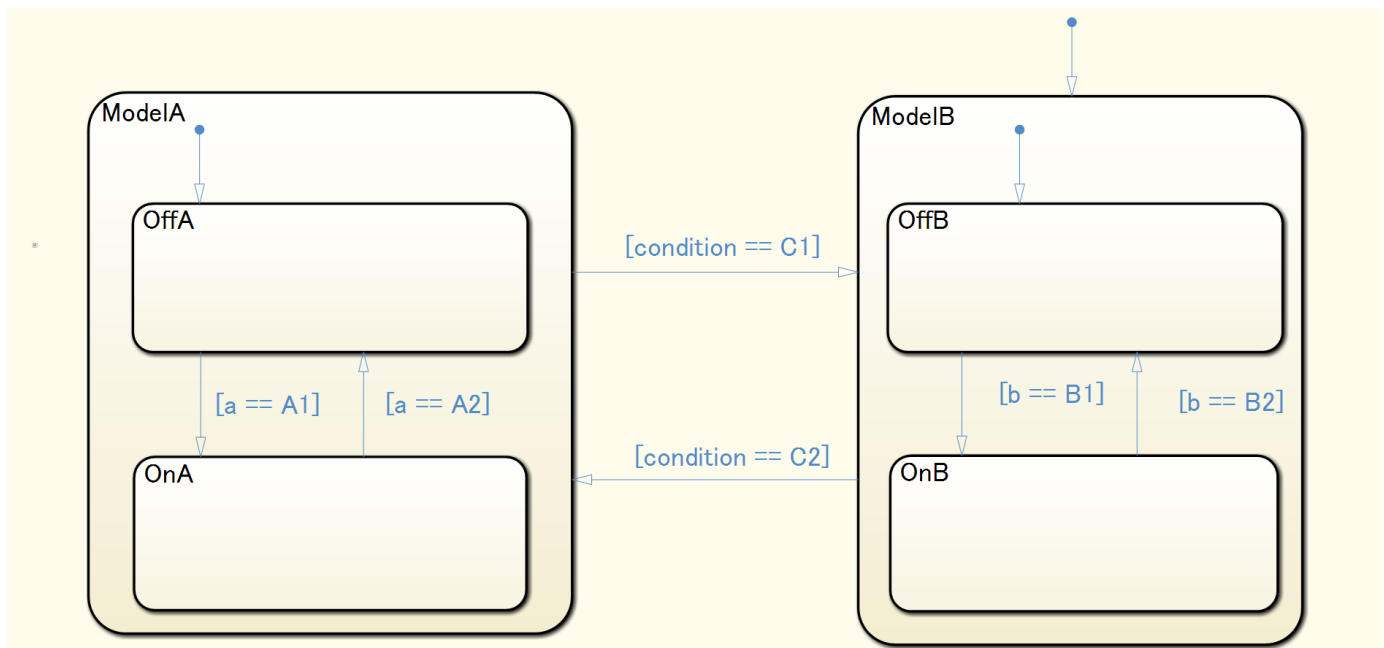
#### Sub ID a

An identical name shall not be used for states, data (inputs and outputs, local data, constants, parameters, data store memory), or event names in a single Stateflow Chart.

#### Custom Parameter

Not Applicable

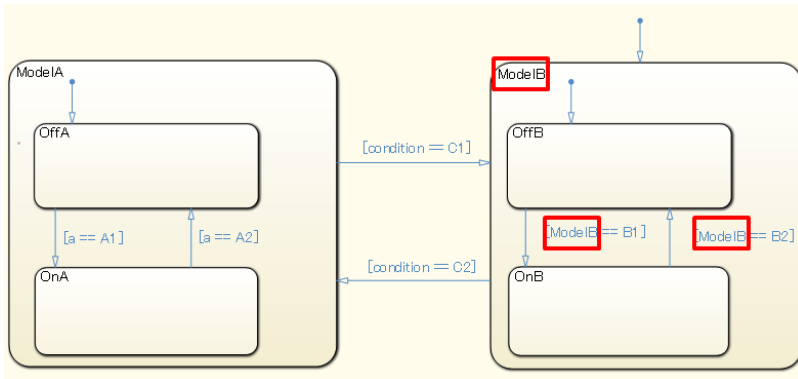
#### Example — Correct



#### Example — Incorrect

Names are duplicated.





## Rationale

Sub ID a:

- Using unique names prevent misunderstanding.

## Verification

Model Advisor check: “Check uniqueness of Stateflow State and Data names” (Simulink Check)

## Last Changed

R2020a

## See Also

- JMAAB guideline jc\_0732, which is available in *Control Algorithm Modeling Guidelines Using MATLAB, Simulink, and Stateflow* on the MathWorks website.

**Introduced in R2020a**

## jc\_0730: Unique state name in Stateflow blocks

### Sub ID Recommendations

- NA-MAAB — a
- JMAAB — a

### MATLAB Versions

All

### Rule

#### Sub ID a

State names in Stateflow Chart block shall be unique.

The content of linked atomic subcharts can be treated as another Stateflow Chart block.

#### Custom Parameter

Not Applicable

### Rationale

Sub ID a:

- Readability is impaired.
- Deviation from the rule can cause unintended code behavior.

### Verification

Model Advisor check: “Check uniqueness of State names” (Simulink Check)

### Last Changed

R2020a

### See Also

- JMAAB guideline jc\_0730, which is available in *Control Algorithm Modeling Guidelines Using MATLAB, Simulink, and Stateflow* on the MathWorks website.
- “States” (Stateflow)
- “Atomic Subcharts” (Stateflow)

### Introduced in R2020a

# jc\_0731: State name format

## Sub ID Recommendations

- NA-MAAB — a
- JMAAB — a

## MATLAB Versions

All

## Rule

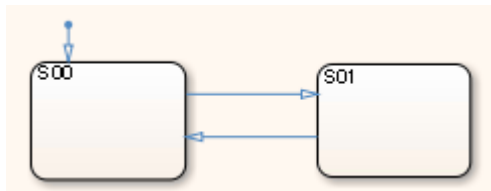
### Sub ID a

The state name shall be followed by a new line that does not include a slash (/).

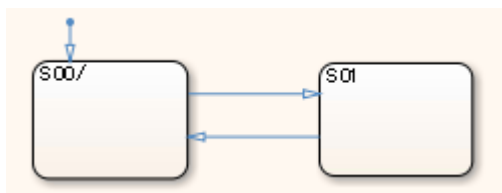
### Custom Parameter

Not Applicable

### Example — Correct



### Example — Incorrect



## Rationale

Sub ID a:

- Readability improves when state names are described consistently.

## Verification

Model Advisor check: “Check usage of State names” (Simulink Check)

## **Last Changed**

R2020a

## **See Also**

- JMAAB guideline jc\_0731, which is available in *Control Algorithm Modeling Guidelines Using MATLAB, Simulink, and Stateflow* on the MathWorks website.
- “States” (Stateflow)

## **Introduced in R2020a**

# jc\_0501: Format of entries in a State block

## Sub ID Recommendations

- NA-MAAB — a
- JMAAB — a

## MATLAB Versions

All

## Rule

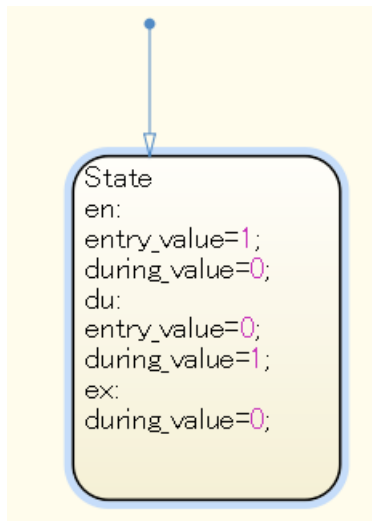
### Sub ID a

A state action statement shall not be written on the same line as a state action type.

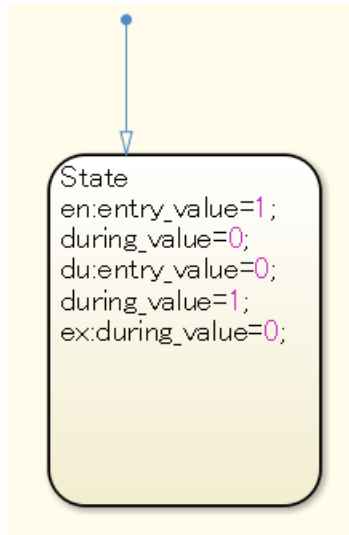
### Custom Parameter

Not Applicable

### Example — Correct



### Example — Incorrect



### Rationale

Sub ID a:

- Readability is impaired.

### Verification

Model Advisor check: “Check entry formatting in State blocks in Stateflow charts” (Simulink Check)

### Last Changed

R2020a

### See Also

- JMAAB guideline jc\_0501, which is available in *Control Algorithm Modeling Guidelines Using MATLAB, Simulink, and Stateflow* on the MathWorks website.
- “States” (Stateflow)

**Introduced in R2020a**

# jc\_0736: Uniform indentations in Stateflow blocks

## Sub ID Recommendations

- NA-MAAB — No recommendations
- JMAAB — a, b, c

## MATLAB Versions

All

## Rule

### Sub ID a

State action types shall not have blank spaces at the start of a line.

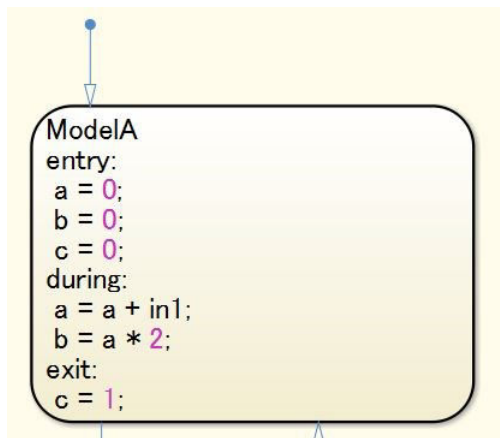
Executable statements shall have one single-byte space at the start of the line.

### Custom Parameter

Number of single-byte spaces

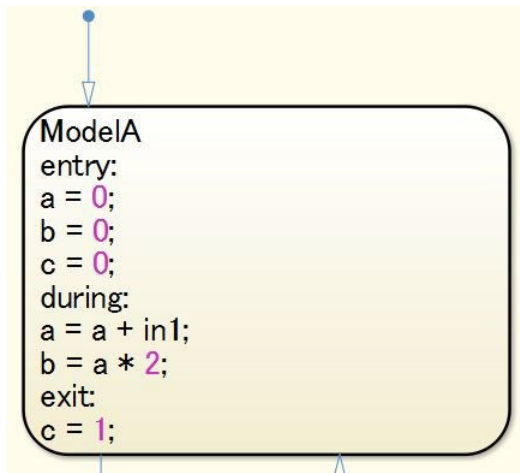
### Example — Correct

Executable statements use one single-byte space at the start of the line.



### Example — Incorrect

Executable statements do not have a single-byte space at the start of the line.

**Sub ID b**

A blank space shall not be entered before the following:

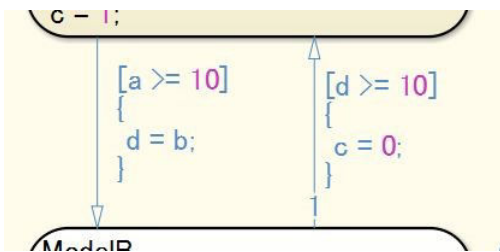
- [ of a transition condition
- { of a condition action
- / of a transition action

**Custom Parameter**

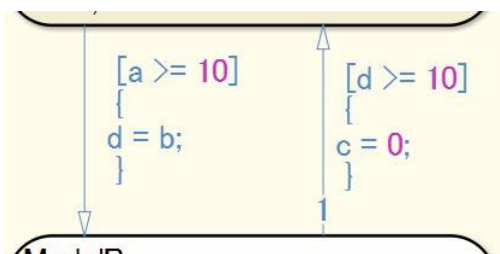
Not Applicable

**Example — Correct**

A blank space is not entered before the [ and { of the transition label condition, condition action, and transition action.

**Example — Incorrect**

A blank space is entered before the [ and { of the transition label condition, condition action, and transition action.





**Sub ID c**

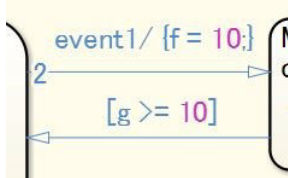
At least one single-byte space shall be entered after the / of a transition action.

**Custom Parameter**

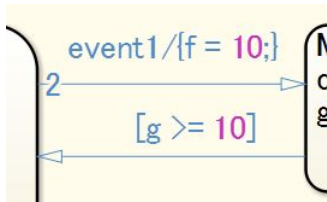
Number of single-byte spaces

**Example — Correct**

Single-byte spaces are entered after the / of the transition action.

**Example — Incorrect**

There are no single-byte spaces after the / of the transition action.

**Rationale**

Sub ID a:

- Using uniform indents before the executable statement clarifies the link between the state action type of a state label and the execution statement, improving readability.

Sub ID b:

- Using uniform indents for transition conditions, condition actions, and transition actions improves readability.

Sub ID c:

- Consistent use of blank spaces improves readability.

**Verification**

Model Advisor check: “Check indentation of code in Stateflow states” (Simulink Check)

**Last Changed**

R2020a

### See Also

- JMAAB guideline jc\_0736, which is available in *Control Algorithm Modeling Guidelines Using MATLAB, Simulink, and Stateflow* on the MathWorks website.
- “Specify Transition Conditions” (Stateflow)
- “Transitions” (Stateflow)

### Introduced in R2020a

# jc\_0739: Describing text inside states

## Sub ID Recommendations

- NA-MAAB — a
- JMAAB — a

## MATLAB Versions

All

## Rule

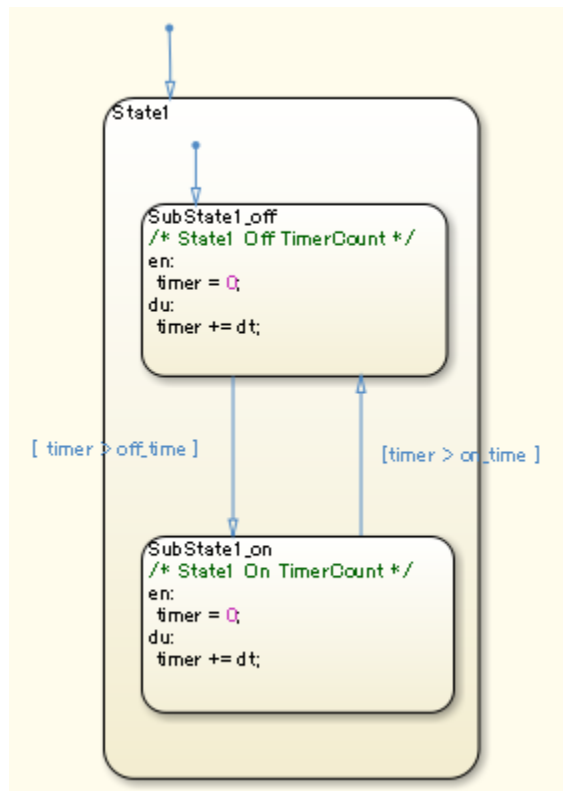
### Sub ID a

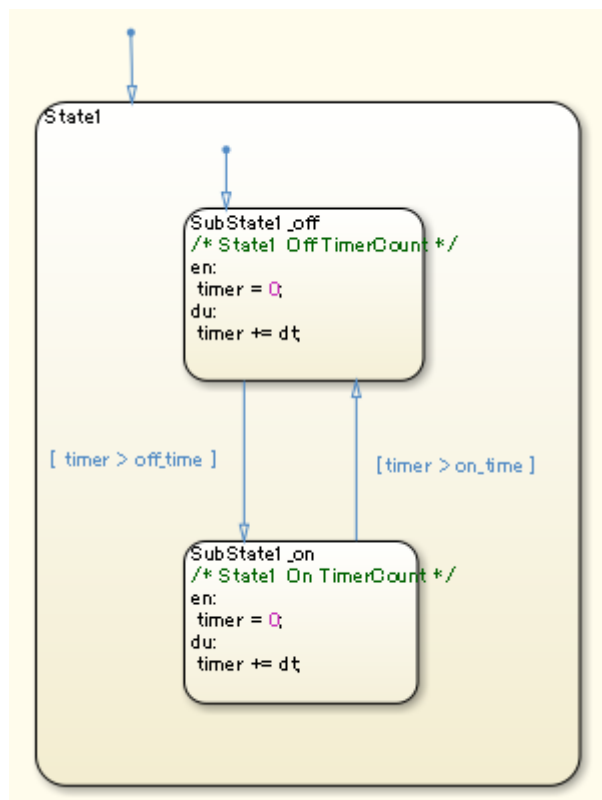
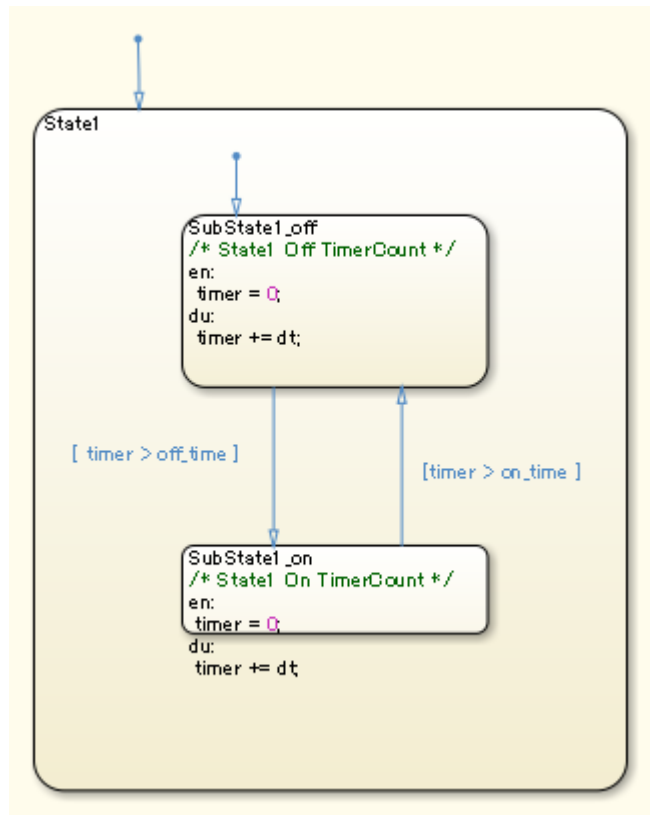
Text inside a state shall not extend beyond the boundaries of the state

### Custom Parameter

Not Applicable

### Example — Incorrect





## Rationale

Sub ID a:

- When the text inside a state extends beyond its boundaries, it can be difficult to determine which state the text belongs.

## Verification

Model Advisor check: “Check for usage of text inside states” (Simulink Check)

## Last Changed

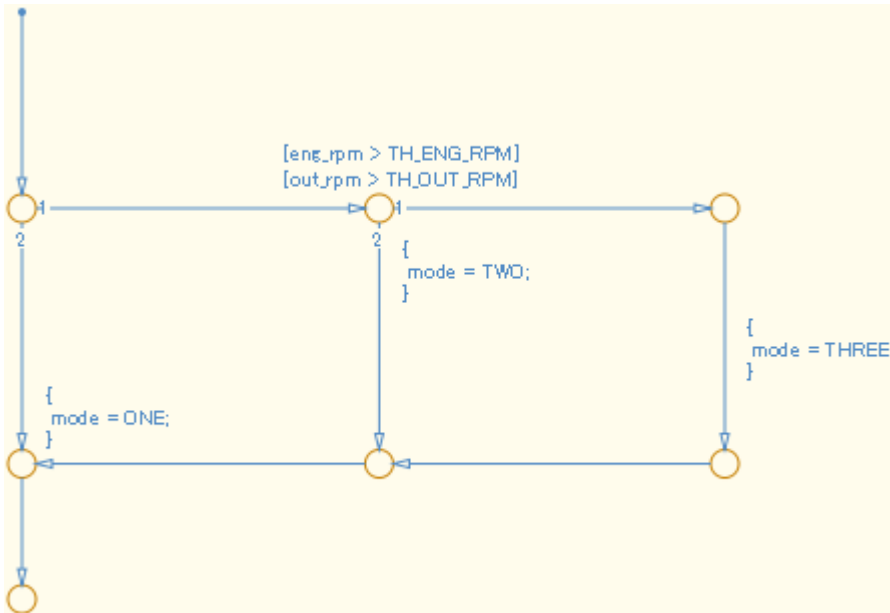
R2020a

## See Also

- JMAAB guideline jc\_0739, which is available in *Control Algorithm Modeling Guidelines Using MATLAB, Simulink, and Stateflow* on the MathWorks website.

**Introduced in R2020a**





**Sub ID a2**

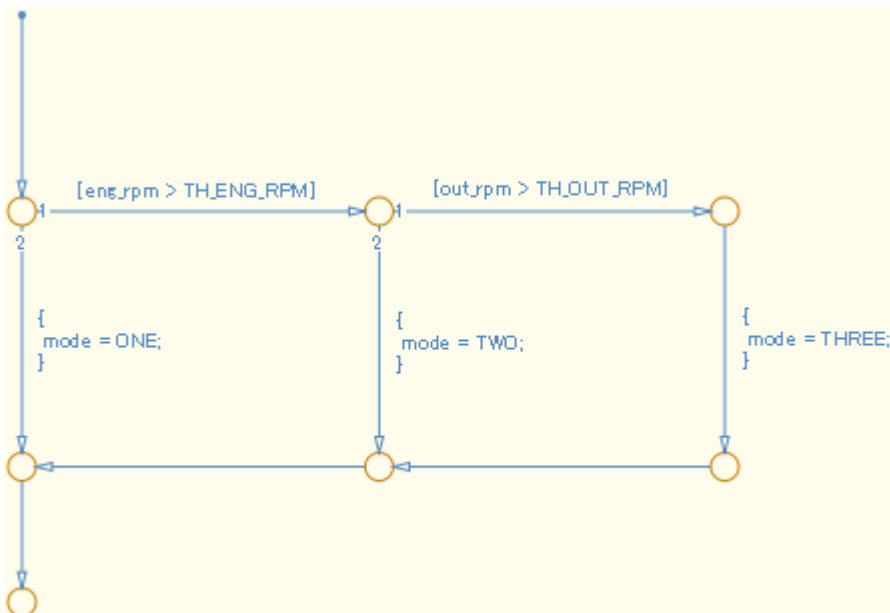
Transition labels are positioned near the center of the transition line.

**Custom Parameter**

Not Applicable

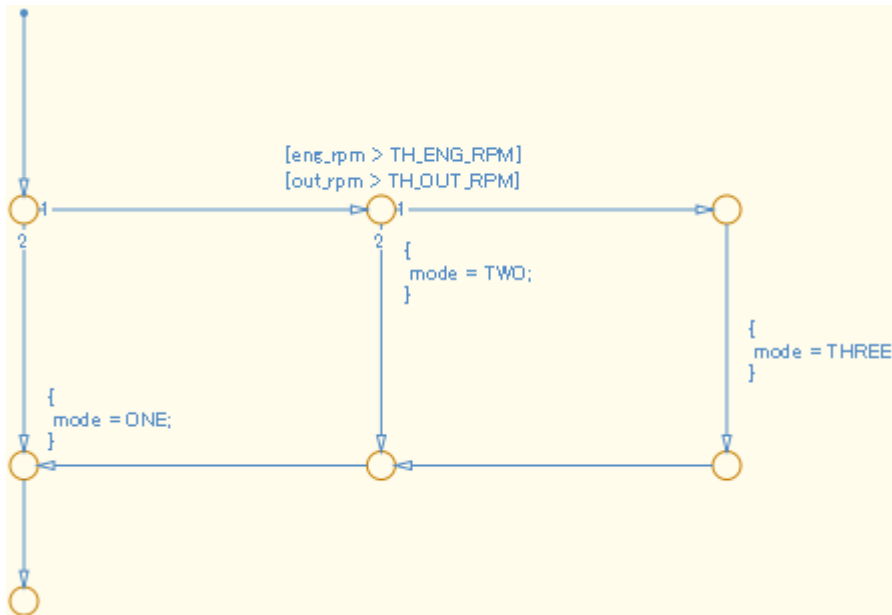
**Example — Correct**

Transition labels are positioned near the center of the transition line.



**Example — Incorrect**

The positioning of transition labels is inconsistent and do not correspond to the transition line.

**Rationale**

Sub IDs a1, a2:

- Consistent positioning of transition labels makes the correspondence between label and line easier to understand.

**Verification**

Model Advisor check: “Check placement of Label String in Transitions” (Simulink Check)

**Last Changed**

R2020a

**See Also**

- JMAAB guideline jc\_0770, which is available in *Control Algorithm Modeling Guidelines Using MATLAB, Simulink, and Stateflow* on the MathWorks website.
- “Transition Labels” (Stateflow)
- “Label Transitions” (Stateflow)
- “Move Transitions” (Stateflow)

**Introduced in R2020a**



# jc\_0771: Comment position in transition labels

## Sub ID Recommendations

- NA-MAAB — a1/a2
- JMAAB — a1/a2

## MATLAB Versions

All

## Rule

### Sub ID a1

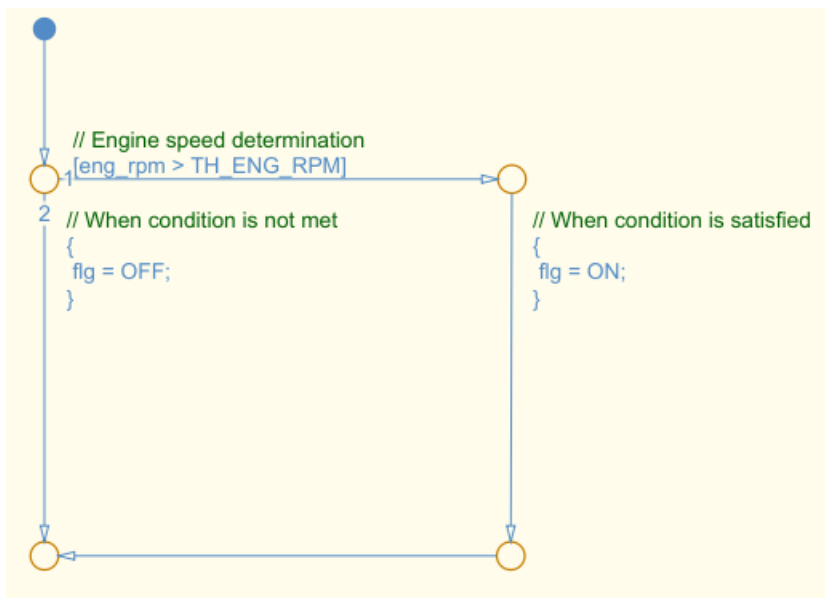
Comments in transition labels shall be positioned above transition conditions, condition actions, and Stateflow events.

### Custom Parameter

Not Applicable

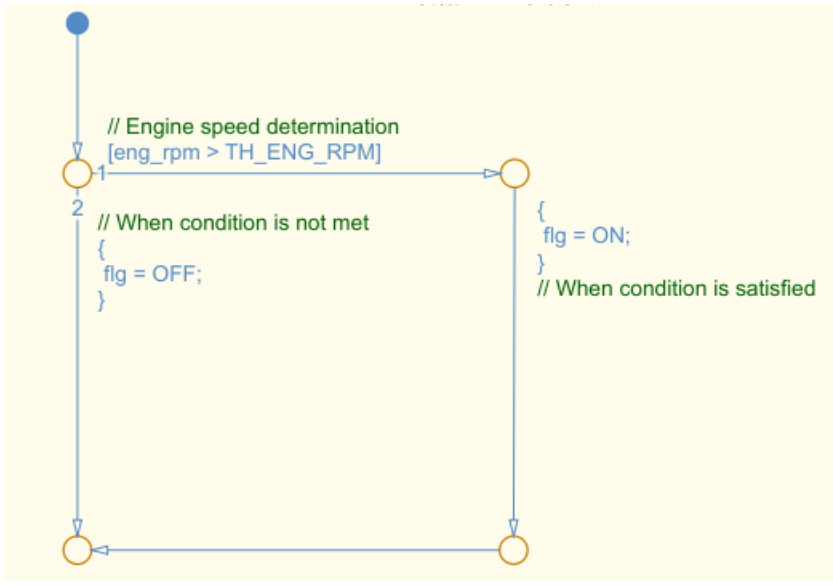
### Example — Correct

The position of the comments in the transition label is uniform.



### Example — Incorrect

The position of the comments in the transition label is inconsistent.



**Sub ID a2**

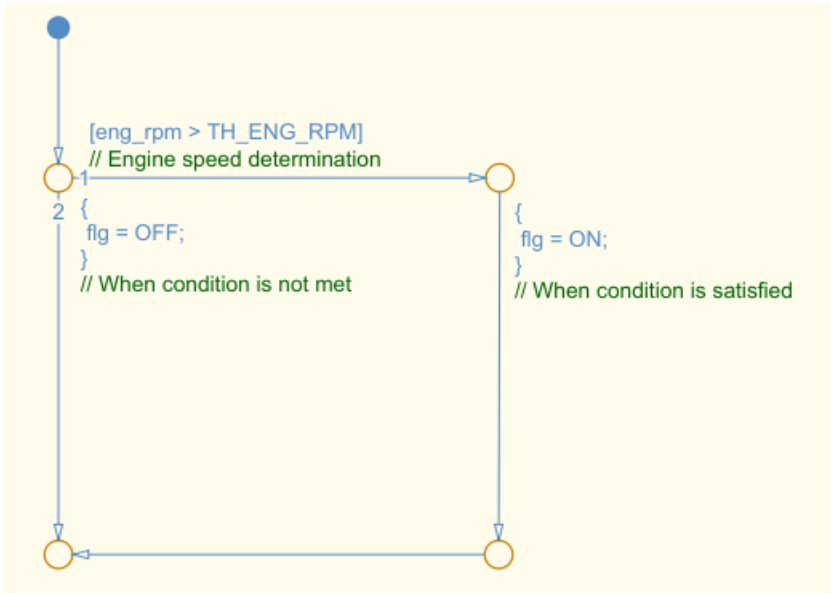
Comments in transition labels shall be positioned below transition conditions, condition actions, and Stateflow events.

**Custom Parameter**

Not Applicable

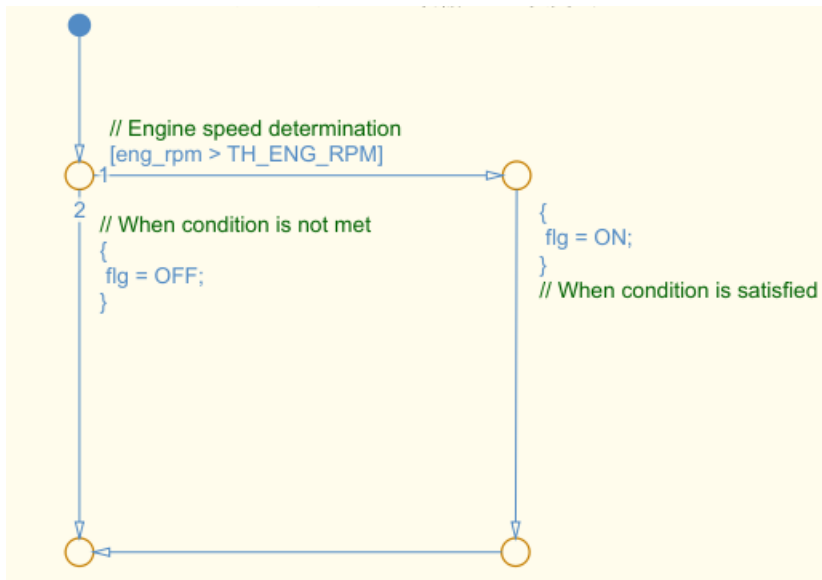
**Example — Correct**

The position of the comments in the transition label is uniform.



**Example — Incorrect**

The position of the comments in the transition label is inconsistent.



## Rationale

Sub IDs a1, a2:

- Uniform positioning of comments in transition labels clarifies to which transition condition, condition action, transition action, or Stateflow event the label corresponds.

## Verification

Model Advisor check: “Check position of comments in transition labels” (Simulink Check)

## Last Changed

R2020a

## See Also

- JMAAB guideline jc\_0771, which is available in *Control Algorithm Modeling Guidelines Using MATLAB, Simulink, and Stateflow* on the MathWorks website.
- “Label Transitions” (Stateflow)
- “Add Descriptive Comments in a Chart” (Stateflow)

**Introduced in R2020a**

## jc\_0752: Condition action in transition label

### Sub ID Recommendations

- NA-MAAB — No recommendations
- JMAAB — a

### MATLAB Versions

All

### Rule

#### Sub ID a

Parentheses in condition actions shall use only curly brackets on a single line.

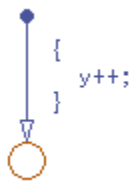
A new line shall start before and after curly brackets.

#### Custom Parameter

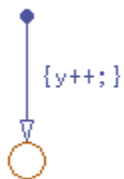
Not Applicable

#### Example — Correct

Note: The example is for a flow chart, but the rule also applies to state transitions.



#### Example — Incorrect



### Rationale

Sub ID a:

- Clarifying condition actions improves readability.

## Verification

Model Advisor check: “Check usage of parentheses in Stateflow transitions” (Simulink Check)

## Last Changed

R2020a

## See Also

- JMAAB guideline jc\_0752, which is available in *Control Algorithm Modeling Guidelines Using MATLAB, Simulink, and Stateflow* on the MathWorks website.
- “Label Transitions” (Stateflow)

**Introduced in R2020a**

## jc\_0774: Comments for through transition

### Sub ID Recommendations

- NA-MAAB — a
- JMAAB — a

### MATLAB Versions

All

### Rule

#### Sub ID a

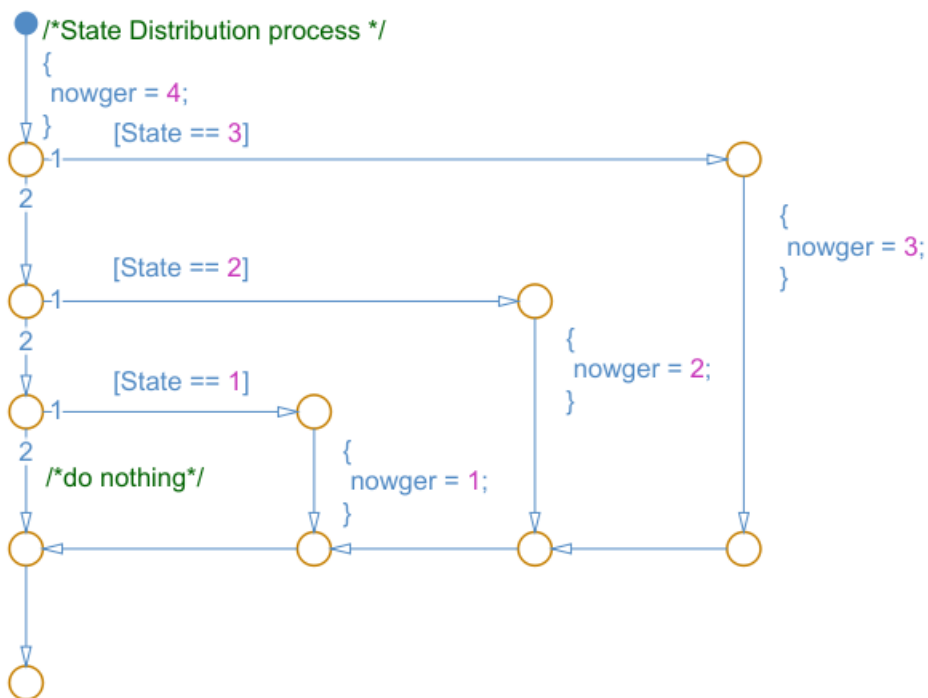
When there is no processing within an unconditional transition, a clarifying comment shall be written on the transition label.

#### Custom Parameter

Not Applicable

#### Example — Correct

The clarifying comment `/*do nothing*/` is provided.





**Introduced in R2020a**



## Miscellaneous

## jc\_0511: Return values from a graphical function

### Sub ID Recommendations

- NA-MAAB — No recommendations
- JMAAB — a

### MATLAB Versions

All

### Rule

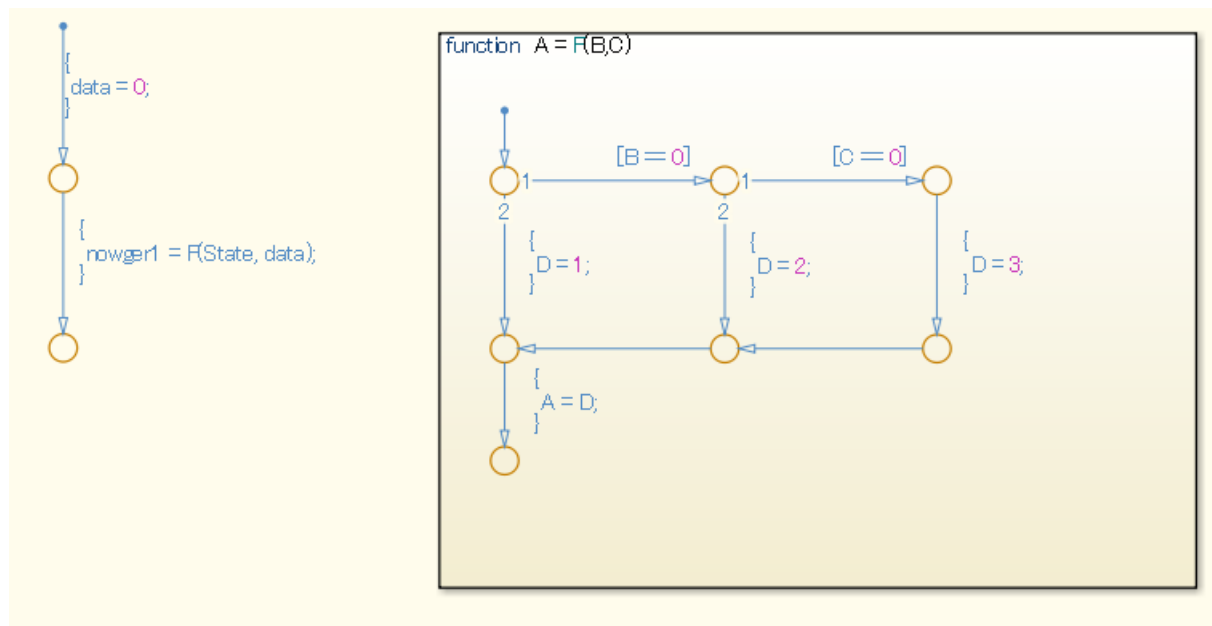
#### Sub ID a

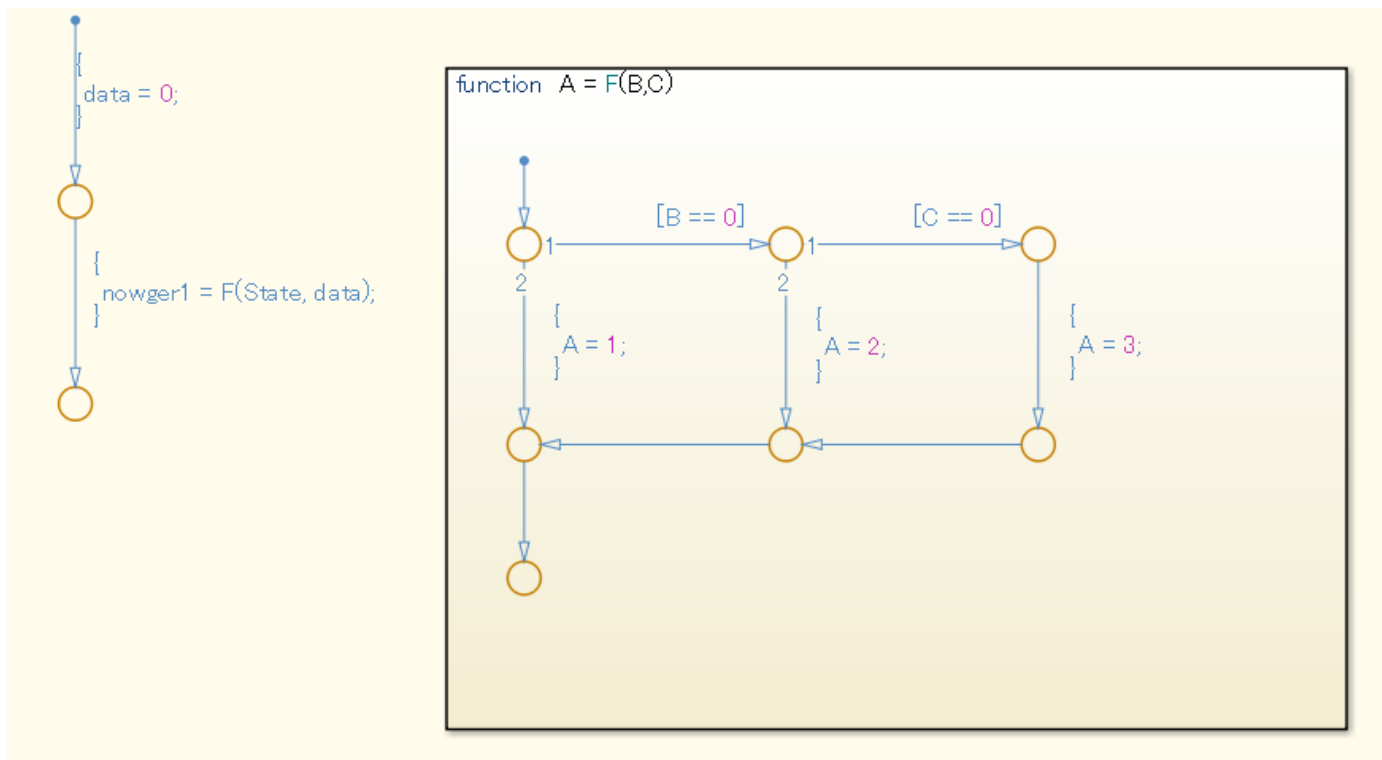
The return value for graphical functions shall be set in one place only.

#### Custom Parameter

Not Applicable

#### Example — Correct



**Example — Incorrect****Rationale**

Sub ID a:

- Modifications to the output name is limited to prevent the changes from being missed or overlooked.

**Verification**

Model Advisor check: “Check return value assignments in Stateflow graphical functions” (Simulink Check)

**Last Changed**

R2020a

**See Also**

- JMAAB guideline jc\_0511, which is available in *Control Algorithm Modeling Guidelines Using MATLAB, Simulink, and Stateflow* on the MathWorks website.
- “Flow Charts in Stateflow” (Stateflow)
- “Create Flow Charts by Using Pattern Wizard” (Stateflow)

**Introduced in R2020a**

# jc\_0804: Prohibited use of recursive calls with graphical functions

## Sub ID Recommendations

- NA-MAAB — a
- JMAAB — a

## MATLAB Versions

All

## Rule

### Sub ID a

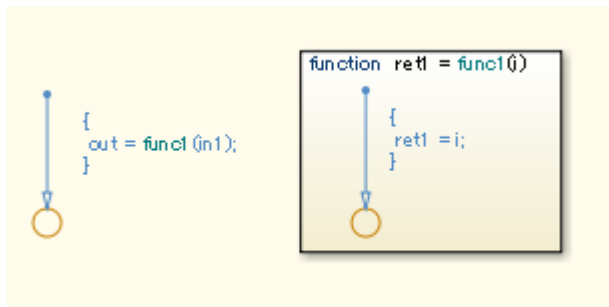
Calls from a graphical function to itself and calls between graphical functions shall be prohibited.

### Custom Parameter

Not Applicable

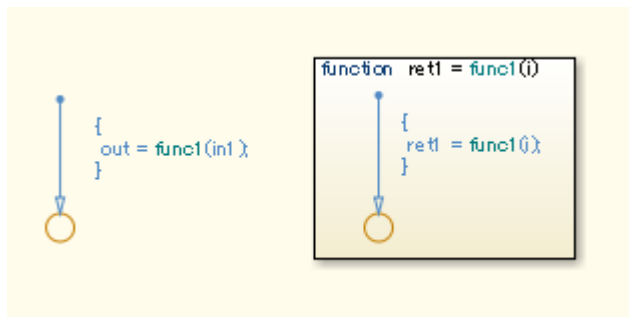
### Example — Correct

Processing is performed within the graphical function.

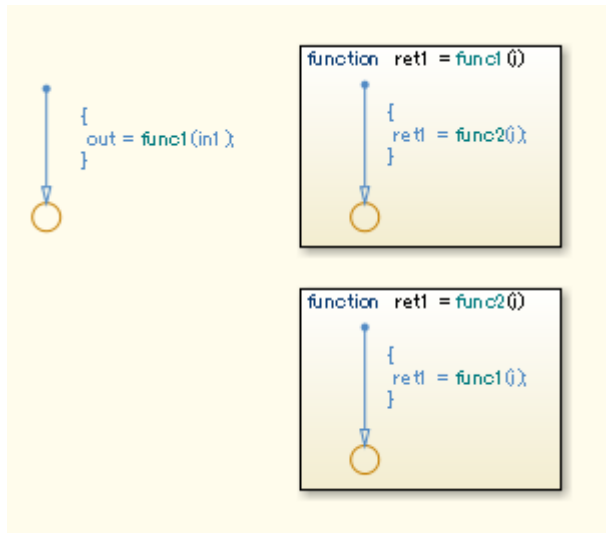


### Example — Incorrect

The graphical function is calling itself.



Graphical functions are calling each other.



### Rationale

Sub ID a:

- Readability decreases. Deviation from the rule can cause unintended overflows and infinite loops.

### Verification

Adherence to this modeling guideline cannot be verified by using a Model Advisor check.

### Last Changed

R2020a

### See Also

- JMAAB guideline jc\_0804, which is available in *Control Algorithm Modeling Guidelines Using MATLAB, Simulink, and Stateflow* on the MathWorks website.
- “Reuse Logic Patterns by Defining Graphical Functions” (Stateflow)
- “How Stateflow Objects Interact During Execution” (Stateflow)

**Introduced in R2020a**

# na\_0042: Usage of Simulink functions

## Sub ID Recommendations

- NA-MAAB — a
- JMAAB — a

## MATLAB Versions

All

## Rule

### Sub ID a

When using a Simulink Function block in a Stateflow Chart, one or more of the following conditions shall be met:

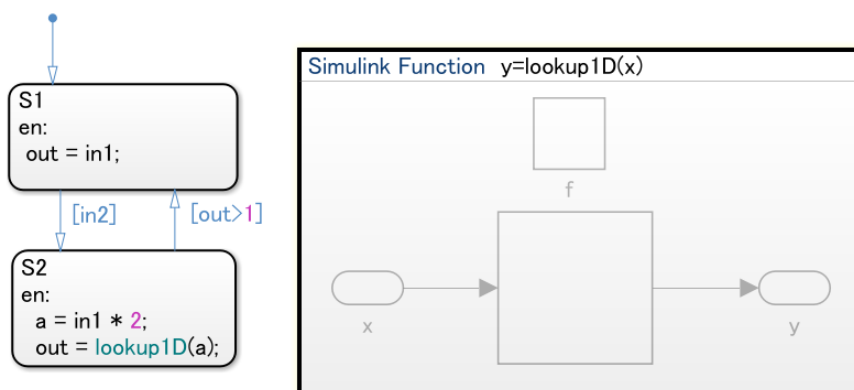
- Input/output variables shall use only local Stateflow Chart data in the Simulink Function block.
- Input/output variables shall use only local Stateflow Chart data and input data in the Simulink Function block.
- The Simulink Function block shall be called from multiple places in the Stateflow Chart.
- The Simulink Function block shall not be called at every time step.

### Custom Parameter

Not Applicable

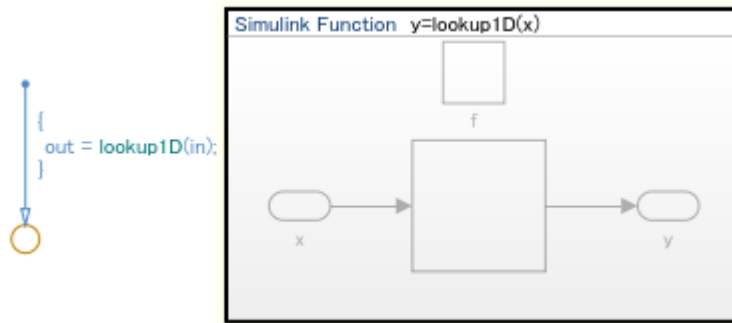
### Example — Correct

The Simulink Function block lookup1D is not called from every time step and, therefore, can be used.



**Example — Incorrect**

The Simulink Function block `lookup1D` is called from every time step and, therefore, cannot be used (out is the Stateflow output data)

**Rationale**

Sub ID a:

- To improve model readability, the use of the Simulink Function block should be used with caution in charts.

**Verification**

Model Advisor check: "Check usage of Simulink function in Stateflow" (Simulink Check)

**Last Changed**

R2020a

**See Also**

- JMAAB guideline na\_0042, which is available in *Control Algorithm Modeling Guidelines Using MATLAB, Simulink, and Stateflow* on the MathWorks website.
- "Simulink Functions Overview"
- "Add a Simulink Function to a Model"

**Introduced in R2020a**



# na\_0039: Limitation on Simulink functions in Chart blocks

## Sub ID Recommendations

- NA-MAAB — a
- JMAAB — a

## MATLAB Versions

All

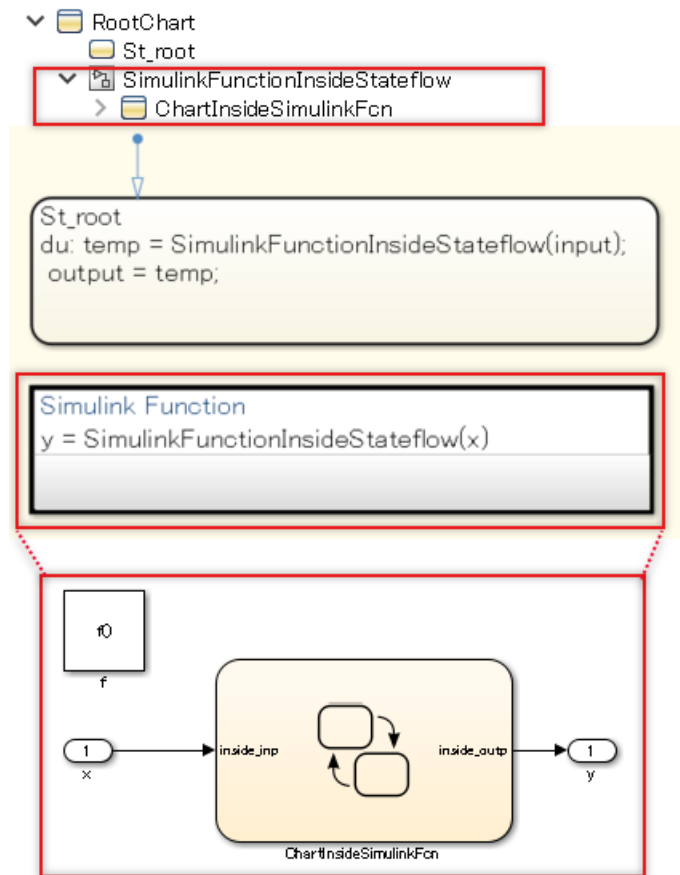
## Rule

### Sub ID a

Stateflow blocks shall not be used in Simulink Function blocks that are included in a Stateflow Chart.

### Custom Parameter

Not Applicable

**Example — Incorrect****Rationale**

Sub ID a:

- Readability decreases and can result in design errors.

**Verification**

Model Advisor check: “Check use of Simulink in Stateflow charts” (Simulink Check)

**Last Changed**

R2020a

**See Also**

- JMAAB guideline na\_0039, which is available in *Control Algorithm Modeling Guidelines Using MATLAB, Simulink, and Stateflow* on the MathWorks website.
- “Simulink Functions Overview”

- “Add a Simulink Function to a Model”

**Introduced in R2020a**



# MATLAB

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- “MATLAB Appearance” on page 5-2
- “MATLAB Data and Operations” on page 5-6
- “MATLAB Usage” on page 5-13

## **MATLAB Appearance**

# na\_0025: MATLAB Function header

## Sub ID Recommendations

- NA-MAAB — a
- JMAAB — Not supported

## MATLAB Versions

All

## Rule

### Sub ID a

The MATLAB Function block shall have a descriptive header.

Information in the header can include, but is not limited to:

- Function name
- Description of function
- Assumptions and limitations
- Description of changes from previous versions
- Lists of inputs and outputs

### Custom Parameter

Not Applicable

### Example

```
%% Function Name: NA_0025_Example_Header
%
% Description: An example of a header file
%
% Assumptions: None
%
% Inputs:
%     List of input arguments
%
% $Revision: R2020a$
% $Author: MathWorks Advisory Board (MAB)$
% $Date: November 20, 2019$
%-----
```

## Rationale

Sub ID a:

- Improves readability, model simulation, testability, and workflow.
- Code generation may not be possible.

## **Verification**

Adherence to this modeling guideline cannot be verified by using a Model Advisor check.

## **Last Changed**

R2020a

## **See Also**

- “Implementing MATLAB Functions Using Blocks”

**Introduced in R2020a**



# na\_0018: Number of nested if/else and case statement

## Sub ID Recommendations

- NA-MAAB — a
- JMAAB — Not supported

## MATLAB Versions

All

## Rule

### Sub ID a

The number of nested levels in `if /else` and case statements shall be limited, typically to three levels.

### Custom Parameter

Maximum nested levels

## Rationale

Sub ID a:

- Improves readability
- Code generation may not be possible.

## Verification

Model Advisor check: “Check nested conditions in MATLAB Functions” (Simulink Check)

## Last Changed

R2020a

## See Also

- “Loops and Conditional Statements”

## Introduced in R2020a

## **MATLAB Data and Operations**

# na\_0024: Shared data in MATLAB functions

## Sub ID Recommendations

- NA-MAAB — a
- JMAAB — a

## MATLAB Versions

All

## Rule

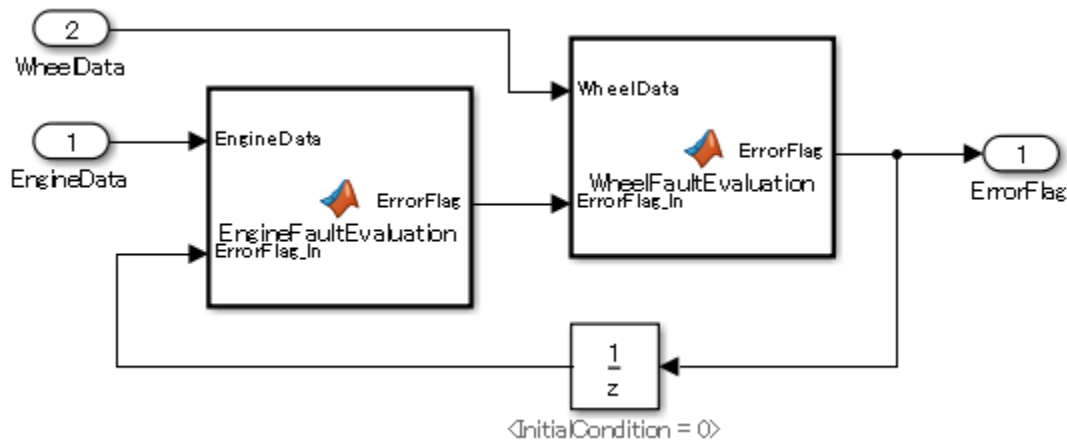
### Sub ID a

Signal lines shall be used to connect data that is shared between MATLAB Function blocks.

### Custom Parameter

Not Applicable

### Example — Correct



```
function ErrorFlag = EngineFaultEvaluation(EngineData,ErrorFlag_In)
%#codegen
RPM_HIGH = 10000;
RPM_LOW = 10;
HIGHRPMFAULT = 2^1;
LOWRPMFAULT = 2^2;
ErrorFlag = ErrorFlag_In;
if EngineData > RPM_HIGH
    ErrorFlag = bitor(ErrorFlag,HIGHRPMFAULT);
end
if EngineData < RPM_LOW
    ErrorFlag = bitor(ErrorFlag,LOWRPMFAULT);
```

```

end

function ErrorFlag = WheelFaultEvaluation(WheelData,ErrorFlag_In)
%#codegen
    SLIP_HIGH = 1000;
    WHEELSLIP = 2^3;
    ErrorFlag = ErrorFlag_In;
    if WheelData > SLIP_HIGH
        ErrorFlag = bitor(ErrorFlag,WHEELSLIP);
    end
end
end

```

### Example — Incorrect



```

function EngineFaultEvaluation(EngineData)
%#codegen
    global ErrorFlag_DataStore
    RPM_HIGH = 10000;
    RPM_LOW = 10;
    HIGHRPMFAULT = 2^1;
    LOWRPMFAULT = 2^2;
    if EngineData > RPM_HIGH
        ErrorFlag_DataStore = bitor(ErrorFlag_DataStore,HIGHRPMFAULT);
    end
    if EngineData < RPM_LOW
        ErrorFlag_DataStore = bitor(ErrorFlag_DataStore,LOWRPMFAULT);
    end
end

function WheelFaultEvaluation(WheelData)
%#codegen
    global ErrorFlag_DataStore
    SLIP_HIGH = 1000;
    WHEELSLIP = 2^3;
    if WheelData > SLIP_HIGH
        ErrorFlag_DataStore = bitor(ErrorFlag_DataStore,WHEELSLIP);
    end
end
end

```

## Rationale

Sub ID a:

- When a data store is used, the readability of the data flow decreases and can lead to errors in the update reference timing.

## Verification

Model Advisor check: “Check MATLAB code for global variables” (Simulink Check)

## Last Changed

R2020a

## See Also

- JMAAB guideline na\_0024, which is available in *Control Algorithm Modeling Guidelines Using MATLAB, Simulink, and Stateflow* on the MathWorks website.
- “Implementing MATLAB Functions Using Blocks”
- “Signal Lines”
- “Resolve Signal Objects for Output Data”

## Introduced in R2020a

## na\_0031: Definition of default enumerated value

### Sub ID Recommendations

- NA-MAAB — a
- JMAAB — a

### MATLAB Versions

All

### Rule

#### Sub ID a

Method `getDefaultValue()` shall be used to explicitly define the default value of an enumeration.

#### Custom Parameter

Not Applicable

#### Example — Correct

See “Specify a Default Enumerated Value”

```
classdef BasicColors < Simulink.IntEnumType
    enumeration
        Red(0)
        Yellow(1)
        Blue(2)
    end
    methods (Static)
        function retVal = getDefaultValue()
            retVal = BasicColors.Blue;
        end
    end
end
```

#### Example — Incorrect

```
classdef(Enumeration) BasicColors < Simulink.IntEnumType
    enumeration
        Red(0)
        Yellow(1)
        Blue(2)
    end
end
```

### Rationale

Sub ID a:

- When an enumerated type does not have a clearly defined a default value, the first enumeration string that is described will be defined as the default, which may not be as intended.

## Verification

Model Advisor check: “Check usage of enumerated values” (Simulink Check)

## Last Changed

R2020a

## See Also

- JMAAB guideline na\_0031, which is available in *Control Algorithm Modeling Guidelines Using MATLAB, Simulink, and Stateflow* on the MathWorks website.
- “Use Enumerated Data in Simulink Models”
- “Define Enumerated Data Types” (Stateflow)
- “Instantiate Enumerations”

## Introduced in R2020a

# na\_0034: MATLAB Function block input/output settings

## Sub ID Recommendations

- NA-MAAB — a
- JMAAB — a

## MATLAB Versions

All

## Rule

### Sub ID a

The data type in the model explorer shall be defined for input and output to the MATLAB Function block.

### Custom Parameter

Not Applicable

## Rationale

Sub ID a:

- Defining the data type for input and output to the MATLAB Function block helps prevent simulation errors and unexpected behavior.

## Verification

Model Advisor check: “Check input and output settings of MATLAB Functions” (Simulink Check)

## Last Changed

R2020a

## See Also

- JMAAB guideline na\_0034, which is available in *Control Algorithm Modeling Guidelines Using MATLAB, Simulink, and Stateflow* on the MathWorks website.
- “Implementing MATLAB Functions Using Blocks”

## Introduced in R2020a



## **MATLAB Usage**

## na\_0016: Source lines of MATLAB Functions

### Sub ID Recommendations

- NA-MAAB — a
- JMAAB — Not supported

### MATLAB Versions

All

### Rule

#### Sub ID a

The length of MATLAB functions shall be limited. The recommended limit is 60 lines of code. Sub-functions can use an additional 60 lines of code.

This restriction applies to MATLAB functions that reside in the Simulink block diagram and external MATLAB files with a `.m` extension.

#### Custom Parameter

Maximum effective lines of code per function

### Rationale

Sub ID a:

- Improves readability and workflow
- Code generation may not be possible.

### Verification

Model Advisor check: “Check lines of code in MATLAB Functions” (Simulink Check)

### Last Changed

R2020a

### See Also

- “Program a MATLAB Function in a Chart” (Stateflow)
- “Implementing MATLAB Functions Using Blocks”

### Introduced in R2020a

# na\_0017: Number of called function levels

## Sub ID Recommendations

- NA-MAAB — a
- JMAAB — Not supported

## MATLAB Versions

All

## Rule

### Sub ID a

The number of sub-function levels shall be limited, typically to three levels.

MATLAB Function blocks that reside in the Simulink block diagram level counts as the first level, unless it is simply a wrapper for an external MATLAB file with a .m extension. This includes functions that are defined within the block and those in separate .m files.

### Exclusions

The following function types are excluded from the number of levels:

- Standard utility functions, such as built-in functions `sqrt` or `log`
- Commonly used custom utility functions

### Custom Parameter

Maximum function call levels

## Rationale

Sub ID a:

- Improves readability and testability

## Verification

Model Advisor check: “Check the number of function calls in MATLAB Function blocks” (Simulink Check)

## Last Changed

R2020a

## **See Also**

- “Implementing MATLAB Functions Using Blocks”
- “Program a MATLAB Function in a Chart” (Stateflow)
- “Exponents and Logarithms”

**Introduced in R2020a**

# na\_0021: Strings in MATLAB functions

## Sub ID Recommendations

- NA-MAAB — a
- JMAAB — a

## MATLAB Versions

All

## Rule

### Sub ID a

Assignment statements for strings shall not be used in MATLAB functions.

### Custom Parameter

Not Applicable

### Example — Incorrect

An assignment statement for strings is being used in the MATLAB function.

```
function y = fcn(u)
%#codegen

str = 'A';

    for i = 1:u
        str = [str 'B'];
    end

    if strcmp(str, 'ABB')
        y = int16(1);
    else
        y = int16(0);
    end
end
```

## Rationale

Sub ID a:

- MATLAB functions store strings as character arrays. As a result, storing strings of different lengths in the same variable does not support dynamic memory allocation, which prevents the strings from being stored.

Consider using enumerated types when a string is used in a Switch Case block

## Verification

Model Advisor check: “Check usage of character vector inside MATLAB Function block” (Simulink Check)

## Last Changed

R2020a

## See Also

- JMAAB guideline na\_0021, which is available in *Control Algorithm Modeling Guidelines Using MATLAB, Simulink, and Stateflow* on the MathWorks website.
- “Implementing MATLAB Functions Using Blocks”
- “Program a MATLAB Function in a Chart” (Stateflow)

## Introduced in R2020a

# na\_0022: Recommended patterns for Switch/Case statements

## Sub ID Recommendations

- NA-MAAB — a
- JMAAB — Not supported

## MATLAB Versions

All

## Rule

### Sub ID a

Switch/Case statements shall use constant values for Case arguments.

Input variables shall not be used in Case arguments.

### Custom Parameter

Not Applicable

### Example — Correct

```
function outVar = NA_0022_Pass(SwitchVar)
%#codegen
    switch SwitchVar
        case Case_1_Parameter % Parameter
            outVar = 0;
        case NA_0022.Case_2 % Enumerated Data Type
            outVar = 2;
        otherwise
            outVar = 10;
    end
end
```

### Example — Incorrect

```
function outVar = NA_0022_Fail(Case_1,Case_2,Case_3,SwitchVar)
%#codegen
    switch SwitchVar
        case Case_1
            outVar = 1;
        case Case_2
            outVar = 2;
        case Case_3
            outVar = 3;
        otherwise
            outVar = 10;
```

```
    end  
end
```

## **Rationale**

Sub ID a:

- Improves model simulation and testability.
- Code generation may not be possible.

## **Verification**

Model Advisor check: “Check usage of recommended patterns for Switch/Case statements” (Simulink Check)

## **Last Changed**

R2020a

## **See Also**

- “Loops and Conditional Statements”

**Introduced in R2020a**



# jc\_0801: Prohibited use of the /\* and \*/ comment symbols

## Sub ID Recommendations

- NA-MAAB — a
- JMAAB — a

## MATLAB Versions

All

## Rule

### Sub ID a

As comment symbols /\* and \*/ are automatically assigned in the generated code, the symbol shall not be used in:

- Code Generate Templates (.cgt) files
- mpt.Signal description
- mpt.Parameter description

### Custom Parameter

Not Applicable

### Example — Incorrect

Included in a .cgt file.

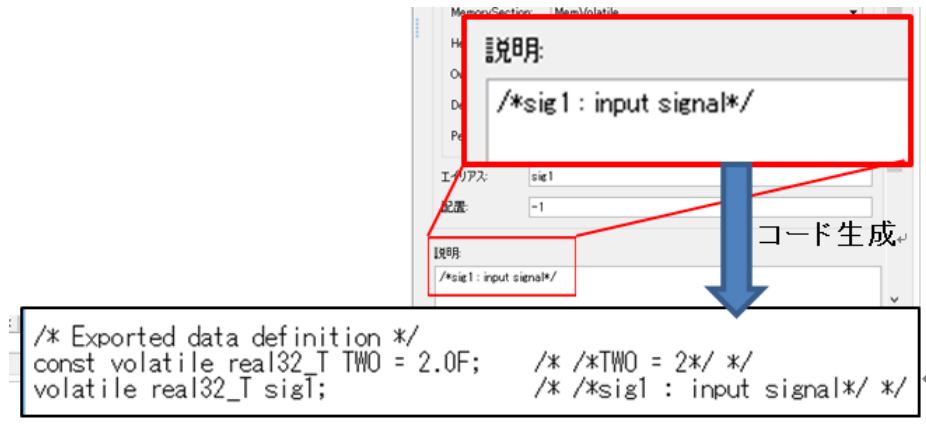
```

ert_code_template_NG.cgt +
%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%% Custom file banner section (optional)
%%
<FileBanner style="classic">
File: %<FileName>
/*
Code generated for Simulink model '%<ModelName>'.
*/
Model version : %<ModelVersion>

コード生成
/*
* File: mo0004a_NG.c
* /*
* Code generated for Simulink model 'mo0004a_NG'.
* */
* Model version : 1.10

```

Included in the `mpt.Signal` description.



## Rationale

Sub ID a:

- Since comment symbols `/*` and `*/` are automatically assigned in the generated code, comments can be unintentionally nested and behave differently than expected.

## Verification

Model Advisor check: “Check for use of C-style comment symbols” (Simulink Check)

## Last Changed

R2020a

## See Also

- JMAAB guideline `jc_0801`, which is available in *Control Algorithm Modeling Guidelines Using MATLAB, Simulink, and Stateflow* on the MathWorks website.
- “Code Generation Template (CGT) Files” (Embedded Coder)
- “MPT Data Object Properties” (Embedded Coder)
- “Specify Comment Style for C/C++ Code” (Embedded Coder)
- “Add Custom Comments for Variables in the Generated Code” (Embedded Coder)

**Introduced in R2020a**

# Considerations

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- “Considerations for Determining Guideline Operation Rules” on page 6-2
- “Considerations for Applying Guidelines to a Project” on page 6-5

## Considerations for Determining Guideline Operation Rules

Prior to selecting the modeling guidelines to adopt for your project, it is important that you consider various aspects of your project and models, such as:

- “Process Definition and Development Environment” on page 6-2
- “MATLAB and Simulink Versions” on page 6-2
- “MATLAB and Simulink Settings” on page 6-2
- “Usable Blocks” on page 6-3
- “Using Optimization and Configuration Parameters” on page 6-3

### Process Definition and Development Environment

The model base development that utilizes simulation is suitable for developing a safe product. However, this does not mean that a system is safe simply because the design can be simulated. While high quality control and functions is necessary, the process definition and development environment being used is equally important. The foundation for a safe system is determined at the start of the project, long before development begins.

### MATLAB and Simulink Versions

The version of MATLAB and Simulink that is used at each development stage is determined at the start of the project. That version must be used by everyone during that development stage.

Different MATLAB versions can be used for different stages in the development process. For example, you can generate and verify the code in R2017b and then use Simulink Design Verifier™ to develop test cases R2020a.

It is necessary to regularly check the bug report published by MathWorks, which are available on the MathWorks website at <https://www.mathworks.com/support/bugreports>. Depending on the bug, a version change may be required; a decision that can be reversed if necessary. During this evaluation, it is important to consider risk from both:

- Malfunctions that result from a bug
- Result from upgrading the version

It is necessary to always have a process that allows adaptation to the latest version and to appropriately evaluate and judge what is the safest option.

### MATLAB and Simulink Settings

MATLAB and Simulink settings shall adhere to the project. It is important that Simulink settings that affect appearance are applied consistently across the project.

Options to be unified include:

- Simulink environment settings:
  - New model standard font settings (block, line, annotation)
- Mask (Edit mask):

- Icons and Ports
- Information display:
  - Library links
  - Sample Time
  - (Block) Sorted execution order
  - (Signals and ports) Wide Non-scalar Lines
  - (Signals and ports) Port data types

See guidelines:

- na\_0004: Simulink model appearance settings
- db\_0043: Model font and font size

## Usable Blocks

There are many blocks in Simulink, however, not all are suitable for all aspects of a project. For example, only some blocks are suitable for generating production-quality code. Or, depending on the block, a function using a combination of basic blocks can be represented by using one block. Usable blocks and design should be defined and limited to the requirements and specifications of the project.

Significantly limiting the number of available blocks can cause adverse effects, such as decreased readability due to variation within the descriptions for the same function, decreased code efficiency, and increased user libraries.

You must register custom blocks in the project's user library.

See guideline db\_0143: Usable block types in model hierarchy for defining usable blocks

## Using Optimization and Configuration Parameters

It is important to consider how you are using optimization options and configuration parameters for your project.

### Optimization Parameters

Optimization options significantly affect generated code. Closely evaluate and apply the optimization options with regards to how they impact the security and safety considerations for your project or product.

As an example of how optimization parameters can impact a process:

For embedded automotive products, it is critical that processing time is fast and RAM/ROM requirements are minimal. To accommodate these requirements, optimization parameters are applied on the **Conditional Input Branch Execution** pane. These optimization parameters improve the computation rate by executing only where the condition holds during execution of the conditional branch by using the Switch block.

In contrast, for the aviation industry, the **Conditional Input Branch Execution** pane is disabled because stabilizing the execution speed is key. Calculation on both sides is preferred in order to maintain a stable computation time, even if calculation is needed only on the side where the condition holds.

## **Configuration Parameters**

Consider these configuration parameters:

### *Hardware Implementation Settings*

Describes model system hardware characteristics, including products and test hardware configuration setup for simulation and code generation. Configure these parameters so they are compatible with the microcomputer that the project uses. Unintended utility functions can be inserted if signed integer division rounding is undefined.

### *Model Reference Settings*

Specified when using model references. Refers to options to include other models in this model, options to include this model in another model, and build options of simulation and code generation targets.

### *Simulation Target Setting*

Configures a simulation target of a model with MATLAB Function, Stateflow Chart (Stateflow), or Truth Table (Stateflow) blocks.

### *High-Integrity Configuration Settings*

For additional information about the high-integrity configuration settings, see “Configuration Parameter Considerations” in the “High-Integrity System Modeling” guidelines.

### *Code Generation Configuration Settings*

For additional information the about the code generation configuration settings, see the “Code Generation” modeling guidelines.

## Considerations for Applying Guidelines to a Project

It is important that you consider the following when applying modeling guidelines to a project:

- “Using the Model Analysis Process When Applying Guidelines” on page 6-5
- “Adoption of the Guideline Rule and Process Settings” on page 6-5
- “Setting the Guideline Rule Application Field and the Clarifying the Exclusion Condition” on page 6-5
- “Parameter Recommendations in the Guidelines” on page 6-6
- “Verifying Adherence to the Guidelines” on page 6-6
- “Modifying Adherence to the Guidelines” on page 6-6

### Using the Model Analysis Process When Applying Guidelines

Model design specification should be defined prior to reviewing the guidelines. Doing so makes the process of determining which guidelines to apply and the implementation of the guidelines more efficient.

For example, the analysis of a simple model can use function `sldiagnostics` to investigate how often a specific block is used. Adjust the operation rules list by specifying blocks that are frequently used and those that are not.

Furthermore, reusability at a later stage is improved by adding rules that:

- Unify description styles
- Anticipate in advance the man-hours needed to correct models
- Measuring tendencies, such as where to place blocks that have feedback status variables (Unit Delay block), whether the Unit Delay block should be inside or outside the subsystem, or whether the Abs block should be set on the output side of the subsystem, and if it should process at the input side after receiving a signal.

### Adoption of the Guideline Rule and Process Settings

At the start of the project, it should be determined which guidelines apply to each development process. The guidelines should be evaluated and applied so that they correspond with the development process. Considerations may include questions such as:

- Will the guideline be applied only at the code generation stage?
- Will the adopted guideline rule change for each process stage?

### Setting the Guideline Rule Application Field and the Clarifying the Exclusion Condition

The field to which the guidelines apply must be determined. For example, guidelines can be:

- Limited to a model that represents the AUTOSAR field of application
- Applied to a general software field, such as where models implement interrupts (add processes that prohibit interruption during calculation).

- Specific to fields where general engineers edit the models. The intention of these rules is to ensure that the models are easily understandable in those fields.

---

**Note** Specialized fields can be excluded from the constraints of these guidelines by limiting the scope and applying unique set of guidelines that are specific in this environment.

---

Specialized fields, such as those where modelers design custom library blocks, are not typically targeted by these guidelines.

Furthermore, when having a control model that is operated with Rapid Control Prototyping (RCP) , the entire model should not be set as a target; instead, the field needs to be limited. It is necessary to generate the code and review the areas that are implemented in the built-in microcomputer as well as the areas that are not. These guidelines do not apply to control models such as those scheduler models that are made solely for RCP and are not implemented, or for interface sections with blocks that correspond to drivers such as CAN and PWM signals for operating actual machines.

### Parameter Recommendations in the Guidelines

Guidelines should not be adopted as they are written without further evaluation.

Implementation of guideline rules and parameter recommendations should be evaluated to determine the impact on the project and the development processes being used. In addition, consideration needs to be taken as to the effect on other guidelines and how applying custom parameters can affect simulation or code generation.

### Verifying Adherence to the Guidelines

At the beginning of a project, it is important to determine how and when the project will be evaluated to ensure adherence to the guidelines.

The decision whether to use an automated checking mechanism (third part or internal) or perform manual checks is very important. Also, the stage at which the checks occur, as well as developing a system for revising the check rule criteria, is important.

Automated checking can significantly reduce the time required for review. It is recommended that an additional, manual review also be performed by a skilled person, even if everything can be checked automatically.

### Modifying Adherence to the Guidelines

The decision to apply a guideline or a rule can change. When doing so, it is important to specify a process and procedure for determine the root cause of the request and evaluate the potential impact the change can have on the project and the organization.

When evaluating the change request, first listen to the needs of the modeler and determine the root cause of the request. When the request is based on the user not understanding block usage or a guideline rule, training should occur instead of revising the rule.

The procedure to relax the rules as needed should be implemented when there are restrictions due to company objectives and control specifications or hardware (such as microcomputers).



# Using Simulink and Stateflow

## Understanding Model Architecture

When evaluating the modeling guidelines for your project, it is important that you understand the architecture of your controller model, such the function/subfunction layers, schedule layer, control flow layer, section layer, and data flow layer.

### Hierarchical Structure of a Controller Model

This section provides a high-level overview of the hierarchical structuring in a basic model, using a controller model as an example. This table defines the layer concepts in a hierarchy.

|              | <b>Layer concept</b> | <b>Layer purpose</b>   |
|--------------|----------------------|--|
| Top Layer    | Function layer       | Broad functional division  |
|              | Schedule layer       | Expression of execution timing (sampling, order)   |
| Bottom Layer | Sub function layer   | Detailed function division   |
|              | Control flow layer   | Division according to processing order (input → judgment → output, etc.)                           |
|              | Selection layer      | Division (select output with Merge) into a format that switches and activates the active subsystem |
|              | Data flow layer      | Layer that performs one calculation that cannot be divided   |

When applying layer concepts:

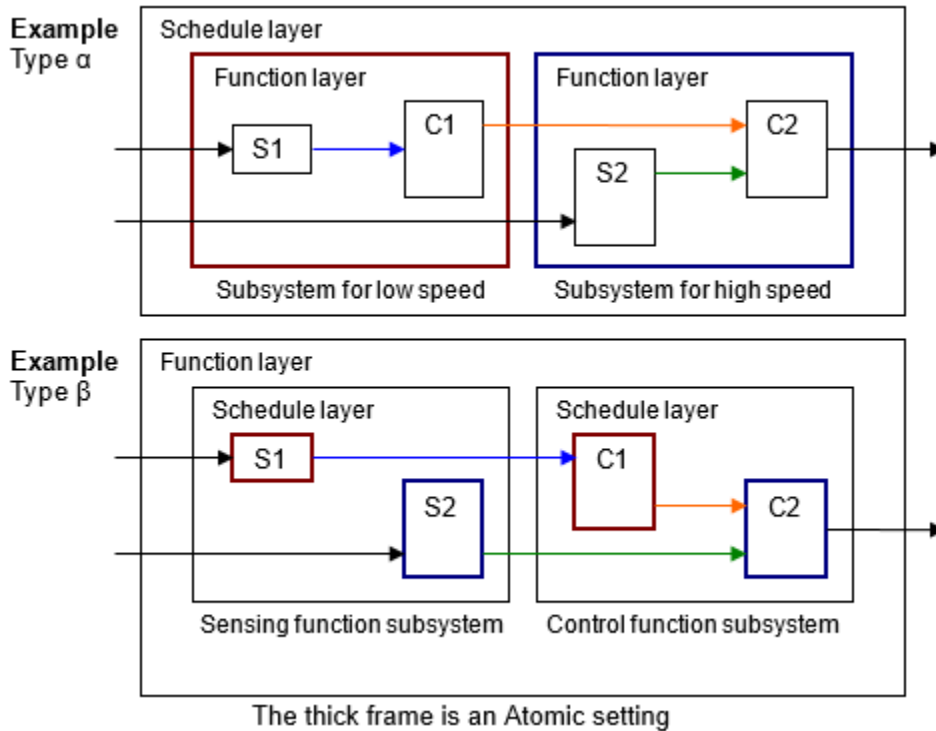
- Layer concepts shall be assigned to layers and subsystems shall be divided accordingly.
- When a layer concepts is not needed, it does not need to be allocated to a layer.
- Multiple layer concepts can be allocated to one layer.

When building hierarchies, division into subsystems for the purpose of saving space within the layer shall be avoided.

#### Top Layer

Layout methods for the top layer include:

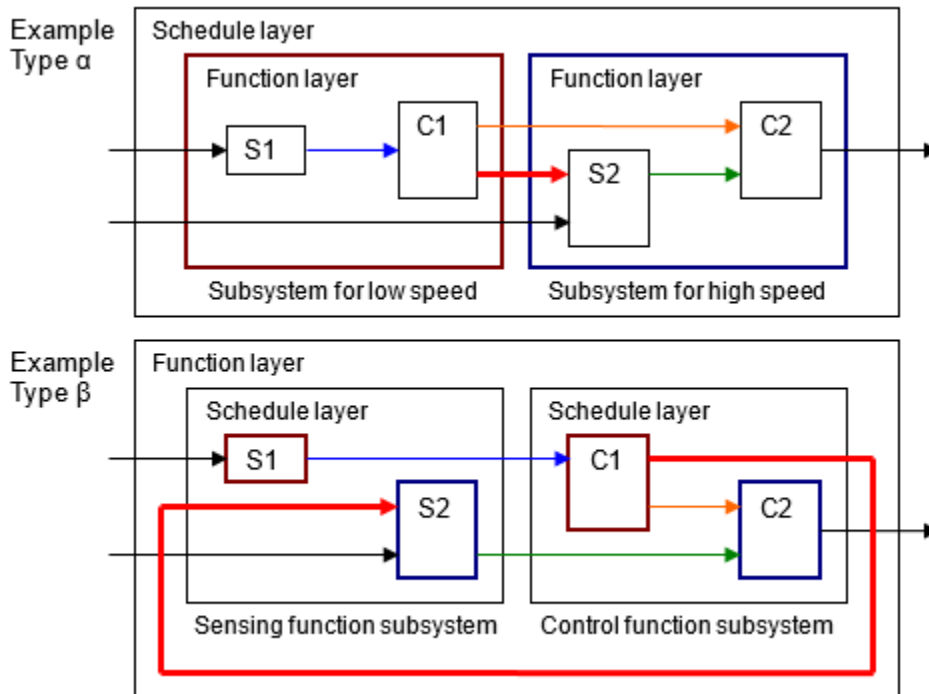
- Simple control model — Represents both the function layer and schedule layer in the same layer. Here, function is execution unit. For example, a control model has only one sampling cycle and all functions are arranged in execution order
- Complex control model Type  $\alpha$  — The schedule layer is positioned at the top. This method makes integration with the code easy, but functions are divided, and the readability of the model is impaired.
- Complex control model Type  $\beta$  — Function layers are arranged at the top and schedule layers are positioned below the individual function layers.



### Function Layers and Sub-Function Layers

When modeling function and sub-function layers:

- Subsystems shall be divided by function, with the respective subsystems representing one function.
  - One function is not always an execution unit so, for that reason, the respective subsystem is not necessarily an atomic subsystem. In the type β example below, it is more appropriate for a function layer subsystem to be a virtual subsystem. Algebraic loops are created when these change into atomic subsystems.
  - Individual functional units shall be described.
  - When the model includes multiple large functions, consider using model references for each function to partition the model.



### Schedule Layers

When scheduling layers:

- System sampling intervals and execution priority shall be set. Use caution when setting multiple sampling intervals. In connected systems with varying sampling intervals, ensure that the system is split for each sampling interval. This minimizes the RAM needed to store previous values in the situation where the processing of signals values differs for fast cycles and slow cycles.
- Priority ranking shall be set. This is important when designing multiple, independent functions. When possible, computation sequence for all subsystems should be based on subsystem connections.
- Two different types of priority rankings shall be set, one for different sampling intervals and the other for identical sampling rates.

There are two types of methods that can be used for setting sampling intervals and priority rankings:

- For subsystems and blocks, set the block parameter **sample time** and block properties **priority**.
- When using conditional subsystems, set independent priority rankings to match the scheduler.

Patterns exist for many different conditions, such as the configuration parameters for custom sampling intervals, atomic subsystem settings, and the use of model references. The use of a specific pattern is closely linked to the code implementation method and varies significantly depending on the status of the project. Models that are typically affected include:

- Models that have multiple sampling intervals
- Models that have multiple independent functions
- Usage of model references

- Number of models (and whether there is more than one set of generated code)

For the generated code, affected factors include:

- Applicability of a real-time operating system
- Consistency of usable sampling intervals and computation cycles to be implemented
- Applicable area (application domain or basic software)
- Source code type: AUTOSAR compliant - not compliant - not supported.

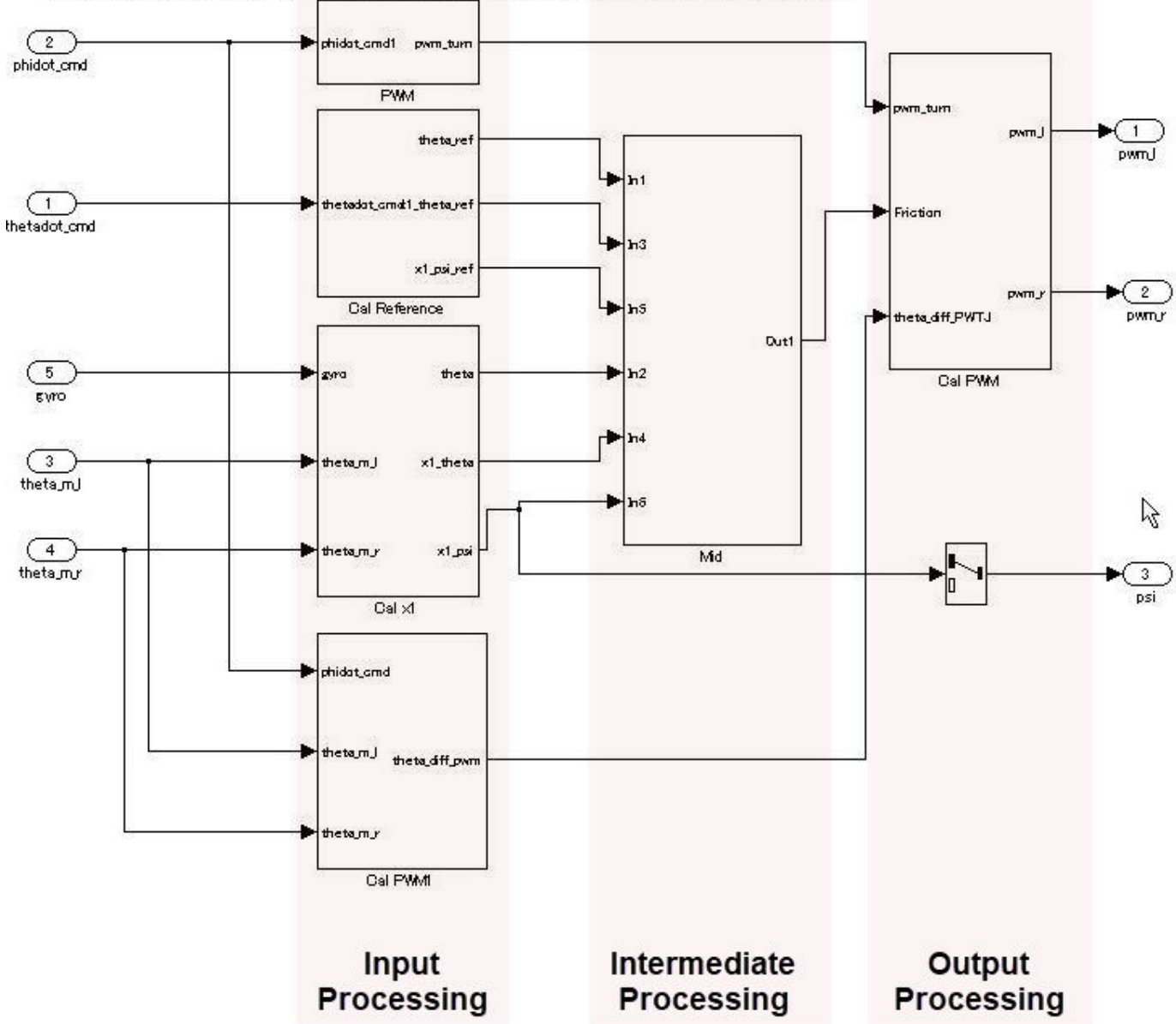
### **Control Flow Layers**

In the hierarchy, the control layer expresses all input processing, intermediate processing, and output processing by using one function. The arrangement of blocks and subsystems is important in this layer. Multiple, mixed small functions should be grouped by dividing them between the three largest stages of input processing, intermediate processing and output processing, which forms the conceptual basis of control. The general configuration occurs close to the data flow layer and is represented in the horizontal line. The difference in a data flow layer is its construction from multiple subsystems and blocks.

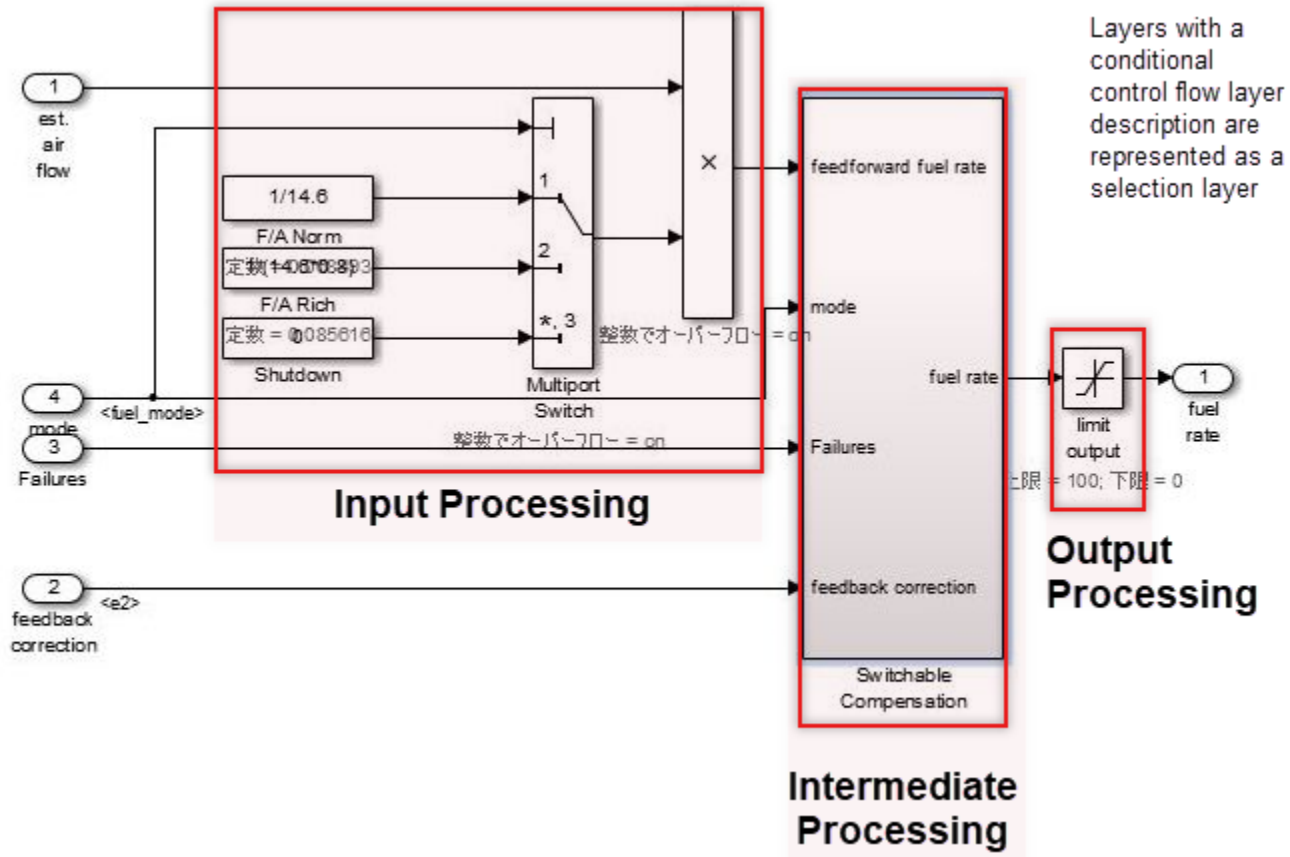
In control flow layers, the horizontal direction indicates processing with different significance; blocks with the same significance are arranged vertically.

### NXTway-GS Controller

Calculate PWM duty to minimize the difference between reference and measured value.



Block groups are arranged horizontally and are given a provisional meaning. Red borders, which signify the delimiter for processing that is not visible, correspond to objects called virtual objects. Using annotations to mark the delimiters makes it easier to understand.



Control flow layers can co-exist with blocks that have a function. They are positioned between the sub-function layer and the data flow layer. Control flow layers are used when:

- The number of blocks becomes too large
- All is described in the data flow layer
- Units that can be given a minimum partial meaning are made into subsystems

Placement in the hierarchy organizes the internal layer configuration and makes it easier to understand. It also improves maintainability by avoiding the creation of unnecessary layers.

When the model consists solely of blocks and does not include a mix of subsystems, if the horizontal layout can be split into input/intermediate/output processing, it is considered a control flow layer.

### Selection Layers

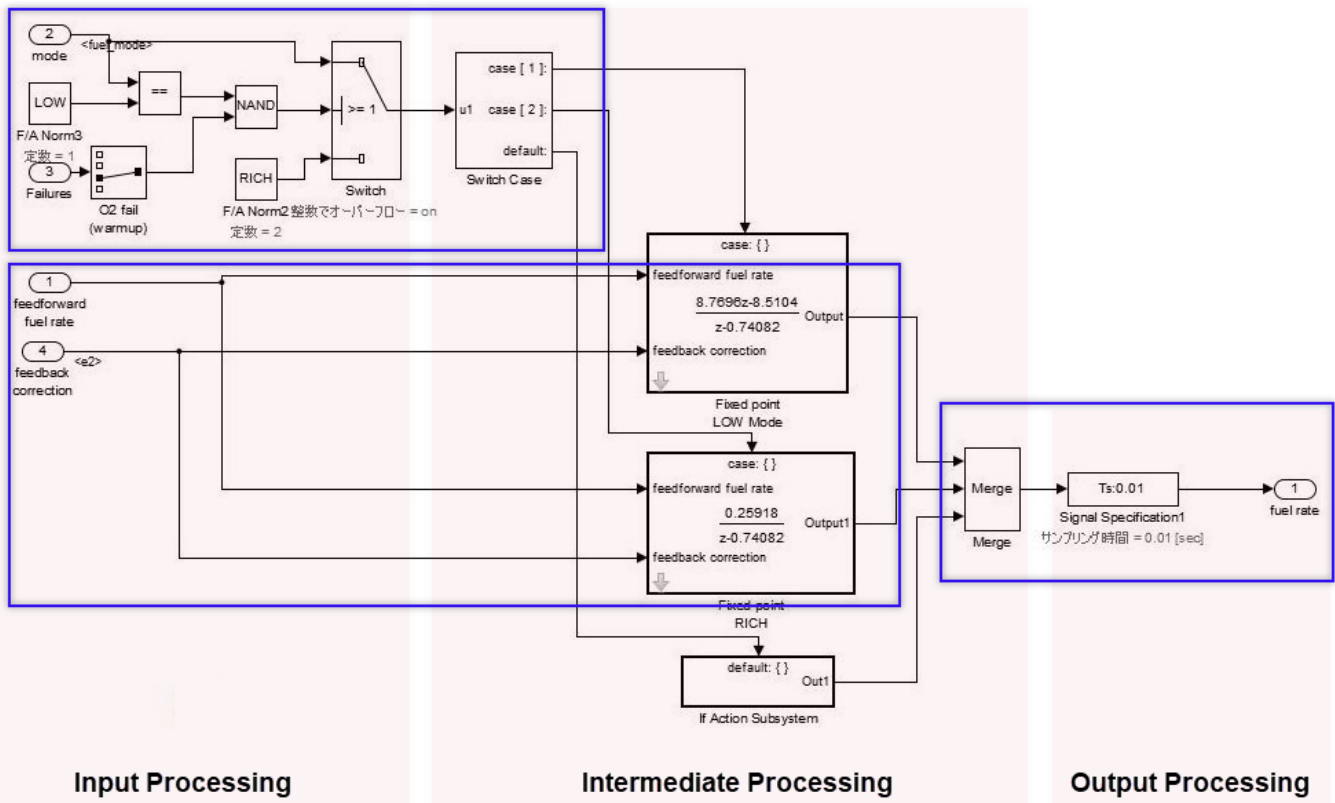
When modeling selection layers:

- Selection layers should be written vertically or side-by-side. There is no significance to which orientation is chosen.
- Selection layers shall mix with control flow layers.

When a subsystem has switch functions that allow only one subsystem to run depending on the conditional control flow inside the red border, it is referred to as a selection layer. It is also described as a control flow layer because it structures input processing/intermediate processing (conditional control flow)/output processing.

In the control flow layer, the horizontal direction indicates processing with different significance. Parallel processing with the same significance is structured vertically. In selection layers, no significance is attached to the horizontal or vertical direction, but they show layers where only one subsystem can run. For example:

- Switching coupled functions to run upwards or downwards, changing chronological order
- Switching the setting where the computation type switches after the first time (immediately after reset) and the second time
- Switching between destination A and destination B



**Data Flow Layers**

A data flow layer is the layer below the control flow layer and selection layer.

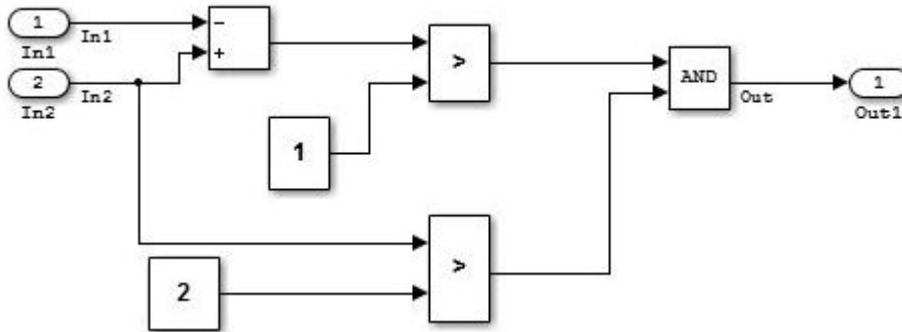
A data flow layer represents one function as a whole; input processing, intermediate processing and output processing are not divided. For instance, systems that perform one continuous computation that cannot be split.

Data flow layers cannot coexist with subsystems apart from those where exclusion conditions apply. Exclusion conditions include:

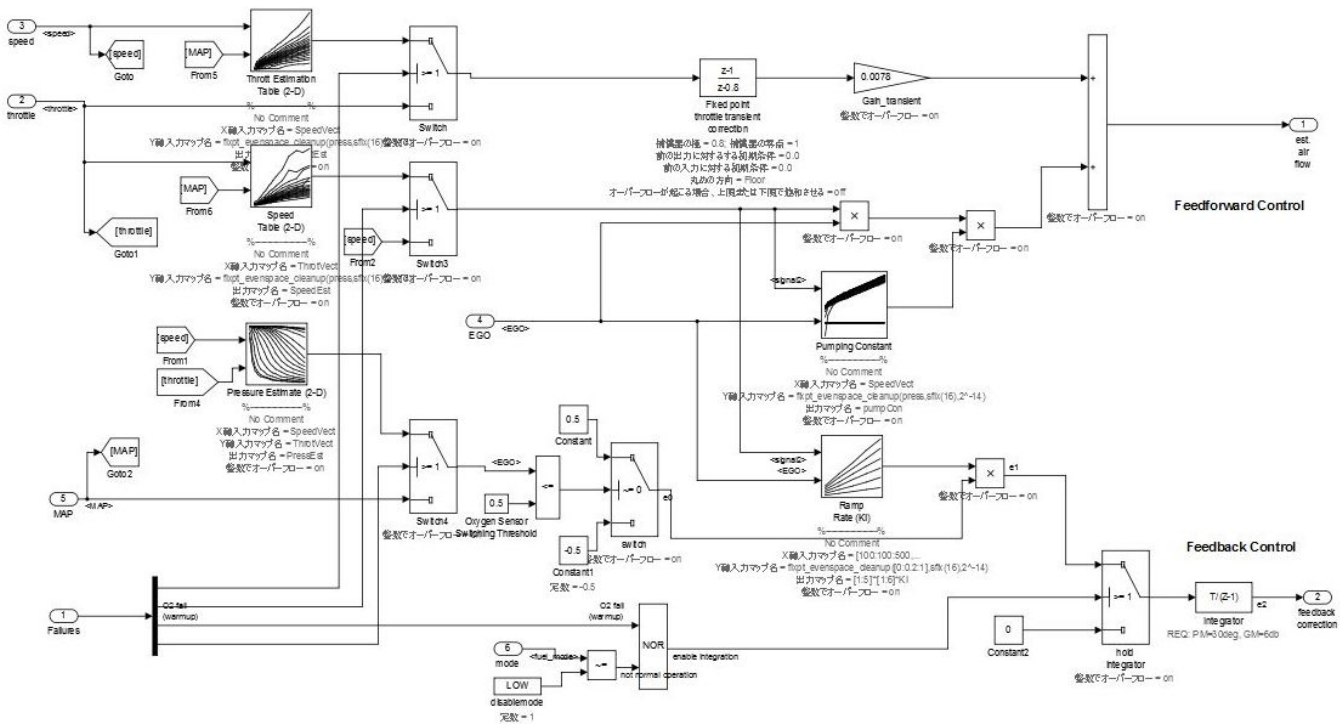
- Subsystems where reusable functions are set
- Masked subsystems that are registered in the Simulink standard library
- Masked subsystems that are registered in a library by the user

Example of a simple data flow layer.





Example of a complex data flow layer.



When input processing and intermediate processing cannot be clearly divided as described above, they are represented as a data flow layer.

A data flow layer becomes complicated when both the feed forward reply and feedback reply from the same signal are computed at the same time. Even when the number of blocks in this type of cases is large, the creation of a subsystem should not be included in the design when the functions cannot be clearly divided. When meaning is attached through division, it should be designed as a control flow layer.

## Relationship between Simulink Models and Embedded Implementation

Running an actual micro controller requires embedding the code that is generated from the Simulink model into the micro controller. This requirement affects the configuration Simulink model and is dependent on:

- The extent to which the Simulink model will model the functions
- How the generated code is embedded
- The schedule settings on the embedded micro controller

The configuration is affected significantly when the tasks of the embedded micro controller differs from those modeled by Simulink.

**Scheduler Settings in Embedded Software**

The scheduler in embedded software has single-task and multi-task settings.

*Single-task schedule settings*

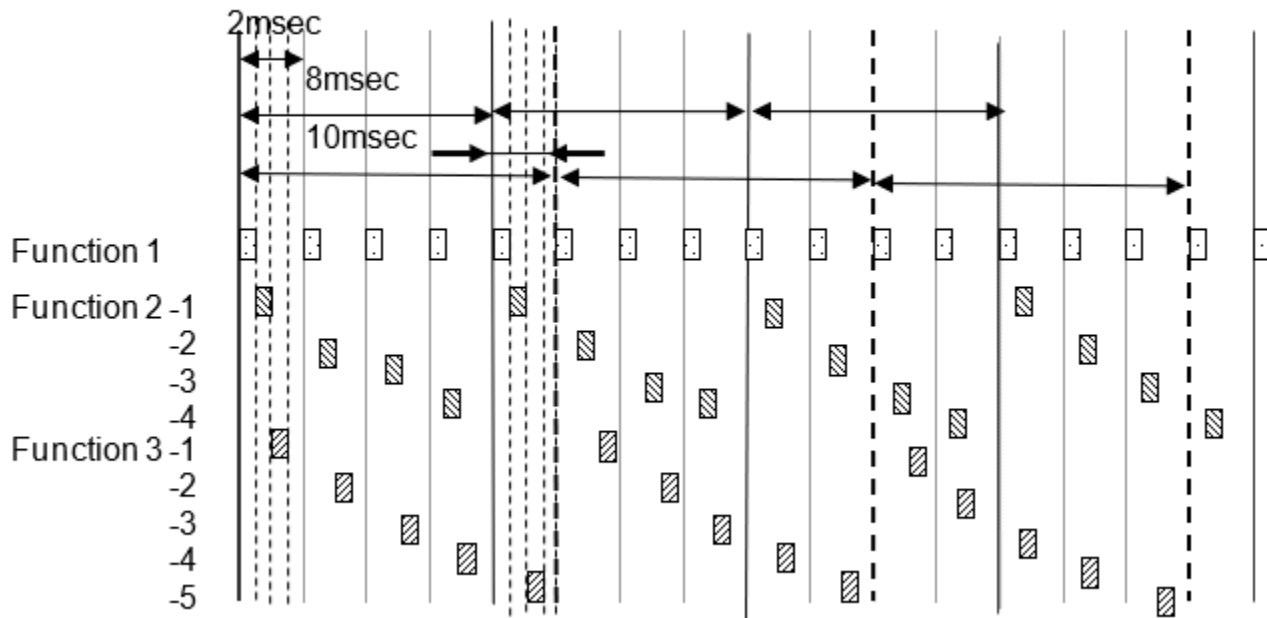
A single-task scheduler performs all processing by using basic sampling. Therefore, when processing of longer sampling is needed, the function is split so the CPU load is as evenly distributed as possible, and then processed using basic sampling. However, as equal splitting is not always possible, functions may not be able to be allocated to all cycles.

For example, basic sampling is 2 millisecond, and sampling rates of 2 millisecond, 8 millisecond and 10 millisecond exist within the model. An 8 millisecond function is executed once for every four 2 millisecond cycles, and a 10 millisecond function is executed once for every five. The number of executions is counted every 2 millisecond and the sampling function specified by this frequency is executed. Attention needs to be paid to the fact that the 2 millisecond, 8 millisecond and 10 millisecond cycles are all computed with the same 2 millisecond. Because all computations need to be completed within 2 millisecond, the 8 millisecond and 10 millisecond functions are split into several and adjusted so that all 2 millisecond computations are of an almost equal volume.

The following diagram shows the 8 millisecond function split into 4 and the 10 millisecond function split into 5.

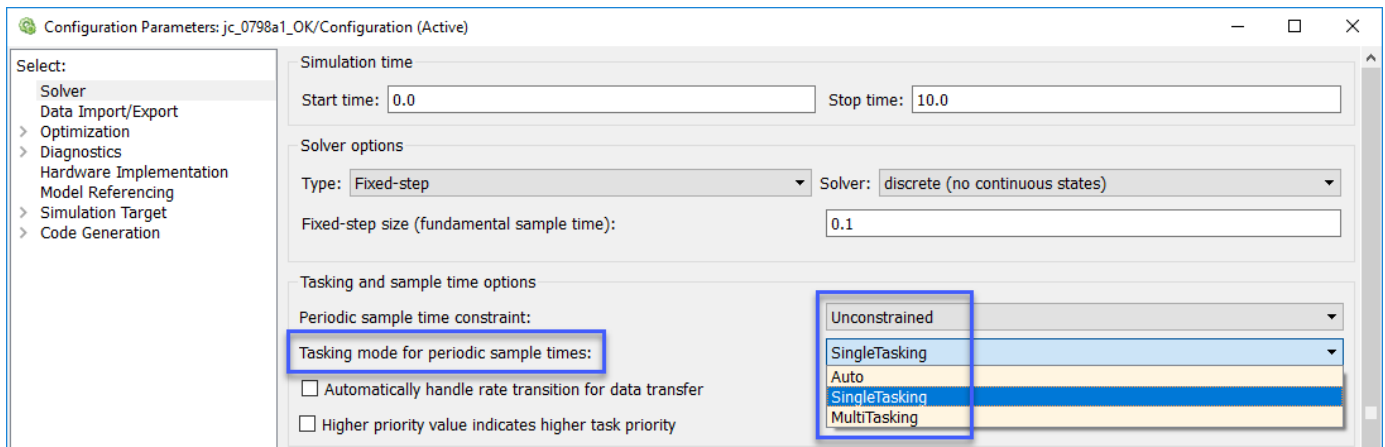
| Functions | Fundamental frequency | Offset       |
|-----------|-----------------------|--------------|
|           | 8millisecond          | 0millisecond |
| 2-2       | 8millisecond          | 2millisecond |
| 2-3       | 8millisecond          | 4millisecond |
| 2-4       | 8millisecond          | 6millisecond |
| 3-1       | 10millisecond         | 0millisecond |
| 3-2       | 10millisecond         | 2millisecond |
| 3-3       | 10millisecond         | 4millisecond |
| 3-4       | 10millisecond         | 6millisecond |
| 3-5       | 10millisecond         | 8millisecond |

All computations must be contained within the 2 msec cycle

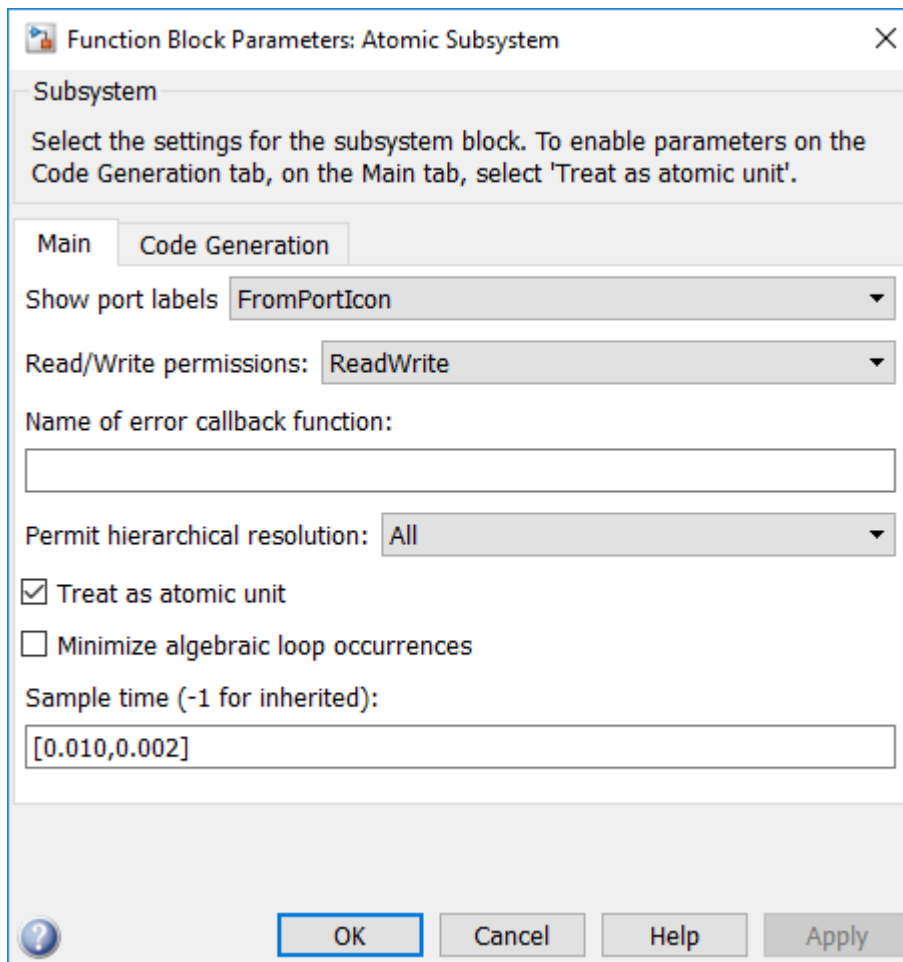


To set frequency-divided tasking:

- 1 Set configuration parameter **Tasking mode for periodic sample times** to `SingleTasking` for Simulink task setting.

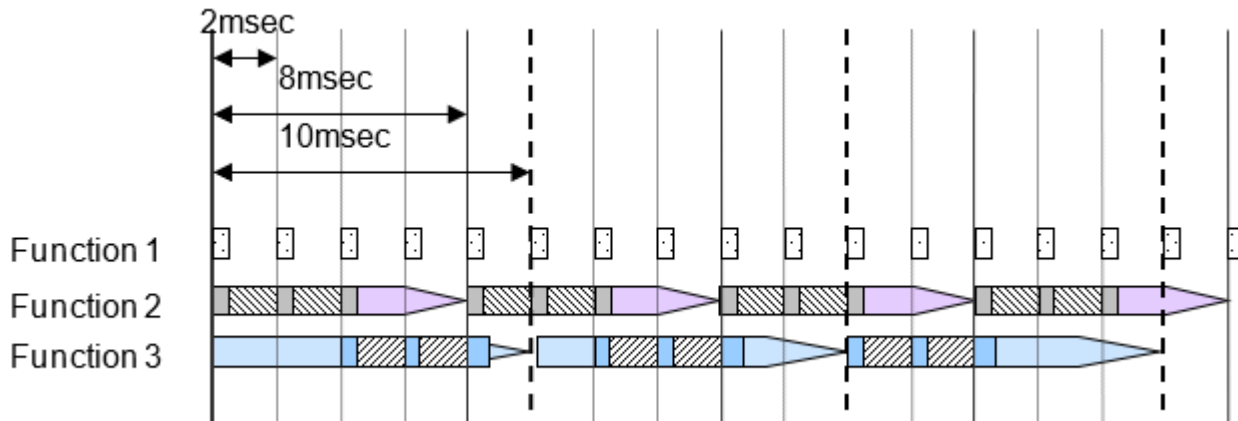


- 2 In the Atomic Subsystem block parameter **Sample time**, enter the sampling period offset values. A subsystem for which a sampling period can be specified is referred to as an atomic subsystem.



*Multi-task scheduler settings*

Multi-task sampling is executed by using a real-time OS that supports multi-task sampling. In single-task sampling, equalizing the CPU load is not done automatically, but a person divides the functions and allocates them to the appointed task. In multi-task sampling, the CPU performs the computations automatically in line with the current status; there is no need to set detailed settings. Computations are performed and results are output starting from the task with the highest priority, but the task priorities are user-specified. Typically, fast tasks are assigned highest priority. The execution order for this task is user-specified.



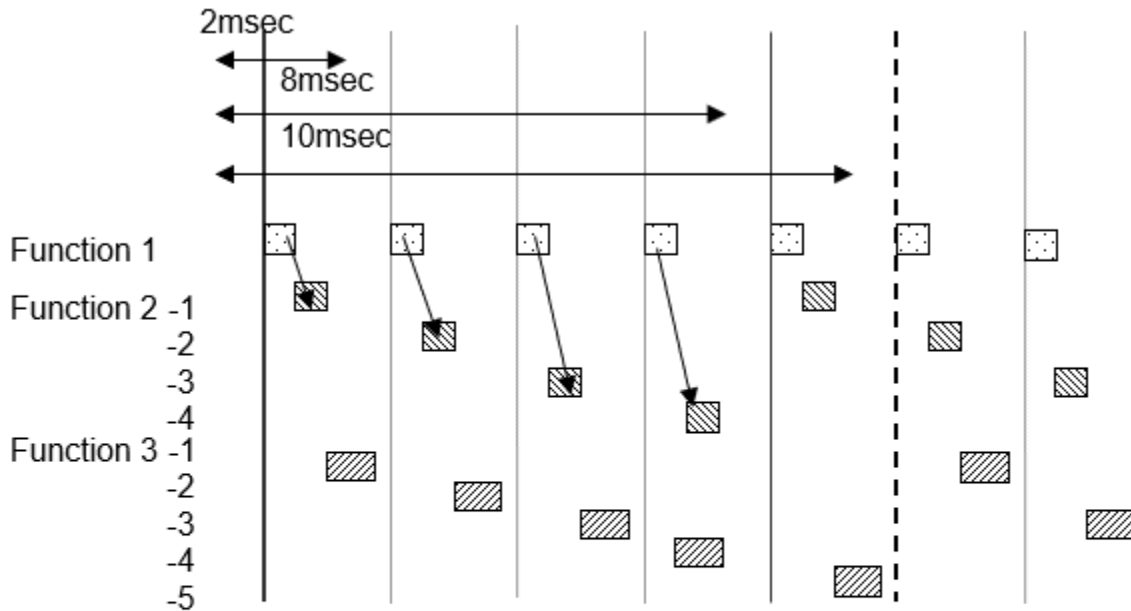
It is important that computations are completed within the cycle, including slow tasks. When the processing of a high priority computation finishes and the CPU is available, the computation for the system with the next priority ranking begins. A high priority computation process can interrupt a low priority computation, which is then aborted so the high priority computation process can execute first.

### Effect of Connecting Subsystems with Sampling Differences

If subsystem B with a 20 millisecond sampling interval uses the output of subsystem A with a 10 millisecond sampling interval, the output result of subsystem A can change while subsystem B is computing. If the values change partway through, the results of subsystem B's computation may not be as expected. For example, a comparison is made in subsystem B's first computation with the subsystem A output, and the result is computed with the conditional judgment based on this output. At this point, the comparison result is true. It is then compared again at the end of subsystem B; if the output from A is different, then the result of the comparison can be false. Generally, in this type of function development it may happen that the logic created with true, true has become true, false, and an unexpected computation result is generated. To avoid this type of malfunction, when there is a change in task, output results from subsystem A are fixed immediately before they are used by subsystem B as they are used in a different RAM from that used by the subsystem A output signals. In other words, even if subsystem A values change during the process, the values that subsystem B are looking at is in a different RAM, so no effect is apparent.

When a model is created in Simulink and a subsystem is connected that has a different sampling interval in Simulink, Simulink automatically reserves the required RAM.

However, if input values are obtained with a different sampling interval through integration with hand-coded code, the engineer who does the embedding work should design these settings. For example, in the RTW concept using AUTOSAR, different RAMs are all defined at the receiving and exporting side.



If Function 2 uses the computation results of Function 1, computation results for Function 1 do not change during computation for Functions 2-1, 2-2, 2-3, but there is a possibility that Functions 2-1, 2-2, 2-3 use different values that have been computed on the respective different time axes.

Allocate different RAM for signal values with a different rates

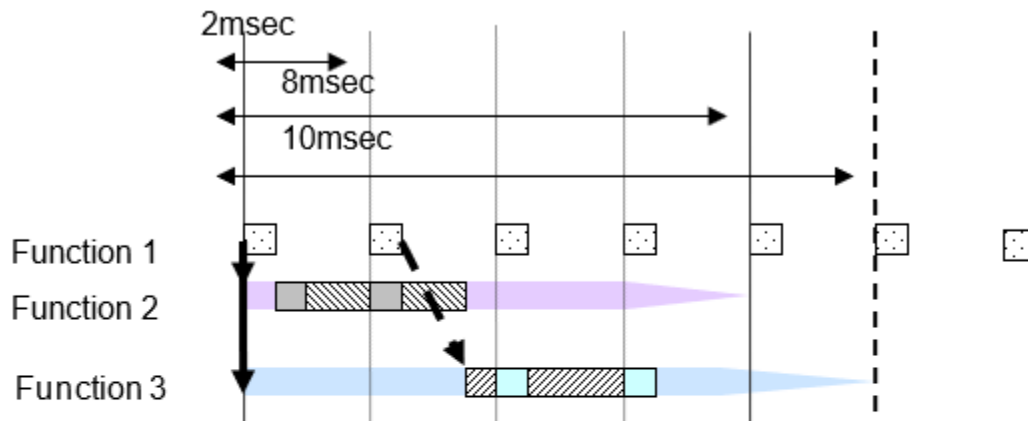
*Single-task scheduler settings*

Signal values are the same within the same 2 millisecond cycle, but when there are different 2 millisecond cycles, the computation value differs from the preceding one. When Function 2-1 and 2-2 uses signal A of Function 1, be aware that 2-1 and 2-2 uses results from different times.

*Multi-task scheduler settings*

For multi-task, you cannot specify at what point to use the computation result to use. With multi-task, always store signals for different tasks in new RAM.

Before new computations are performed within the task, all values are copied.



Do not immediately use values that are being updated.

The value should be held at the beginning of the task.

If Function 2 uses the computation results of Function 1, it is possible that computation results from Function 1 will replace them while Function 2 is computing. For that reason, computation results that vary at the point when computation starts for each sampling are typically stored in a different RAM.

## Using Simulink and Stateflow in Modeling

When using Stateflow, Simulink is required for inputs, outputs, and structuring. Stateflow alone can perform a variety of formula processing. When using Simulink, complex state variables can be realized through methods, such as using the Switch Case block.

Either Simulink or Stateflow can be used to model specific parts of control, however, the application of either product in the development workflow is based on the user's understanding of the underlying algorithms and, ultimately, comes down to the organization to determine which tool is best suited for their needs. Determining whether Simulink or Stateflow should be used for design should be determined by a group of people in accordance with the task. Whether implementation in Stateflow is done by using state transitions or with flow charts should also be specified.

In most cases, Stateflow is less efficient with regards to RAM. Therefore, Simulink has an advantage in computations that use simple formulas. In addition, Simulink is more advantageous for situations where state variables are operated with simple flip-flops and the Relay block. When evaluating whether to use Simulink or Stateflow in a project, these topics should be taken into consideration:

- Increasing RAM: There must always be a RAM available for visualization of Stateflow inputs, outputs and internal variables.
- Equation error handling: When general computational formulas are used internally, the user designs ways to prevent overflow.
- Splitting and separating functions: When performing calculations that use Simulink outside of Stateflow, there is a possibility that they may split, thus reducing readability. There are also times where readability may improve. This can be difficult to judge.

There are cases where Stateflow has more efficient code than Simulink for optimum expressions that are close to code, but most of these result in a model that is difficult to understand. If code already exists, it is more advantageous to use S-functions instead of Stateflow modelling. Stateflow can note computations where specific arrangements are specified, or computations using for-loops, more efficiently than Simulink, but in recent years it has also become convenient to use MATLAB language for descriptions. If needed, consider using MATLAB language for modelling.

For Stateflow models, when dealing with states as described below, readability improves by describing them as state transitions:

- Different output values are output for identical inputs.
- Multiple states exist (as a guide, three or more).
- States with meaningful names instead of just numbers.
- Inside a state, initialization (first time) and differentiation during execution (after the second time) is required.

For instance, in flip-flop circuits, different values are outputted for inputs. State variables are limited to 0 and 1. However, a meaningful name cannot be added to each state simply by retaining boolean type numbers. There is also no distinction between initialization and execution within the state. Thus, only one flip-flop applies out of the four above, so Simulink is more beneficial.

In Stateflow, situations that can be represented as states are implemented as state transitions and conditional branches that are not states are implemented as flow charts. Truth tables are classified as a conditional branch implementation method. When designing states as state transitions by using Stateflow, `Classic` should be selected as the state machine type so that it is implemented as software into the control system's embedded micro controller.



HDL Coder™ is supported by Stateflow. When using HDL Coder, Mealy or Moore must be selected; Moore mode is more appropriate when protection is required against internal electric leaks.

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**Note** HDL Coder use cases are not described in these guidelines.

---

## Simulink Functionality

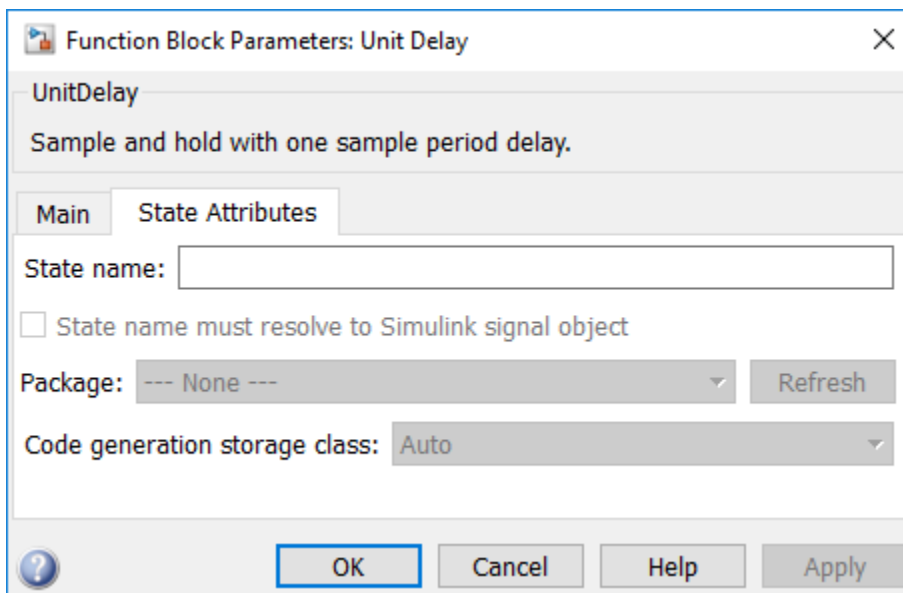
This section provides information about using Simulink for modeling.

### Blocks with State Variables

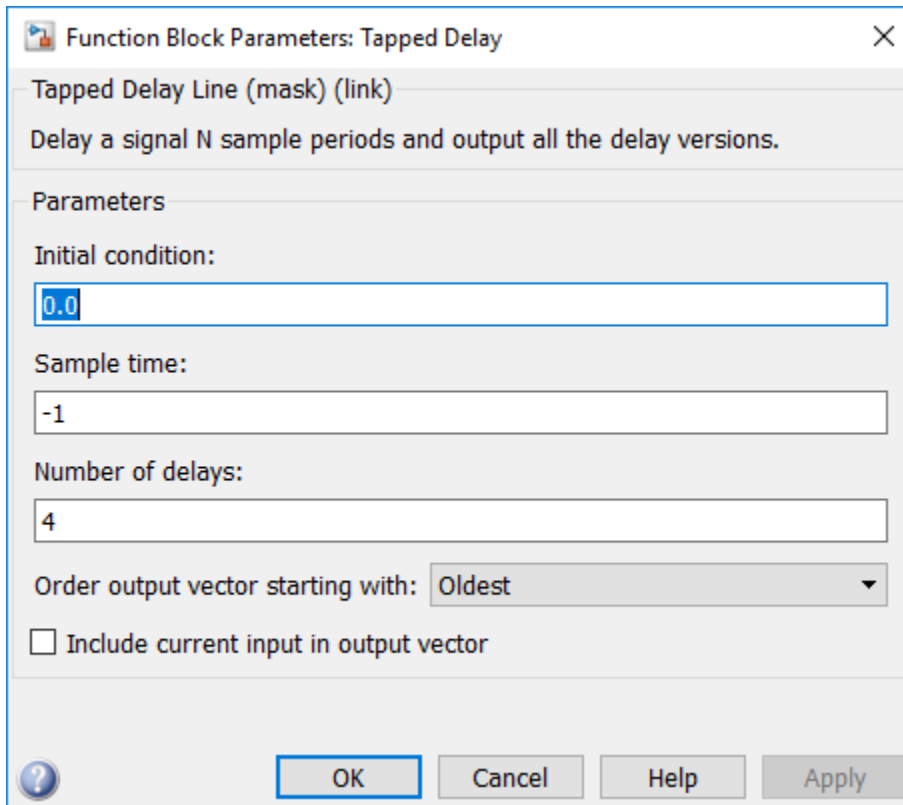
Blocks with state variables are primarily grouped into Simulink and discrete types.

For most of these blocks, the user can set the state attributes and initial values by using the block parameters. A conditional subsystem can have state variables, depending on the structure pattern.

In this example, the Unit Delay block has state attributes.



In this example, the Tapped Delay block does not have state attributes.

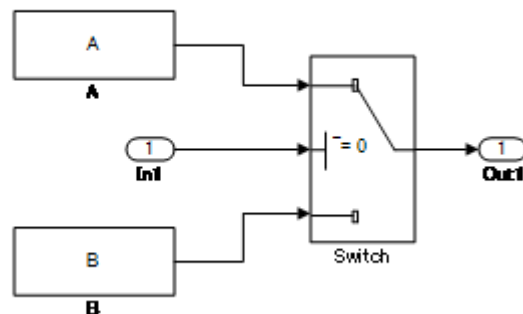


See guideline: jc\_0640

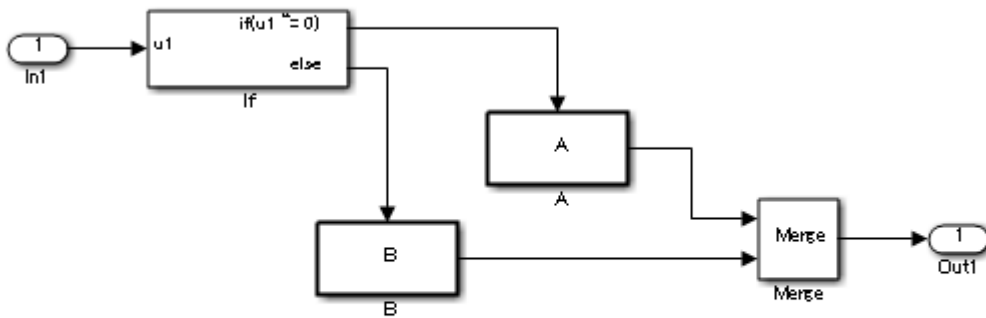
### Branch Syntax with State Variables

The Switch block and conditional subsystems behave differently when state variables are used.

Depending on the configuration setting, when any state variable exists, the Switch block generally executes subsystem A when the condition of the control port is satisfied. If the condition is not satisfied, it executes only subsystem B without calculating subsystem A. However, when the subsystem A contains a state variable, calculation for the state variable within the subsystem A is processed even when the conditions of the control port are not satisfied.



In the conditional subsystem, subsystem A is calculated when the condition is satisfied. When is not satisfied, subsystem B is calculated instead of subsystem A, regardless of the existence of any state variables in subsystem A.



The reset action in a recalculation can be specified by using the {Action Port} setting.

The behavior of subsystem A when using a Switch block and a conditional control flow is listed in the following tables. Familiarize yourself with these behaviors to determine which structure, the Switch block, or conditional subsystem is most suitable for the intended purpose.

This table shows the behavior of subsystem A

| Control port condition | (in subsystem A)<br>State variables | Switch   | Conditional subsystem |
|------------------------|-------------------------------------|--|-----------------------|
| Hold                   | No                                  | Executed   | Executed              |
|                        | Yes                                 |  |                       |
| Not hold               | No                                  | Not executed   | Not executed          |
|                        | Yes                                 | Minimally-processed<br>*Executed calculations related to the state variables |                       |

This table provides the initialization timing of subsystem A.

|  | Action Port | Initialize |
|--|-------------|------------|
|  |             |            |

|                       |       |                          |
|-----------------------|-------|--------------------------|
| Switch                | —     | First time only          |
| Conditional subsystem | Hold  | First time only          |
|                       | Reset | At returned by condition |

See guidelines:

- jc\_0656: Usage of Conditional Control blocks
- jc\_0657: Retention of output value based on conditional control flow blocks and Merge blocks

### Subsystems

A subsystem is used for compiling various blocks and subsystems.

Subsystems can also be used for other purposes. Usage methods that are not functional subsystems include:

- Mask display of the subsystem is used to describe the outline or display fixed form documents, such as "classified"
- The open functions (callback functions in the block properties) of the subsystem is used for running several tools or displaying explanatory text separate from the model
- Subsystems whose setting have changed to a mask subsystem (a subsystem that was simply set to NoReadOrWrite) by a user with administrative rights to make a change, but other users cannot see the content.

These non-typical subsystems are outside of the scope of the guidelines and, if excluded, should be put on an exclusion list managed within the project.

See guidelines:

- jc\_0201: Usable characters for subsystem names
- jc\_0243: Length restriction for subsystem names
- db\_0143: Usable block types in model hierarchy
- db\_0144: Use of subsystems
- db\_0141: Signal flow in Simulink models
- jc\_0653: Delay block layout in feedback loops
- jc\_0171: Clarification of connections between structural subsystems
- jc\_0602: Consistency in model element names
- jc\_0081: Inport and Outport block icon display
- db\_0081: Unconnected signals and blocks

### Atomic Subsystems and Virtual Subsystems

There are two types of subsystems, Virtual subsystem and Atomic subsystems. The primary difference between these subsystems is whether the subsystem is treated as a single execution unit. The virtual subsystem is the default subsystem block.

In a model, the border for a Virtual subsystem is thin as compared the border for the Atomic subsystem, which is thick and bold.

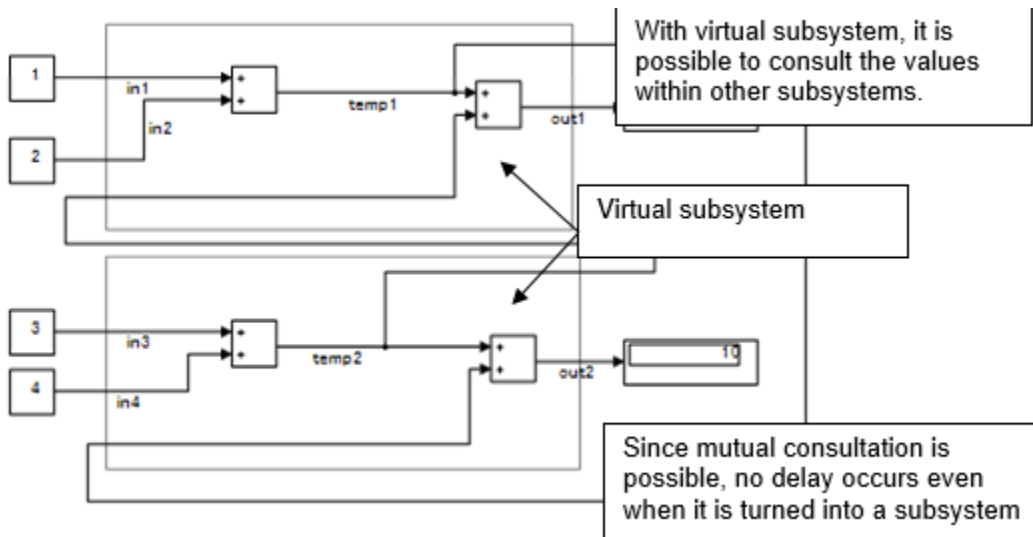


### Virtual Subsystems

A block that provides a visual representation is known as a "virtual block". For example, a Mux block that compiles several signal lines, a From block that hands out the signal, and a Goto block that corresponds to a virtual block. Since the subsystem block in the default setting only constitutes a visual hierarchical structure, these blocks are considered virtual blocks. The subsystem is referred to as a virtual subsystem.

Consider a subsystem that consults an external calculation result within a subsystem, as shown in the following example. This system is calculated from these four equations.

- $temp1 = in1 + in2$
- $temp2 = in3 + in4$
- $out1 = in1 + in2 + temp2$
- $out2 = temp1 + in3 + in4$



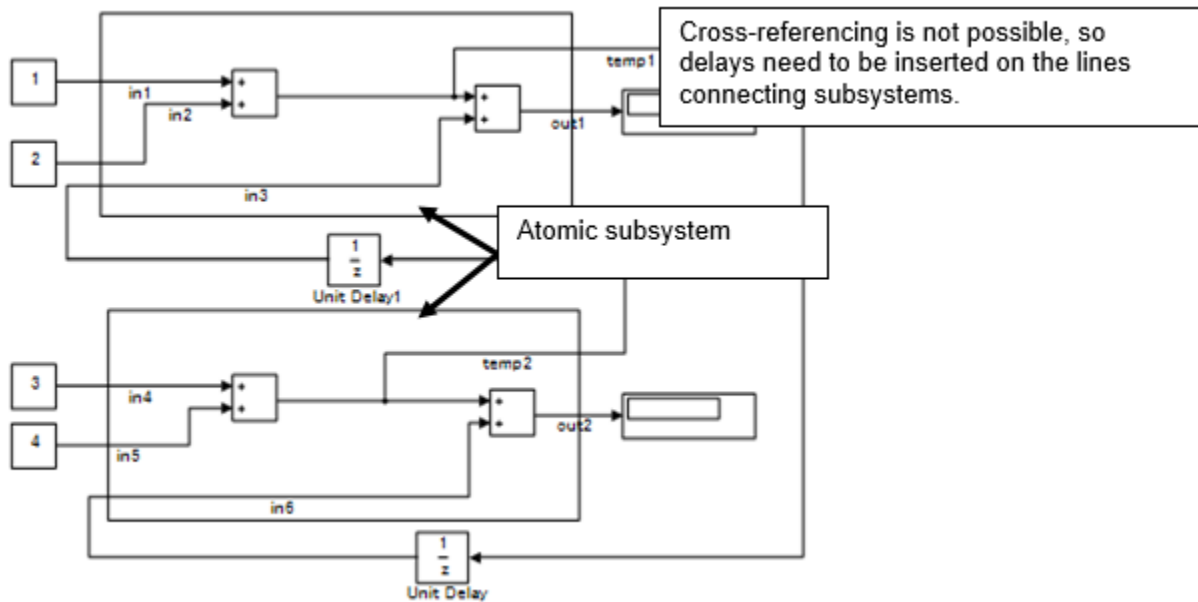
### Atomic Subsystems

An atomic subsystem is detached from the external system and is not subject to cross-border optimization. Atomic subsystems do not use the results of the internal calculations of each subsystem. Therefore, interim output value will use a calculation result that is delayed by a session.

- $temp1 = in1 + in2$
- $temp2 = in4 + in5$
- $out1 = in1 + in2 + in3$
- $out2 = in4 + in5 + in6$

- in3= temp2
- in6= temp1

Atomic subsystems prohibit the direct referencing of the interim calculation results to other subsystems.



Notes on atomic subsystems:

- Atomic subsystems can select C-source function settings.
- As explained above, the internal section of an atomic subsystem will become encapsulated (objectified).
- Depending on the relationship before and after, a static RAM section should be secured inside the subsystem for the output signal.
- Atomic subsystems (including the addition of function settings) should be used with caution. Factor setting will not simply have a factor name inserted within a C code. It should be acknowledged that it is described as a mathematically independent system and the conditions under which an atomic subsystem can be used should be reviewed.
- Include the relationship with the structure layer; it is necessary to determine an operation rule per project and to determine its relationship with the guideline rules.

### Signal Name

Signals can be named and are referred to as signal names. When a signal is named, that signal name is displayed as a label. Updates to labels are reflected in the signal name and are also displayed.

The signal name can be propagated to a signal line via a branched signal line or port block and displayed as a signal name.

See guidelines:

- jc\_0222: Usable characters for signal and bus names

- jc\_0245: Length restriction for signal and bus names

Code can be generated by associating a signal name with a signal object (Simulink object or mpt object). Type setting is configured through the data dictionary, setting of the storage class is optional. The recommended data type settings for these blocks include:

- For Inport blocks, set **data type** to auto.
- For Outport blocks, **data type** to auto.
- For Sum blocks, set the output **data type** to Inherit via back propagation.

See guideline jc\_0644: Type setting.

### Vector Signals/Path Signal

Individual scalar signals that compose a vector shall have common functions, data type, and units.

Signals that do not fulfill the conditions as a vector can only be grouped as a bus signal. The Bus Selector block shall be used only with bus signal inputs. It shall not be used to extract a scalar signal from a vector signal.

The following table is an example of a vector signal.

| Types of vector  | Size                |
|--|---------------------|
| Row vector   | [1 n]               |
| Column vector  | [n 1]               |
| Wheel speed subsystem  | [1 wheel number]    |
| Cylinder vector  | [1 cylinder number] |
| Location vector based on a 2-dimensional coordination points | [1 2]               |
| Location vector based on 3-dimensional coordination points   | [1 3]               |

The following table is an example of a bus signal.

| Bus type        | Factor   |
|-----------------|--|
| Sensor bus      | Force vectors  |
|                 | Location   |
|                 | Wheel speed vector [ $\Theta_{lf}$ , $\Theta_{rf}$ , $\Theta_{lr}$ , $\Theta_{rr}$ ] |
|                 | Acceleration   |
|                 | Pressure   |
| Controller bus  | Sensor bus   |
|                 | Actuator bus   |
| Serial data bus | Circulating water temperature  |
|                 | Engine speed, front passenger seat door open   |

See guidelines:

- na\_0010: Usage of vector and bus signals
- jc\_0222: Usable characters for signal and bus names
- jc\_0245: Length restriction for signal and bus names
- db\_0097: Position of labels for signals and buses
- jc\_0630: Usage of Multiport Switch blocks
- jc\_0659: Usage restrictions of signal lines input to Merge blocks

### Enumerated Types

Enumerated type data refers to data that is restricted to a determined numerical value.

The type of blocks that can be used in an enumerated type in Simulink is limited.

To use an enumerated type, you must define the enumerate type by using .m file on MATLAB. For additional information about defining enumeration data types, see “Use Enumerated Data in Simulink Models”.

## Stateflow Functionality

This section provides information about using Stateflow for modeling.

### Operators Available for Stateflow

For additional information about the Stateflow operators, see “Supported Operations for Chart Data” (Stateflow).

See guidelines:

- na\_0001: Standard usage of Stateflow operators
- jc\_0655: Prohibition of logical value comparison in Stateflow

### Differences Between State Transition and Flow Chart

Stateflow can represent both a state transition and a flow chart.

Stateflow allows a flow chart to be designed within a state transition diagram.

An entry action is represented as a flow chart in a state, which starts from a default transition and moves to junctions through transition lines, as illustrated below. Starting from an internal transition line allows a *during* action to be represented in the flow chart.

A flow chart cannot maintain its active state between updates. As a result, a flow chart always ends at a terminating junction (a connective junction that has no valid outgoing transitions).

In contrast, a state transition diagram stores its current state in memory to preserve local data and active state between updates. As a result, state transition diagrams can begin executing where they left off in the previous time step. This means that state transitions are suitable for modeling reactive or supervisory systems that depend on history.

This table defines the start and end points for a flow chart and state transition diagram.

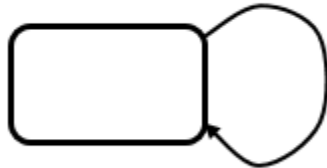
|  | Start point | End point |
|--|-------------|-----------|
|--|-------------|-----------|





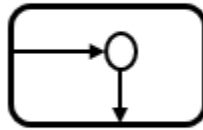
### State Transition Diagram

Self transition outside a state



*A self transition is formed outside a state and then reset after execution.*

Self transition inside a state



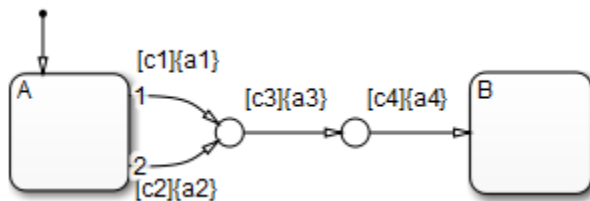
*A self transition is formed inside a state and then reset using a during action.*

See guidelines:

- db\_0132: Transitions in flow charts
- jc\_0752: Condition action in transition label

### Backtrack

This example shows the behavior of transitions with junctions that force backtracking behavior in flow charts. The chart uses implicit ordering of outgoing transitions.



Initially, state A is active and transition conditions c1, c2, and c3 are true. Transition conditions c4 is false.

- 1 The chart root checks to see if there is a valid transition from state A.

There is a valid transition segment marked with the transition condition c1 from state A to a connective junction, therefore:

- a Transition condition c1 is true, so action a1 executes.
- b Transition condition c3 is true, so action a3 executes.
- c Transition condition c4 is not true and, therefore, the control flow backtracks to state A.

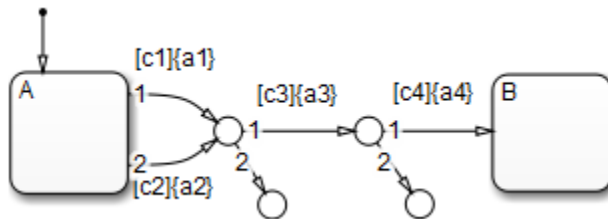
- 2 The chart root checks to see if there is another valid transition from state A.

There is a valid transition segment marked with the transition condition c2 from state A to a connective junction, therefore:

- a Transition condition c2 is true, so action a2 executes.
- b Transition condition c3 is true, so action a3 executes.

- c Transition condition c4 is not true and, therefore, the control flow backtracks to state A.
- 3 The chart goes to sleep.

To resolve this issue, consider adding unconditional transition lines to terminating junctions. The terminating junctions allow flow to end if either c3 or c4 is not true. This design leaves state A active without executing unnecessary actions.



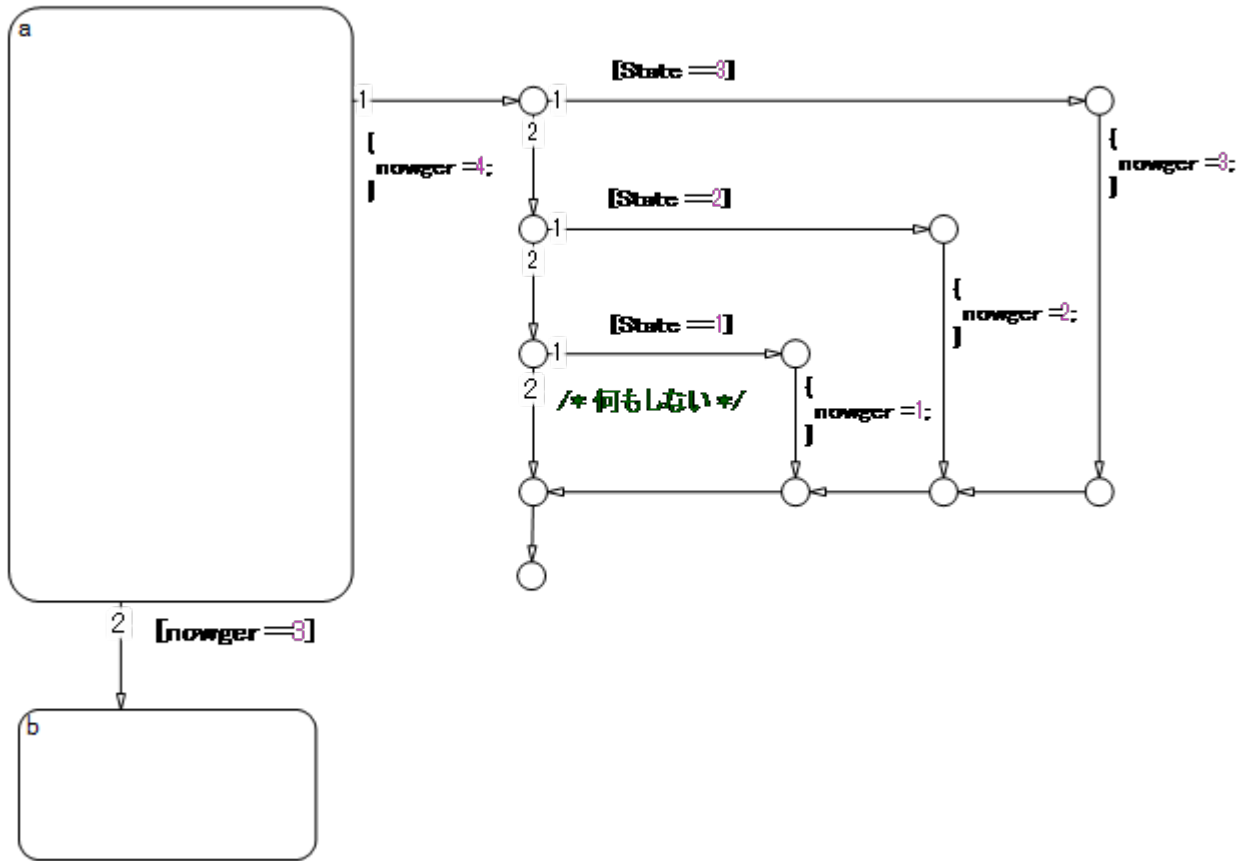
See guidelines:

- jc\_0751: Backtracking prevention in state transition
- jc\_0773: Unconditional transition of a flow chart

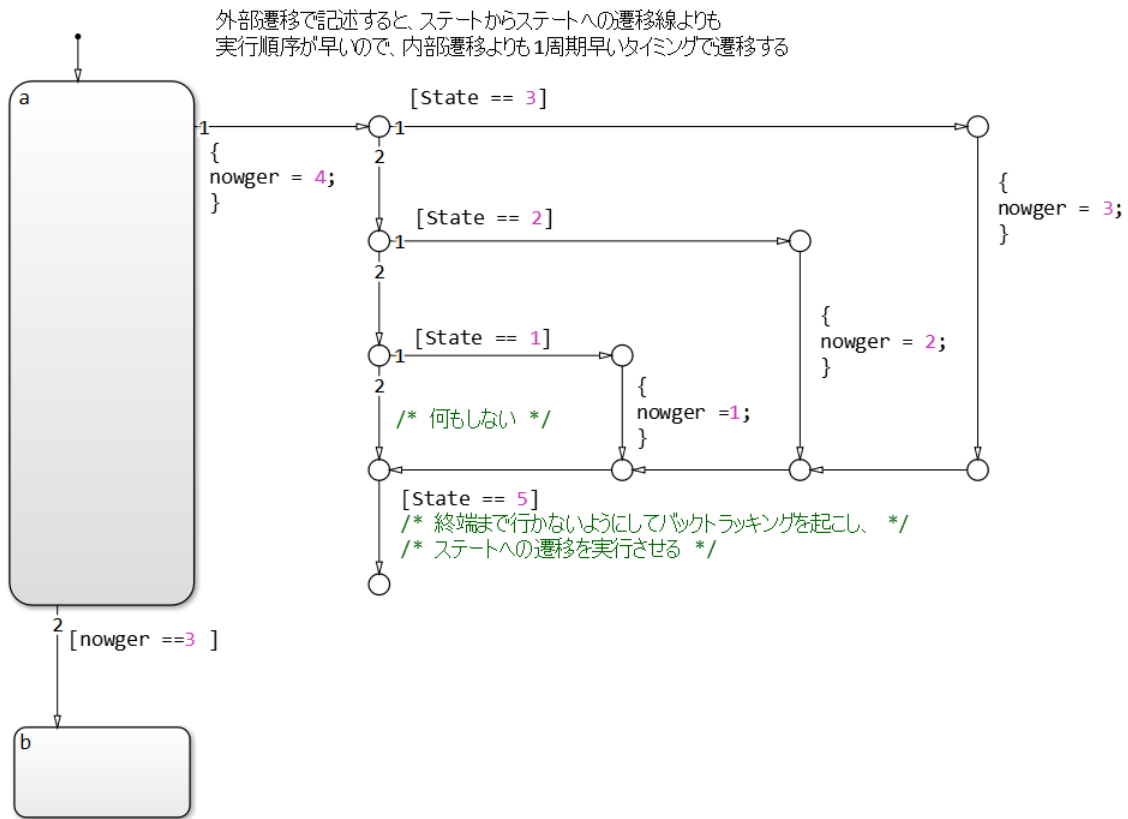
### Flow Chart Outside the State

A flow chart associated with a state can be written inside or outside of the state; however, be attentive to the execution order and backtracking.

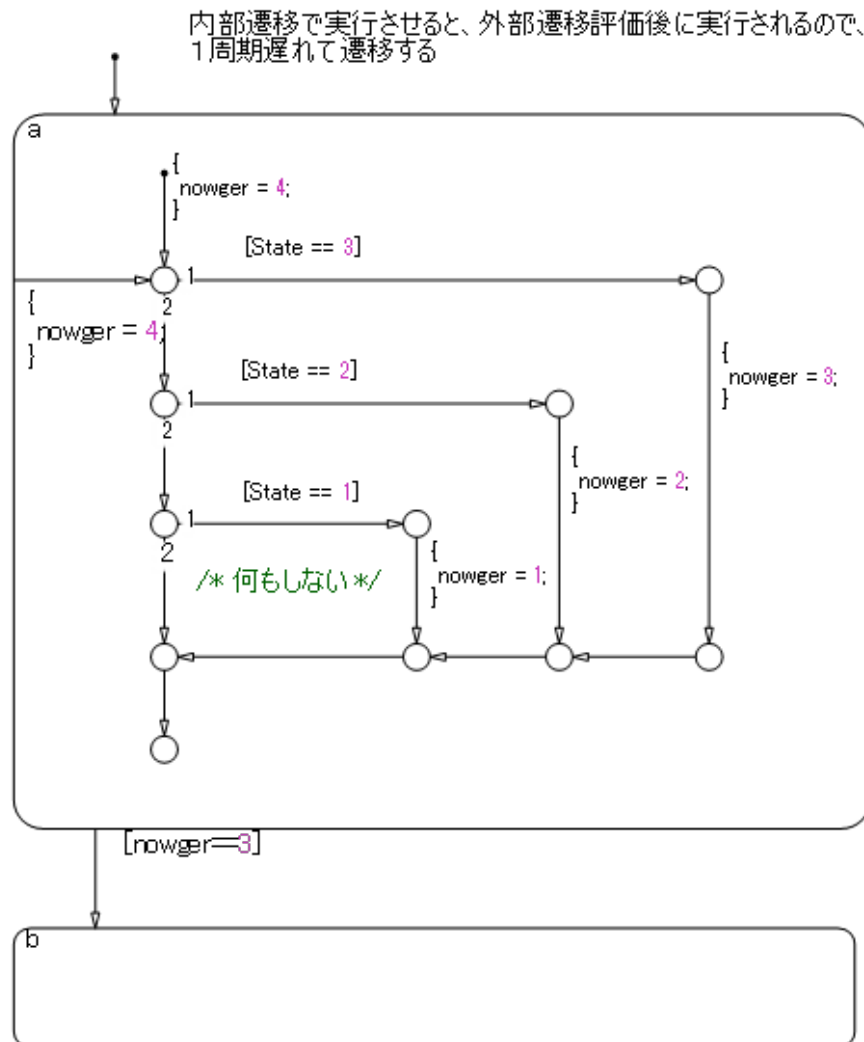
The following flow chart, which evaluates transition from a to b after executing the flow chart outside the state, appears to execute the transition within the same period as that of a newer calculation. However, the transition line to b is not evaluated if the termination point is reached by calculating the transition outside the state. This is a state transition diagram which always stays at a.



Done correctly, as shown below, the transition condition is not positioned at the termination of the external flow chart, allowing the transition line from a to b to be evaluated after the flow chart is executed. This enables the external flow chart to execute before the transition, and to be evaluated using the most recent value at the instant of the transition. Note that this chart contains a dead path where the transition condition will never hold, which can cause an error when the specification is changed in the future. Use this chart structure with caution.



In contrast, the following flow chart is inside a state, which means that the internal flow chart is always calculated when executing state a and can be described as an easily comprehensible structure without dead paths. However, it should be noted that, as a performance characteristic, when state a is executed, the transition from a to b is evaluated in the cycle following that in which the internal flow chart is calculated. Due to this characteristic, the timing of the execution of calculations and transitions for the external flow chart may be off. Use with caution.



See guidelines:

- jc\_0751: Backtracking prevention in state transition
- jc\_0773: Unconditional transition of a flow chart

### Pointer Variables

This code sample is from model `sf_custom`. To open the model, enter the following on the MATLAB command line:

```
openExample('sf_custom')
```

In model `sf_custom`, click **Open my\_header.h**.

```
#include "tmwtypes.h"
```

```
extern real_T my_function(real_T x);
```

```
/* Definition of custom type */
```

```

typedef struct {
    real_T a;
    int8_T b[10];
}MyStruct;

/* External declaration of a global struct variable */
extern MyStruct gMyStructVar;
extern MyStruct *gMyStructPointerVar;

```

In model sf\_custom, click **Open my\_function.c**.

```

#include "my_header.h"
#include <stdio.h>

/* Definition of global struct var */
MyStruct gMyStructVar;
MyStruct *gMyStructPointerVar=NULL;

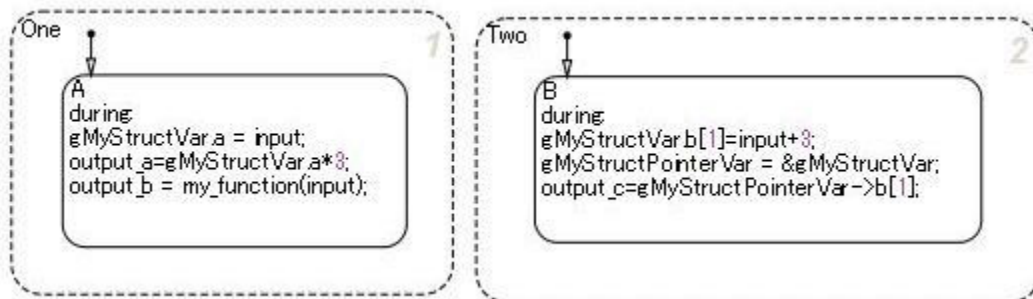
real_T my_function(real_T x)
{
    real_T y;

    y=2*x;

    return(y);
}

```

gMyStructVar is not defined in Stateflow. Typically, functions of my\_function are called from C source for use in Stateflow. However, direct reference to global variables exposed by the C source is also available from Stateflow.



## Initialization

This section provides information about using initialization values.

### Initial Value Setting in Initialization

When a signal needs to be initialized, the initial values shall be set correctly.

When initial values are set inside a block, use an initial value list that includes annotations so you can visually confirm the initial values input.

Cases that require initial values include:

- When state variables are defined AND blocks that have state variables are used.
  - Use the internal block settings.
  - Use the external input values.
- When state variables are defined AND initial values are enabled for a block when a specific configuration is performed.
  - Set initial values in Merge blocks.
  - Use signals registered in the data dictionary.
- When signal settings (with RAM) have been defined that can be referenced from the outside.
  - Use signals registered in the data dictionary.

### **Initial Values of Signals Registered in the Data Dictionary**

Set initial values for signals registered in the data dictionary.

- Discrete block groups, such as Unit Delay and Data Store Memory, have state variables.

In the case of automatic code generation, the signal name, type, and initial value can be set for state variables by matching it to the signal in the data dictionary (associated with Simulink signal objects). When using a signal defined in the data dictionary for a state variable, the respective initial values should conform to the same value.

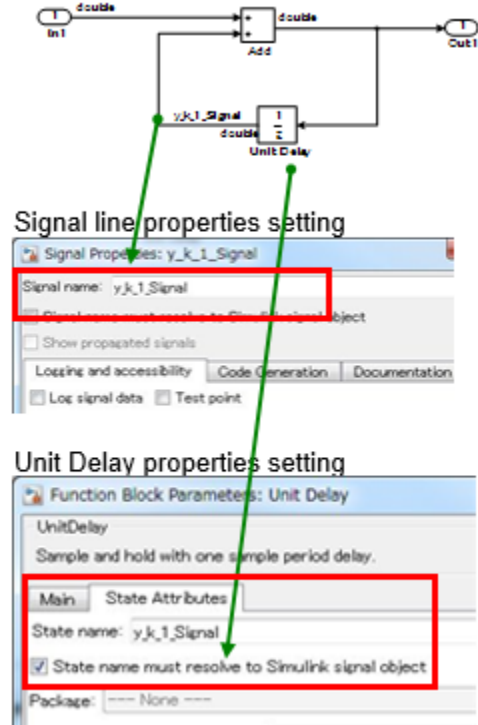
- When using a signal defined in the data dictionary for a state variable

For discrete blocks, such as Unit Delay and Data Store Memory, settings are performed not when using signals defined in the data dictionary for the block output line, but for the state variables inside the block. Even when the signal name of the data dictionary is assigned to the signal line, RAM is reserved in duplicate, which is a waste of RAM.

### **Example — Correct**

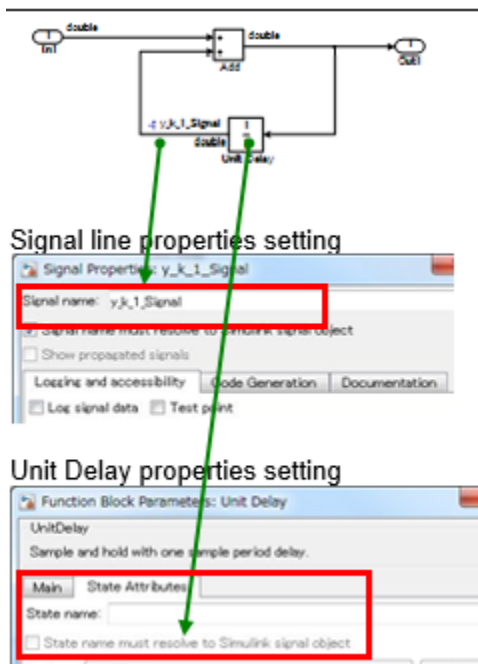
Signal is defined for the state variables inside the block. The signal name is defined and block parameter **State name must resolve to Simulink signal object** is selected.





### Example – Incorrect

Signal is defined for the output signal of the block that has state variables. The signal name is defined and block parameter **State name must resolve to Simulink signal object** is not selected.

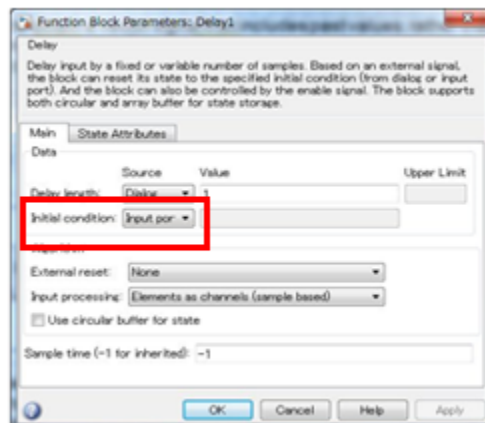
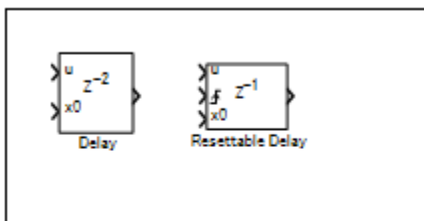
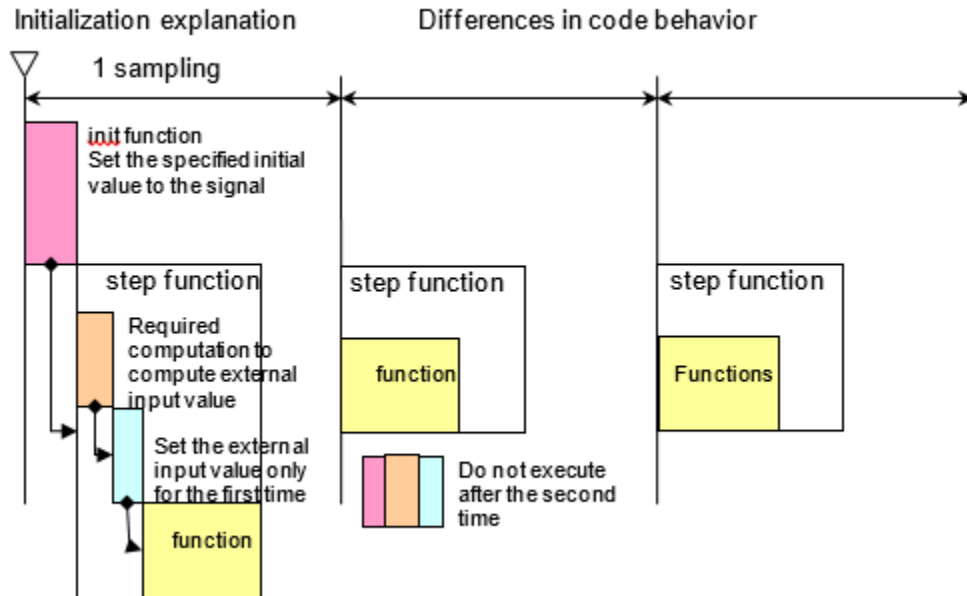


Signal objects that are defined in the Workspace can be automatically associated with signal objects and signal names of the same name by using `disableimplicitsignalresolution(modelname)`. However, for state variables inside the block, they are associated with the state variables inside the block and the signal name of the same name. If a globally set signal is associated with two variables at the same time, it is better to perform settings so that the state variables inside a block and the signal label on the signal line have different names, otherwise the model cannot be simulated.

**Block Whose External Input Value is the Initial Value**

When setting the initial value during initialization, the `init` function is called to set the signal to either the value inside of the block or to the initial value that is defined in the data dictionary. Next, the step function (the data flow executive function) is executed. Here, the external input value is set as the initial value. When modelling, be attentive to the execution functions and execution timing for initialization. This is demonstrated in the following image.

The following image



### Initial Value Settings in a System Configuration that Would Enable Initialization Parameters

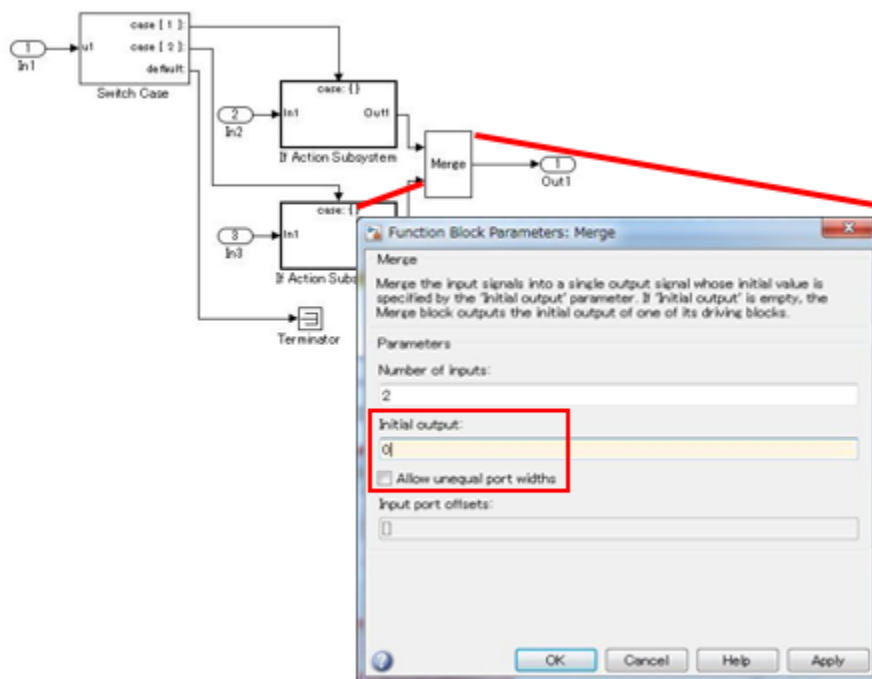
There are system configurations where, depending on their settings, initialization parameters are enabled for combinations of conditional subsystems and Merge blocks. When initial values are required in these combinations, either of the following modeling methods is performed:

- Set values in the Outport block
- Set in values the Merge block
- When an mpt signal is defined behind the Merge block, set the values in the mpt signal

The exception is when there are successive blocks with initial values and the settings for each block are not needed to clearly show the signal's initial value.

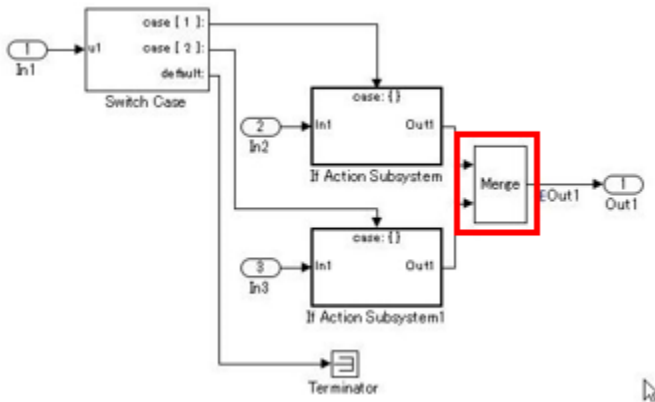
#### Example — Correct

Initial value set in the Merge block.



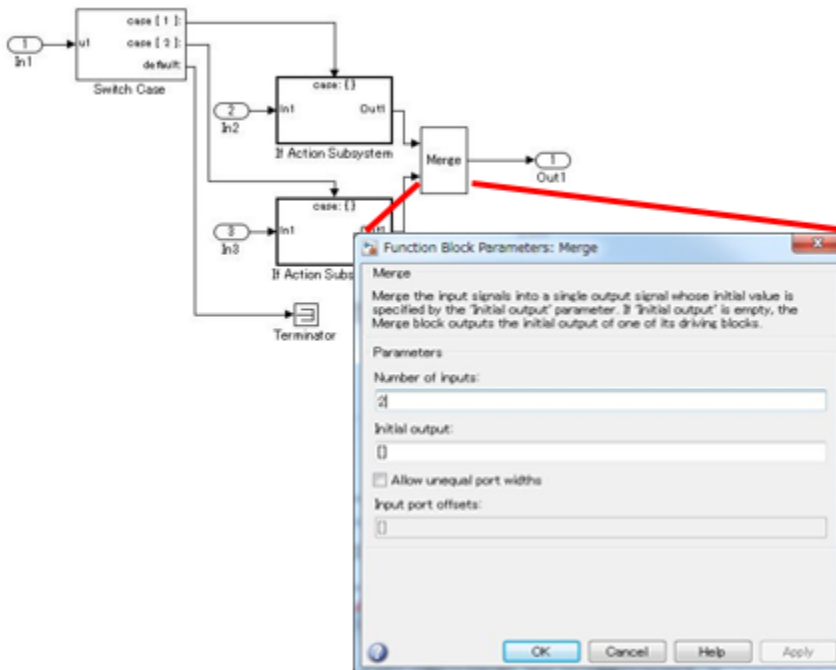
#### Example — Correct

Initial value set in mpt object.



**Example – Incorrect**

Despite the requirement for an initial value setting, it is not shown anywhere.

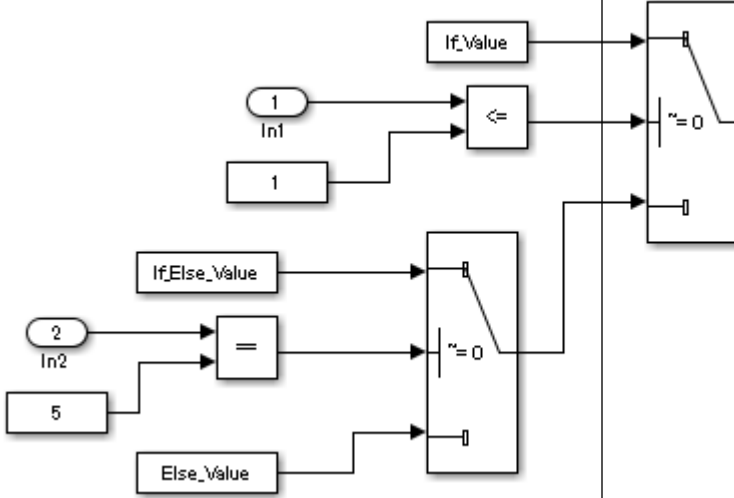
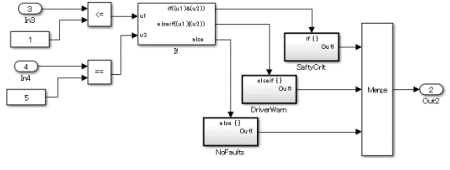


# **Modeling Knowledge**

## Usage Patterns

### Simulink Patterns for If, elseif, else Constructs

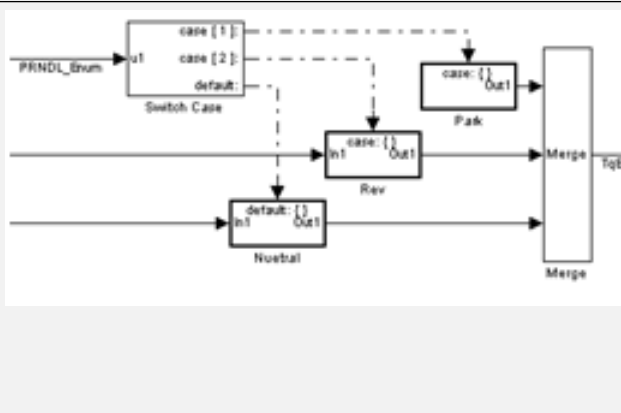
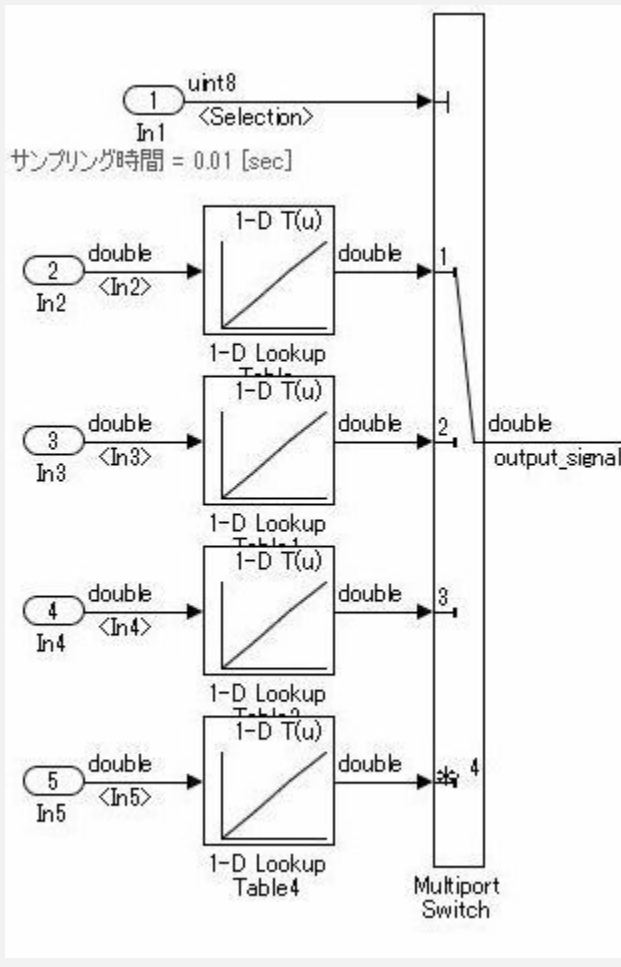
These patterns shall be used for if, elseif, else constructs.

| Function   | Simulink pattern   |
|--|--|
| <p>if, elseif, else construct when the Switch block is used.</p> <pre> if (If_Condition) {     output_signal = If_Value; } else if (Else_If_Condition) {     output_signal = Else_If_Value; } else {     output_signal = Else_Value; }                     </pre>              |   |
| <p>if, elseif, else construct when using and action subsystem</p> <pre> if (Fault_1_Active &amp; Fault_2_Active) {     ErrMsg = SaftyCrit; } else if (Fault_1_Active   Fault_2_Active) {     ErrMsg = DriverWarn; } else {     ErrMsg = NoFaults; }                     </pre> |  |

### Simulink Patterns for case Constructs

These patterns shall be used for case constructs.

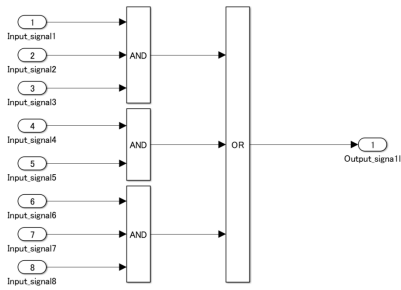
| Function | Simulink Pattern |
|----------|------------------|
|----------|------------------|

|  |   |
|--|---|
| <p>Case construct using an action subsystem.</p> <pre> switch (PRNDL_Enum) {   case 1     TqEstimate = ParkV;     break;   case 2     TqEstimate = RevV;     break;   default     TqEstimate = NeutralV;     break; } </pre>   |                                     |
| <p>Case construct using a Multiport Switch block.</p> <pre> switch (Selection) {   case 1:     output_signal =       look1_binlxpw(In2,y1,x1,3U);     break;   case 2:     output_signal =       look1_binlxpw(In3,y2,x2,3U);     break;   case 3:     output_signal =       look1_binlxpw(In4,y3,x3,3U);     break;   default:     output_signal =       look1_binlxpw(In5,y4,x4,3U);     break; } </pre> |  <p>Sampling time = 0.01 [sec]</p> |

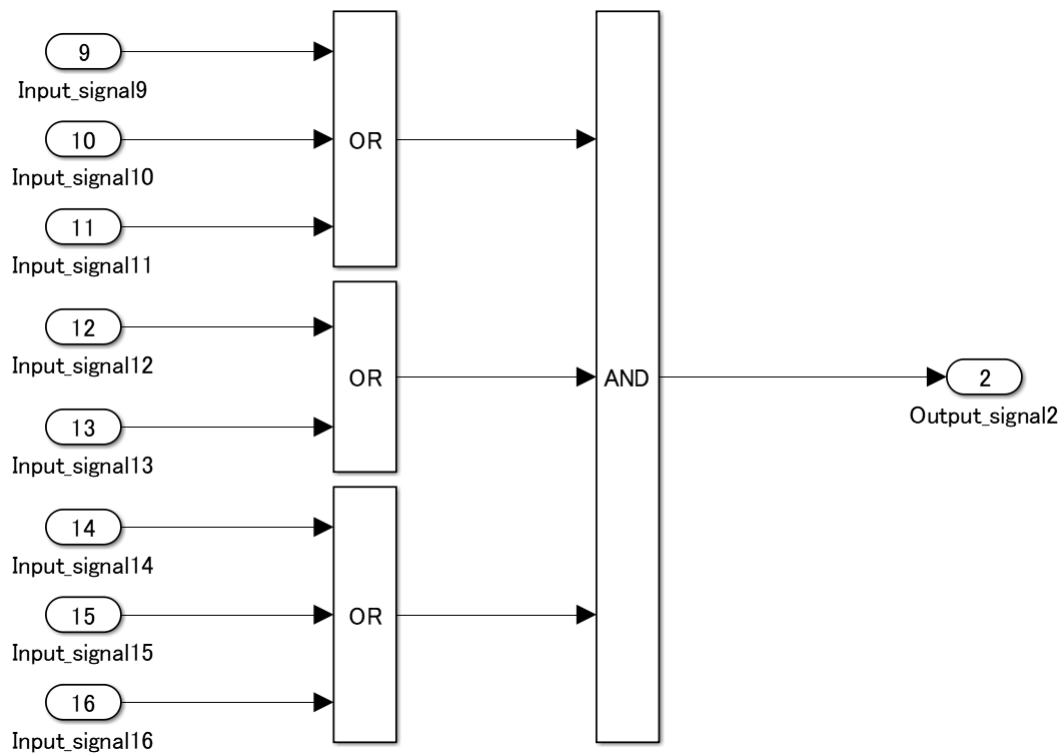
## Simulink Patterns for Logical Constructs

These patterns shall be used for logical constructs.

Conjunctive normal form



Disjunctive normal form

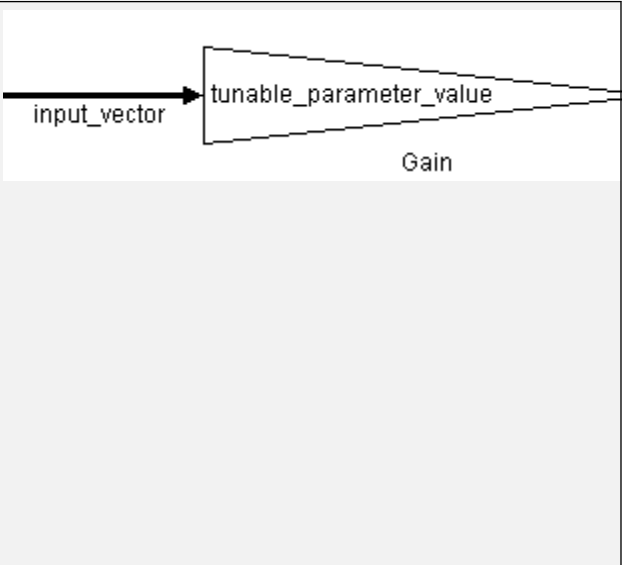
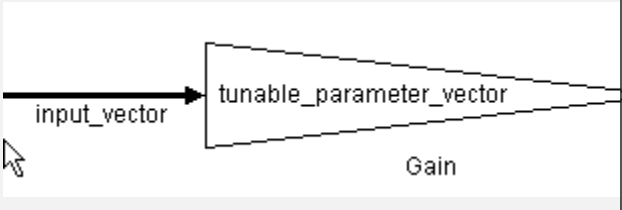
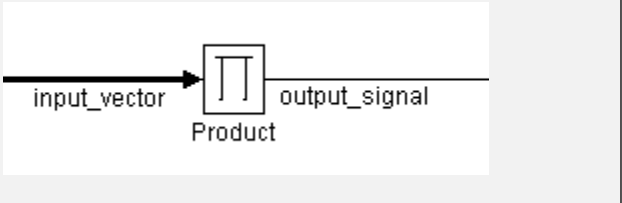
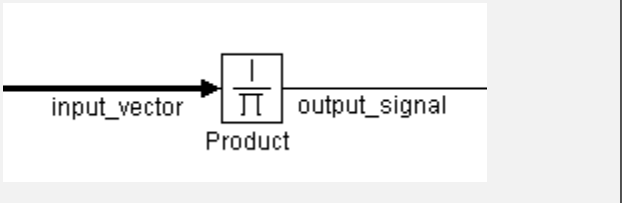
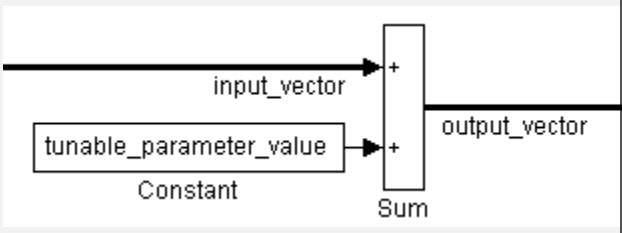


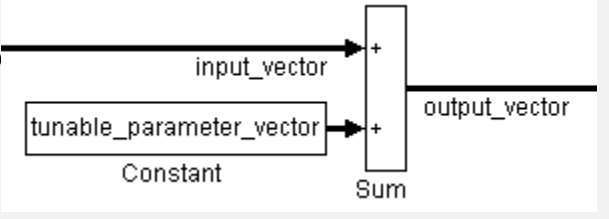
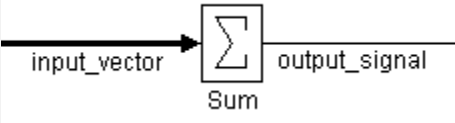
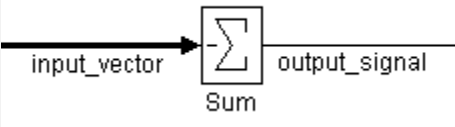
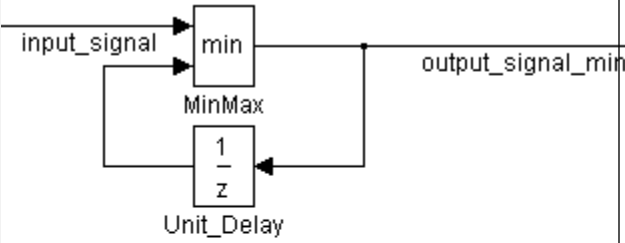
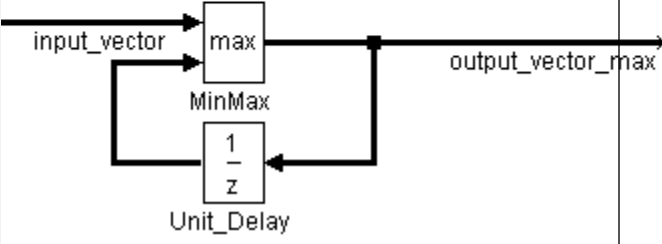
## Simulink Patterns for Vector Signals

These patterns shall be used for vector signals.

| Function | Simulink Pattern |
|----------|------------------|
|----------|------------------|



|  |  |
|--|--|
| <p>Vector signal and parameter (scalar) multiplication</p> <pre>for (i=0; i&gt;input_vector_size; i++) {     output_vector[i] = input_vector[i] *         tunable_parameter_value; }</pre> <p>(Reference: generated code of R2013b)</p> <pre>for (i = 0; i &lt; input_vectorDim; i++) {     output_vector[i] =         tunable_parameter_value *         input_vector[i]; }</pre> <p>(As the code is generated using a variable number of dimensions, the upper limit of the normal loop is a direct value.)</p> |    |
| <p>Multiplication of vector signals and parameters (vectors)</p> <pre>for (i=0; i&gt;input_vector_size; i++) {     output_vector[i] = input_vector[i] *         tunable_parameter_vector[i]; }</pre>   |   |
| <p>Vector signal element multiplication</p> <pre>output_signal = 1; for (i=0; i&gt;input_vector_size; i++) {     output_signal = output_signal *         input_vector[i]; }</pre>  |  |
| <p>Vector signal element division</p> <pre>output_signal = 1; for (i=0; i&gt;input_vector_size; i++) {     output_signal = output_signal /         input_vector[i]; }</pre>  |  |
| <p>Vector signal and parameter (scalar) addition</p> <pre>for (i=0; i&gt;input_vector_size; i++) {     output_vector[i] = input_vector[i] +         tunable_parameter_value; }</pre>   |  |

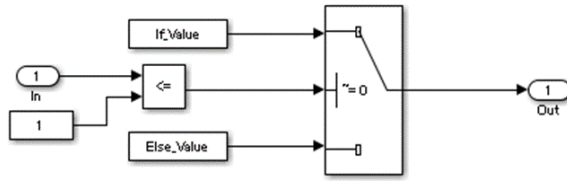
|   |   |
|---|---|
| <p>Vector signal and parameter (vector) addition</p> <p>Vector signal and parameter (vector) addition</p> <pre>for (i=0; i&lt;input_vector_size; i++) {     output_vector[i] = input_vector[i] +         tunable_parameter_vector[i]; }</pre> | <br>    |
| <p>Vector signal element subtraction</p> <pre>output_signal = 0; for (i=0; i&lt;input_vector_size; i++) {     output_signal = output_signal -         input_vector[i]; }</pre>  |   |
| <p>Retention of minimum value/maximum value</p>   | <br> |

## Using Switch and If, Elseif, Else Action Subsystems

The Switch block shall be used for modeling simple if, elseif, else structures when the associated elseif and else actions involve only the assignment of constant values.

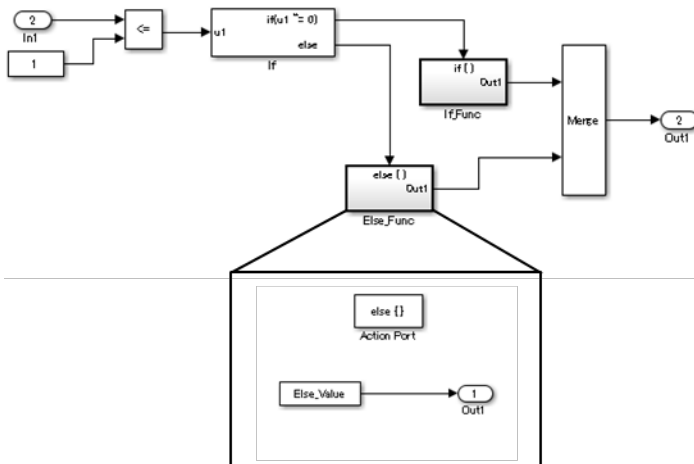
### Example – Recommended

For a simple if, elseif, else structure, use the Switch block.



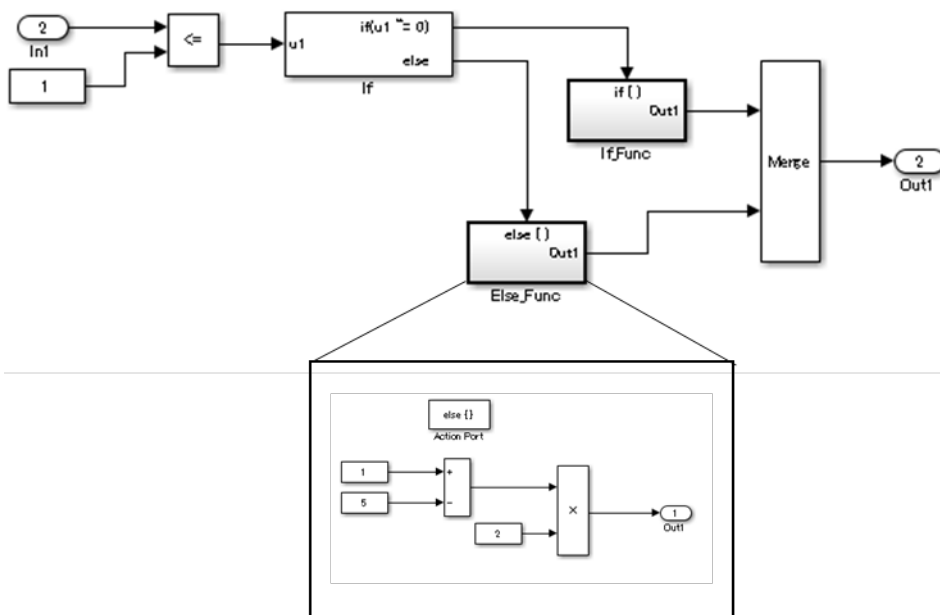
### Example – Not recommended

Using If and If Action Subsystem blocks for a simple if, elseif, else structure.



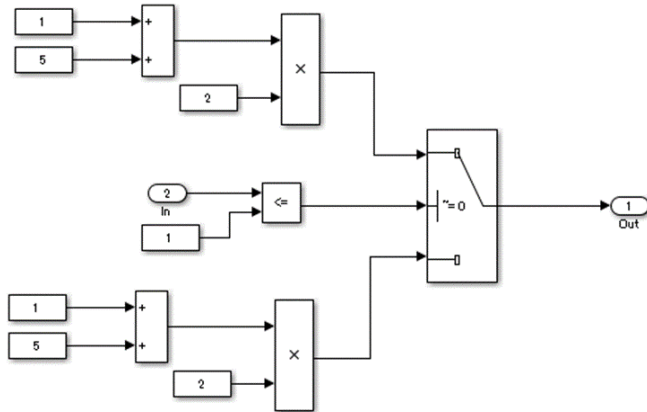
### Example – Recommended

For a complex if, elseif, else structure, use If and If Action Subsystem blocks.



**Example — Not recommended**

Using Switch block for a complex if, elseif, else structure.

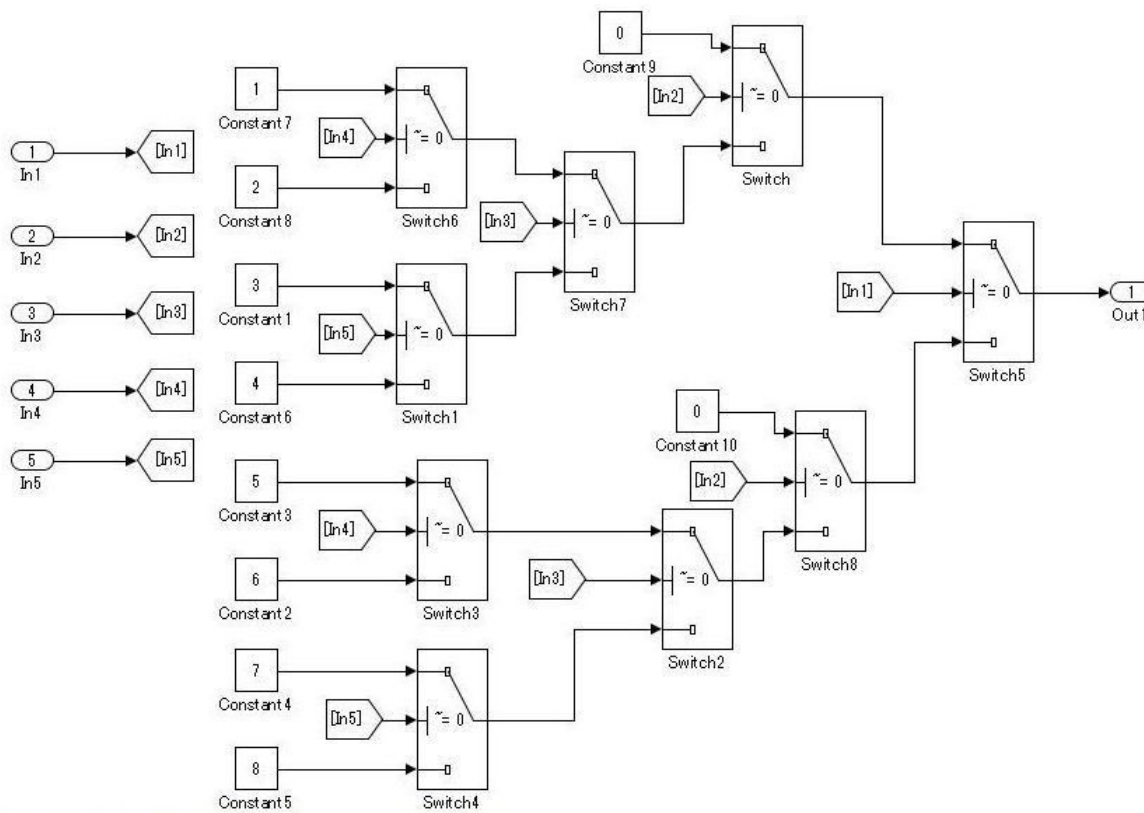


**Use of If, Elseif, Else Action Subsystem to Replace Multiple Switches**

Frequent use of the Switch block for condition bifurcation shall be avoided. Instead, the **upper limit target** shall be used (such as up to three levels). When the target value is exceeded, a conditional control flow using the if, elseif, else action subsystem shall be used.

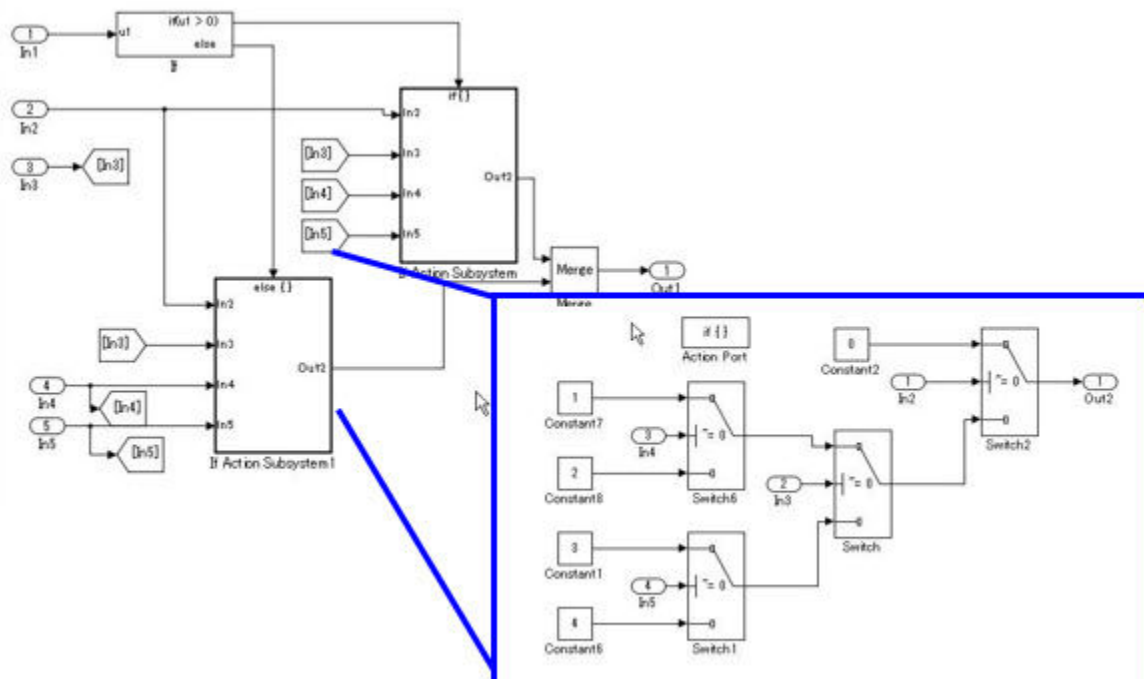
**Example — Not recommended**

Four levels of nesting.



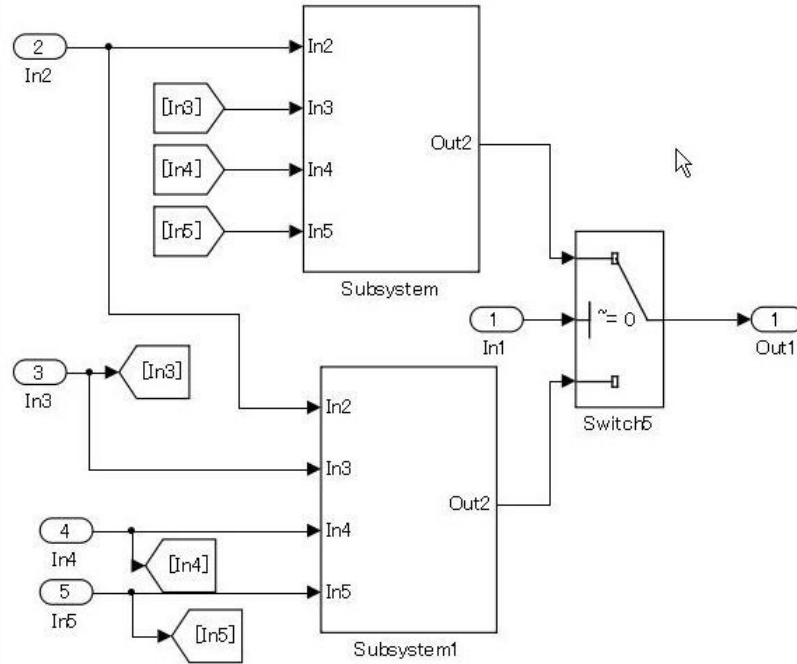
### Example – Recommended

By setting the fourth level as an if action subsystem, nesting is limited to a single level.



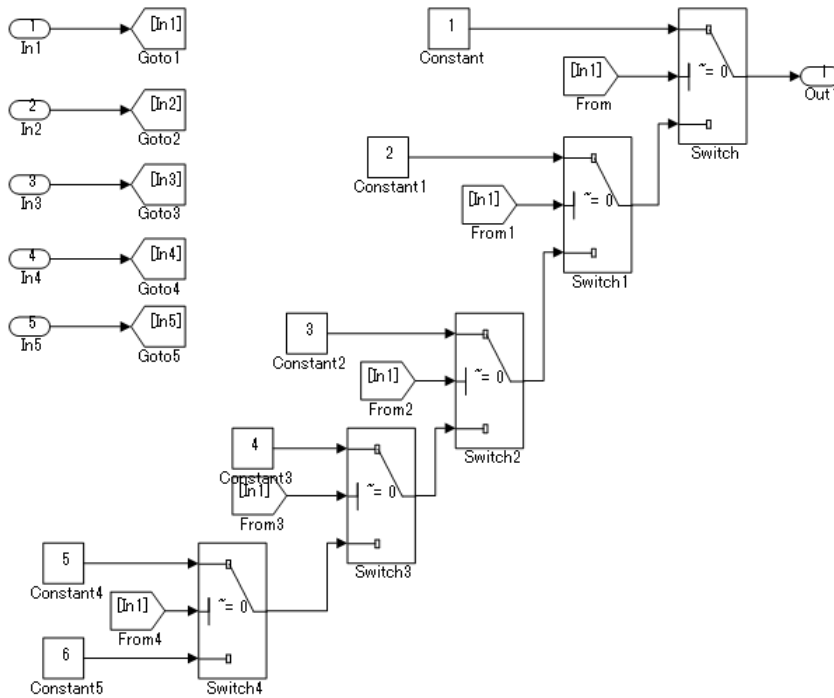
**Example – Not recommended**

Not dividing by using an if action subsystem.



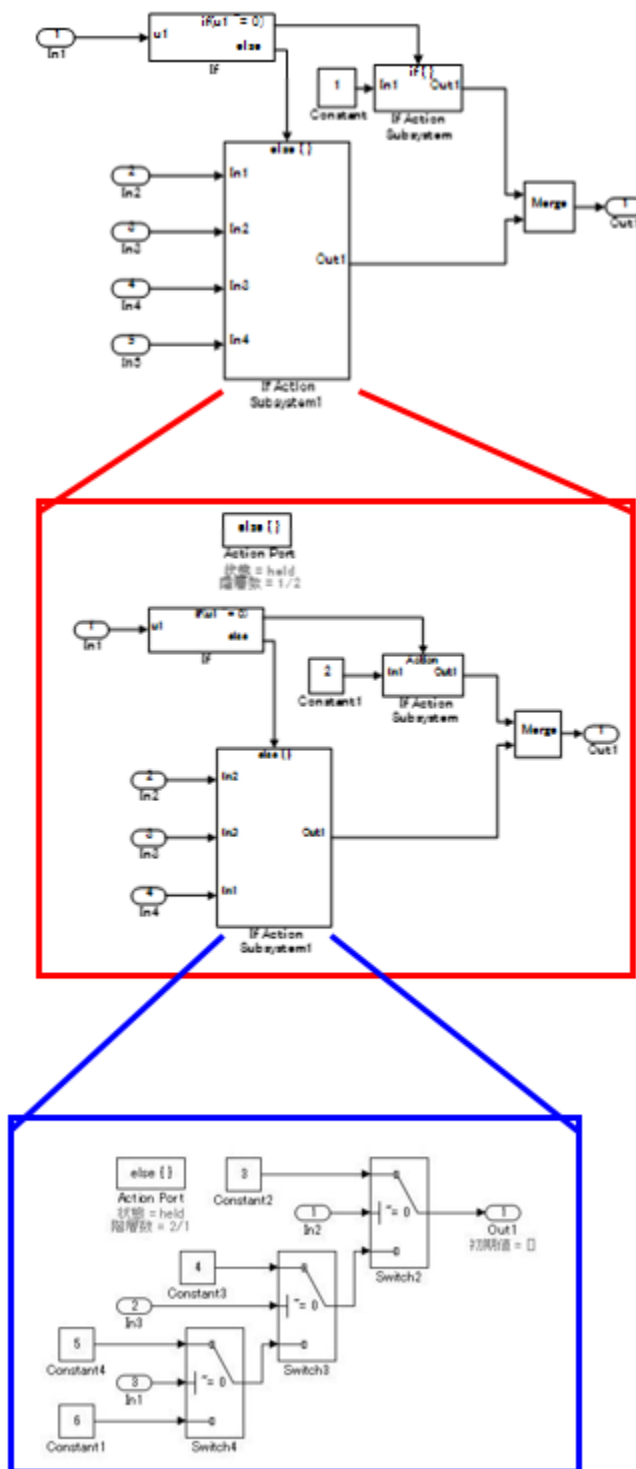
Use atomic subsystem + function setting when the C code limit is applied. In this case, there is no need to use the if, elseif, else action subsystem, but the configuration of the Switch block can be split and encapsulated in the subsystem.

**Example of model with five levels of nesting – Not recommended**



### Example of model with five levels of nesting – Recommended

Use a description method that avoids layering of nesting in the Switch block.



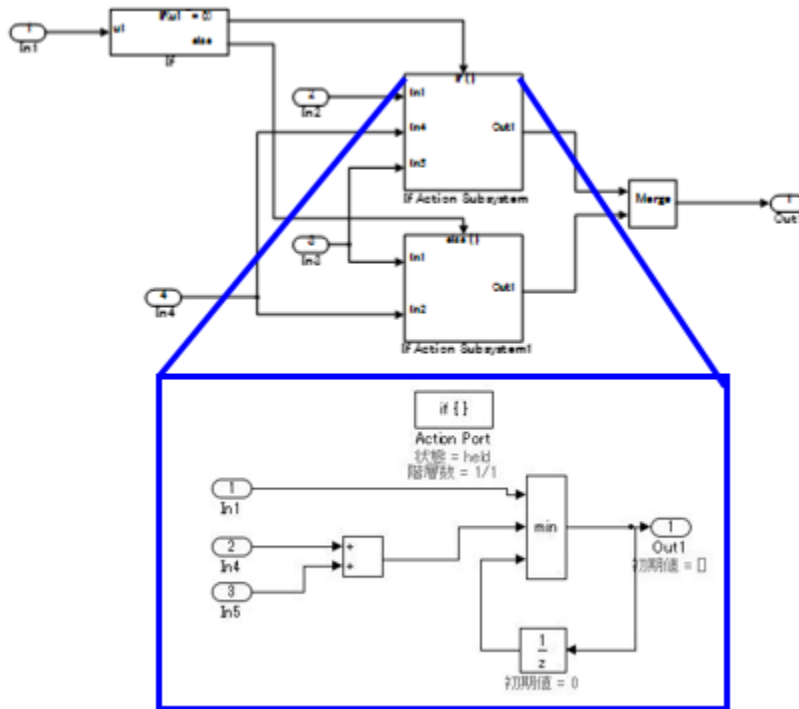
While provided as an example, an `if` action subsystem is not typically used for switching the fixed value. In these Recommended and Not Recommended examples, the generated C code will be the same if the user does not add a function conversion setting. (Confirmed in R2010b to R2013a) The C code is unconstrained.



## Usage Rules for Action Subsystems Using Conditional Control Flow

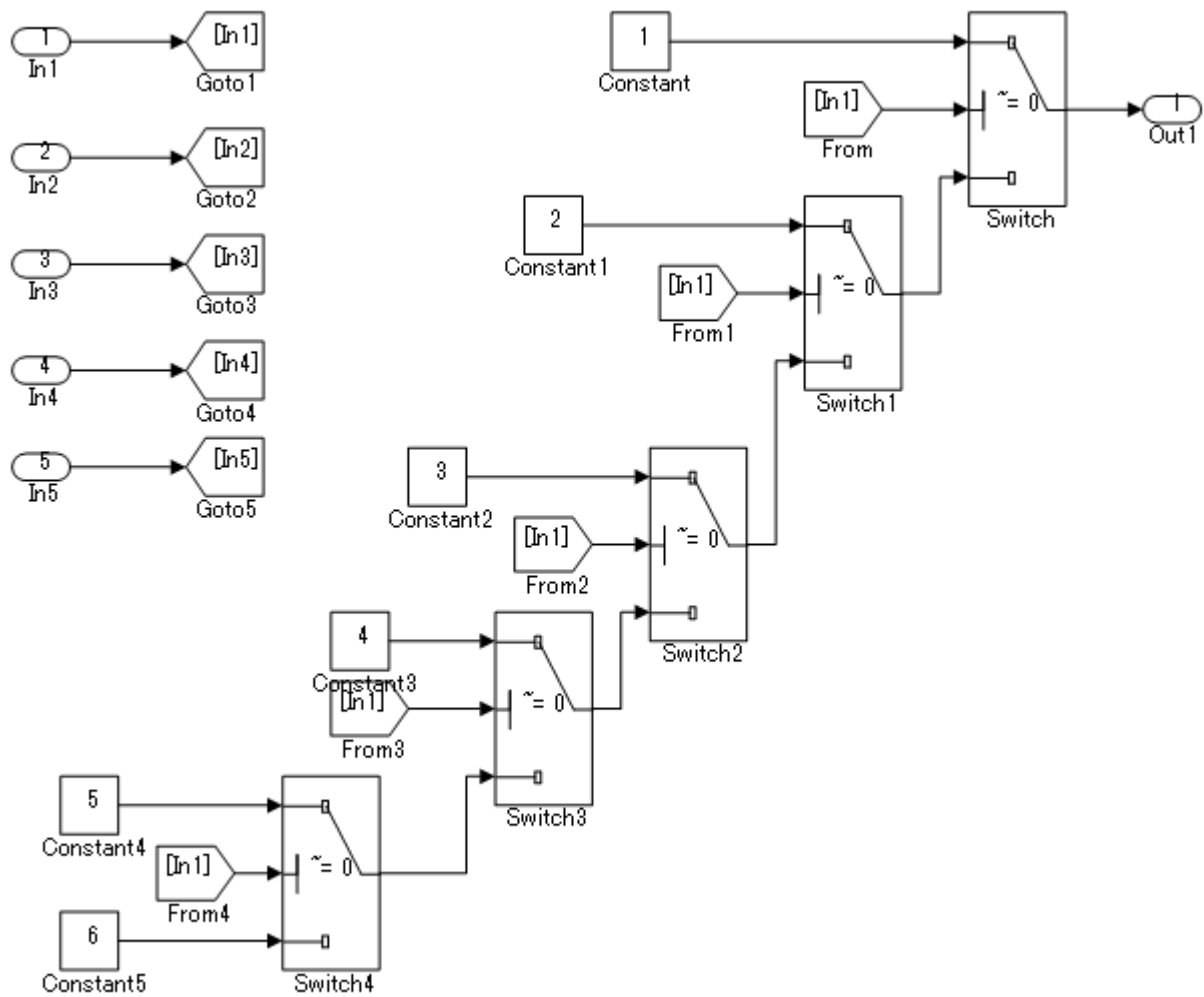
### Example — Recommended

An if action subsystem shall not be used when the associated actions do not have a status variable.



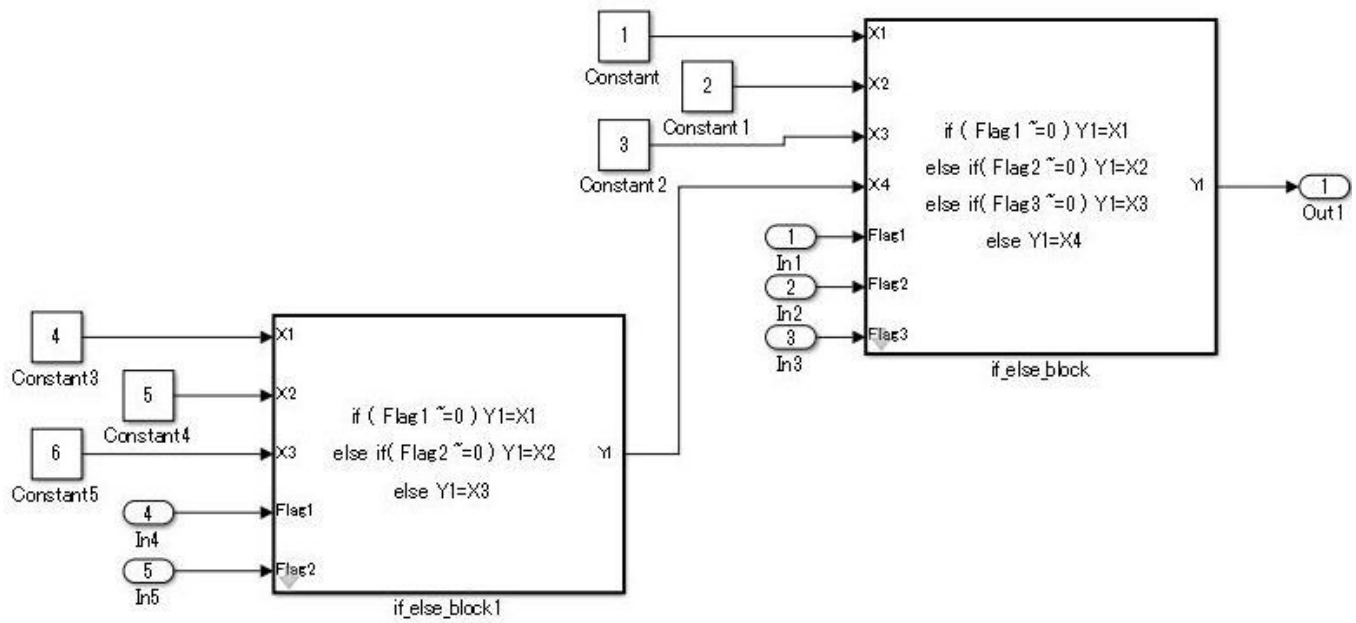
### Example — Recommended

Example of a model using five levels of nesting. Layering by using a subsystem does not occur because there is no internal state.



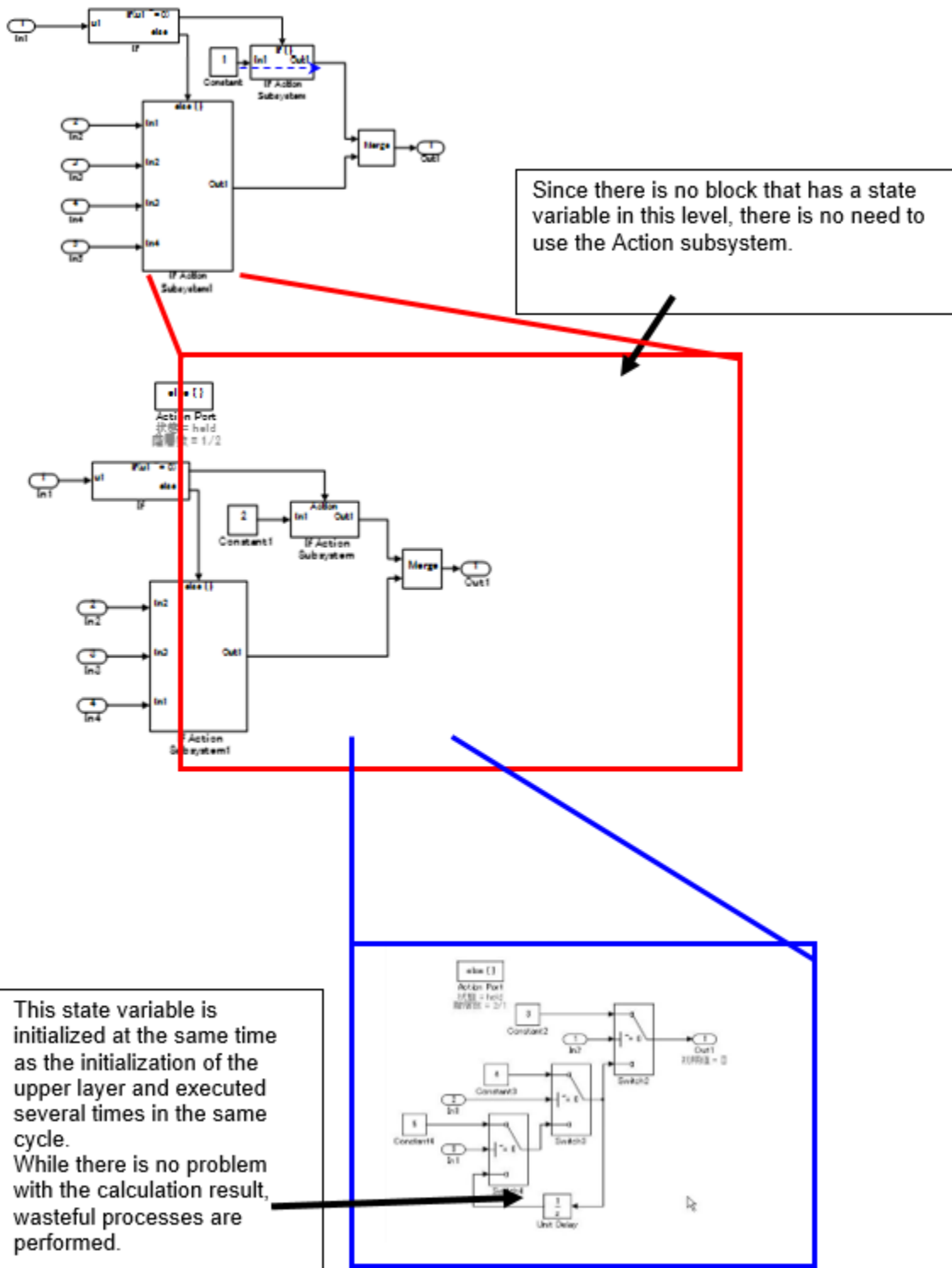
**Example – Recommended**

An atomic subsystem is used to split either side of the Switch block without using an action subsystem.



### Example – Not Recommended

Layering through the use of an unnecessary action subsystem.



If a function can be achieved by using the action subsystem, then layering using the action subsystem is not performed.

In the Not Recommended example, when the lowest level Unit Delay block on the third level is initialized, the conditional subsystem initialization is first executed one time on the upper first level, and then again on the second level for a total of two times of initial value settings. To prevent the generation of unnecessary code, it is recommended that listing not be made in conditional subsystems that reside in levels where the state variable does not exist.

This is based on the concept that the model complexity is reduced by dropping to a level. The purpose of the rule is to avoid the execution of unnecessary initializations.

For bifurcation of systems where the bifurcation condition nest has a deep structure, split by using function conversions to decrease the code bifurcation nesting. Functions before and after the Switch block are divided into respective subsystems, and function settings are applied to the atomic subsystem + function. Be aware, it is possible that this may result in unintentional implementation and unnecessary RAM requirements.

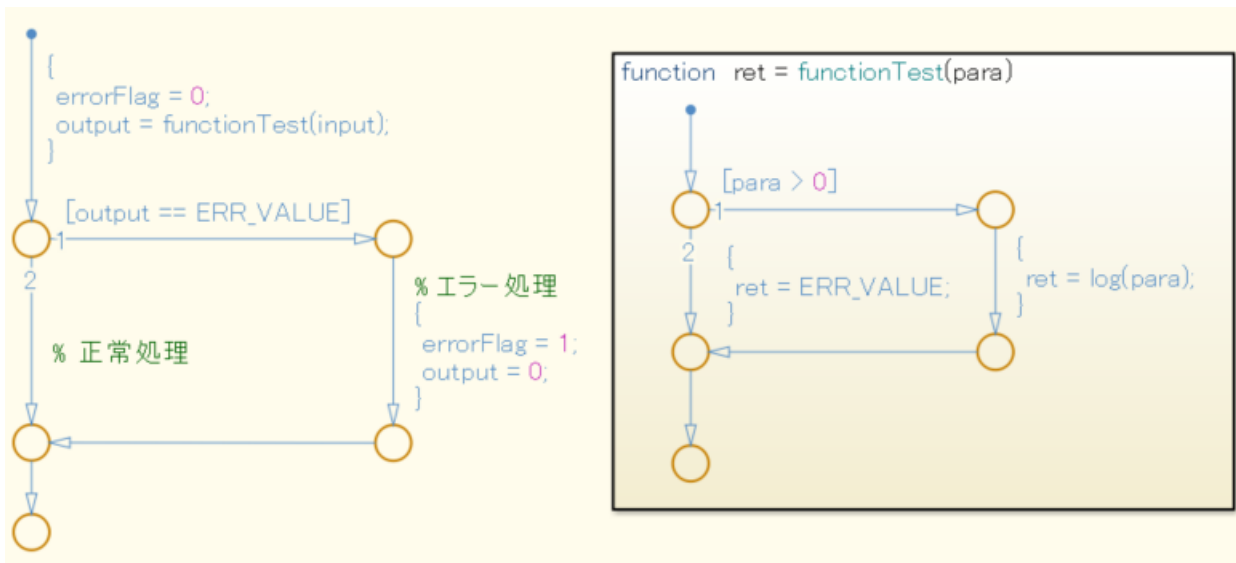
## Test for Information From Errors

When functions that are used in Stateflow (graphical functions, MATLAB functions, etc.) results in an error, the error information shall be transformed into a model structure that will facilitate testing.

Not reviewing the error information returned by the functions can result in unintended behavior.

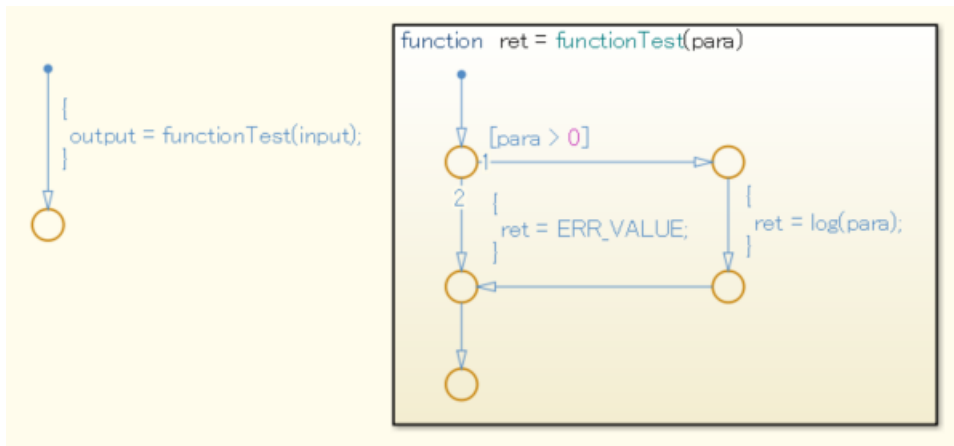
### Example — Recommended

Error information is incorporated into the model structure, allowing the user to review and respond to the errors.



### Example — Not Recommended

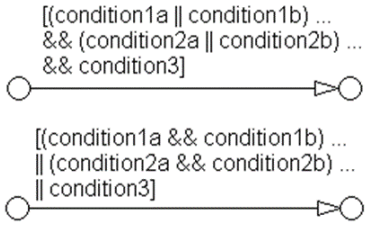
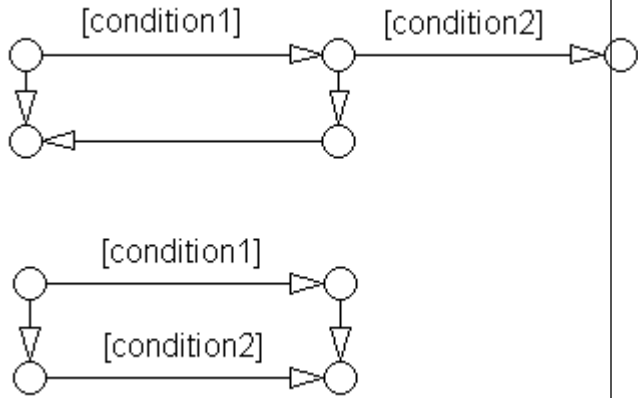
Error information is not incorporated into the model structure.



## Flow Chart Patterns for Conditions

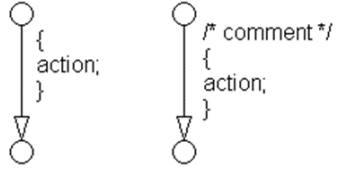
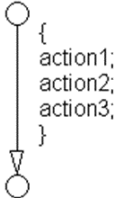
These patterns shall be used for conditions within Stateflow flow charts.

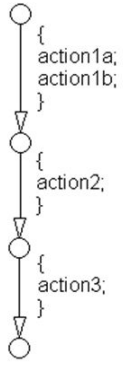
| Function  | Flow Chart Pattern               |
|---|----------------------------------|
| One condition.<br>[condition]   | <br>/* comment */<br>[condition] |
| Up to three conditions, short form.<br>(The use of different logical operators in this form is not allowed. Use subconditions instead.)<br>[condition1 && condition2 && condition3]<br>[condition1    condition2    condition3]                                 | <br>                             |
| Two or more conditions, multiline form.<br>(The use of different logical operators in this form is not allowed. Use subconditions instead.)<br>[condition1 ...<br>&& condition2 ...<br>&& condition3]<br>[condition1 ...<br>   condition2 ...<br>   condition3] | <br>                             |

|  |  |
|--|--|
| <p>Conditions with sub conditions.</p> <p>(The use of different logical operators to connect subconditions is not allowed. The use of brackets is mandatory.)</p> <pre>[(condition1a    condition1b) ... &amp;&amp; (condition2a    condition2b) ... &amp;&amp; (condition3)] [(condition1a &amp;&amp; condition1b) ...    (condition2a &amp;&amp; condition2b) ...    (condition3)]</pre> | <pre>[(condition1a    condition1b) ... &amp;&amp; (condition2a    condition2b) ... &amp;&amp; condition3]</pre>  |
| <p>Conditions that are visually separated.</p> <p>(This form can be combined with the preceding patterns.)</p> <pre>[condition1 &amp;&amp; condition2] [condition1    condition2]</pre>  |   |

## Flow Chart Patterns for Condition Actions

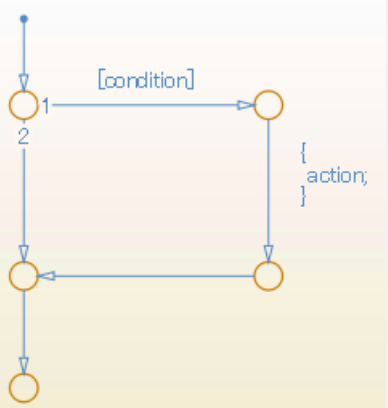
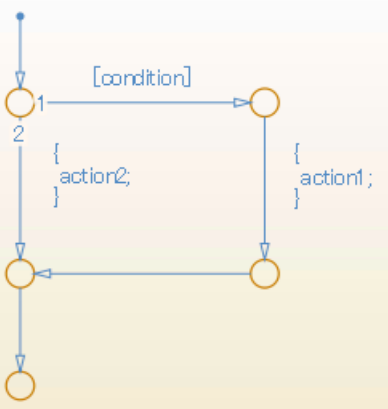
These patterns shall be used for condition actions within Stateflow flow charts

| Function  | Flow Chart Pattern   |
|---|--|
| <p>One condition action.</p> <pre>action;</pre>   |  |
| <p>Two or more condition actions, multiline form.</p> <p>(Two or more condition actions in one line are not allowed.)</p> <pre>action1; ... action2; ... action3; ...</pre> |  |

|  |  |
|--|--|
| <p>Condition actions that are visually separated.</p> <p>(This form can be combined with the preceding patterns.)</p> <pre> action1a; action1b; action2; action3;                     </pre> |  |
|--|--|

### Flow Chart Patterns for If, Elseif, Else Constructs

These patterns shall be used for If constructs within Stateflow flow charts.

| Function   | Flow Chart Pattern   |
|--|--|
| <p>If construct</p> <pre> if (condition){   action; }                     </pre>                             |   |
| <p>If, else construct</p> <pre> if (condition) {   action1; } else {   action2; }                     </pre> |  |



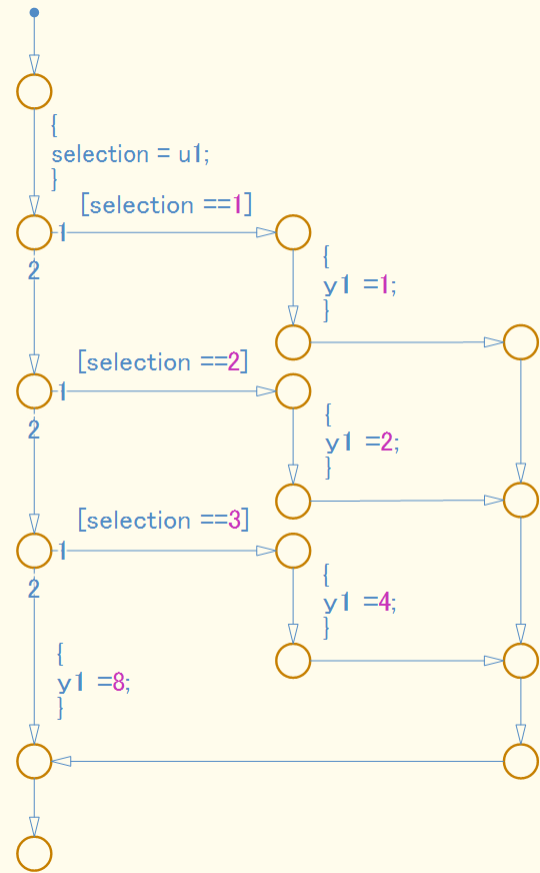


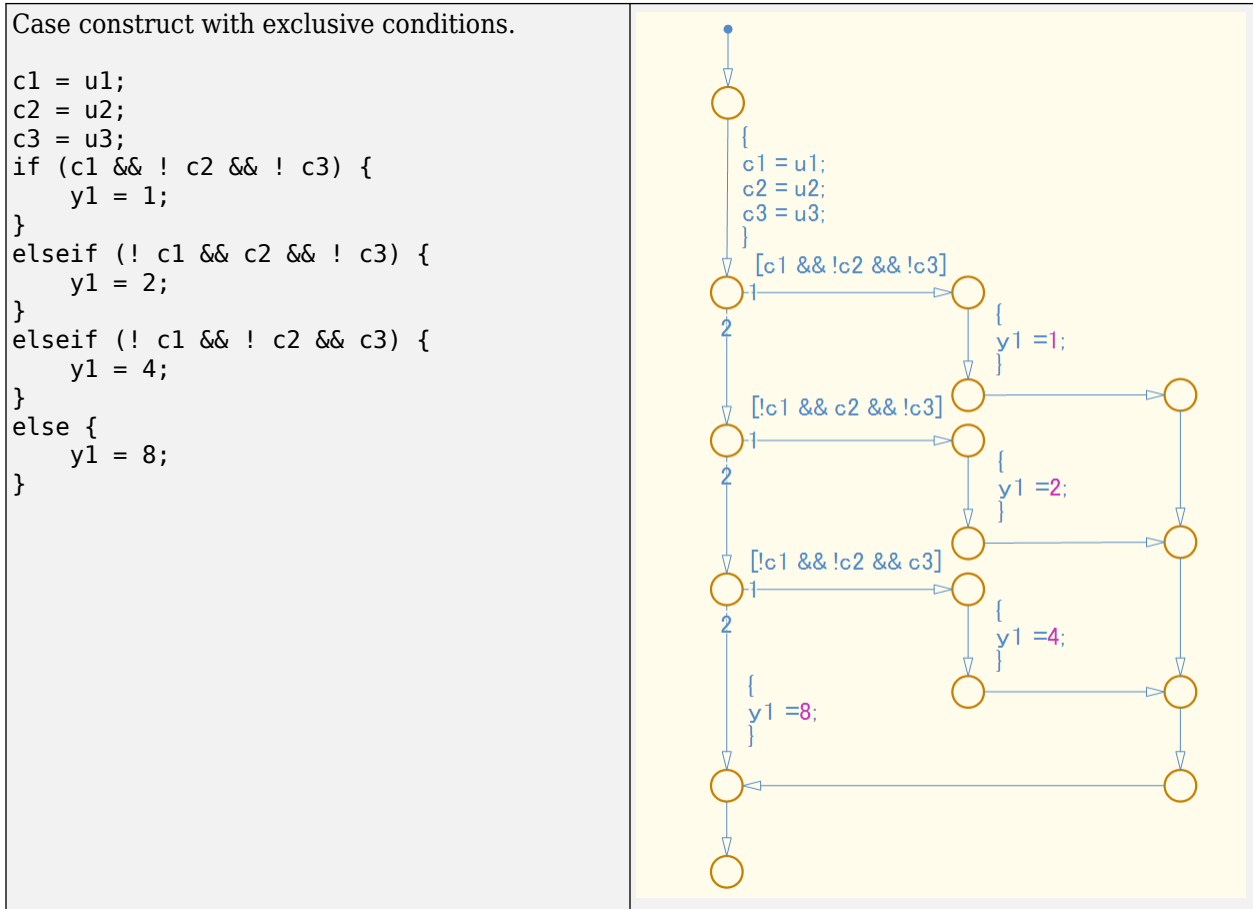
Case construct with exclusive selection.

```

selection = u1;
switch (selection) {
  case 1:
    y1 = 1;
    break;
  case 2:
    y1 = 2;
    break;
  case 3:
    y1 = 4;
    break;
  default:
    y1 = 8;
}

```





## Flow Chart Patterns for Loop Constructs

These patterns shall be used to create loop constructs in Stateflow flow charts.

| Function  | Flow Chart Pattern |
|---|--------------------|
| For loop construct<br><pre> for ( index = 0;       index &lt; number_of_loops;       index++ ) {     action; } </pre> |                    |
| While loop construct<br><pre> while ( condition ) {     action; } </pre>  |                    |

|   |  |
|---|--|
| <p>Do While loop construct.</p> <pre>do {     action; } while ( condition )</pre> |  |
|---|--|

## State Machine Patterns for Conditions

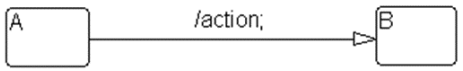
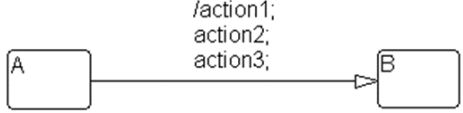
These patterns shall be used for conditions within Stateflow state machines

| Function  | State Machine Pattern |
|---|-----------------------|
| <p>One condition</p> <p>( condition )</p>   |                       |
| <p>Up to three conditions, short form</p> <p>(The use of different logical operators in this form is not allowed, use sub conditions instead)</p> <p>( condition1 &amp;&amp; condition2 )<br/>( condition1    condition2 )</p>  |                       |
| <p>Two or more conditions, multiline form</p> <p>A subcondition is a set of logical operations, all of the same type, enclosed in parentheses.</p> <p>(The use of different operators in this form is not allowed, use sub conditions instead.)</p> <p>( condition1 ...<br/>&amp;&amp; condition2 ...<br/>&amp;&amp; condition3 )<br/><br/>( condition1 ...<br/>   condition2 ...<br/>   condition3 )</p> |                       |

## State Machine Patterns for Transition Actions

These patterns shall be used for transition actions within Stateflow state machines.

| Function | State Machine Pattern |
|----------|-----------------------|
|----------|-----------------------|

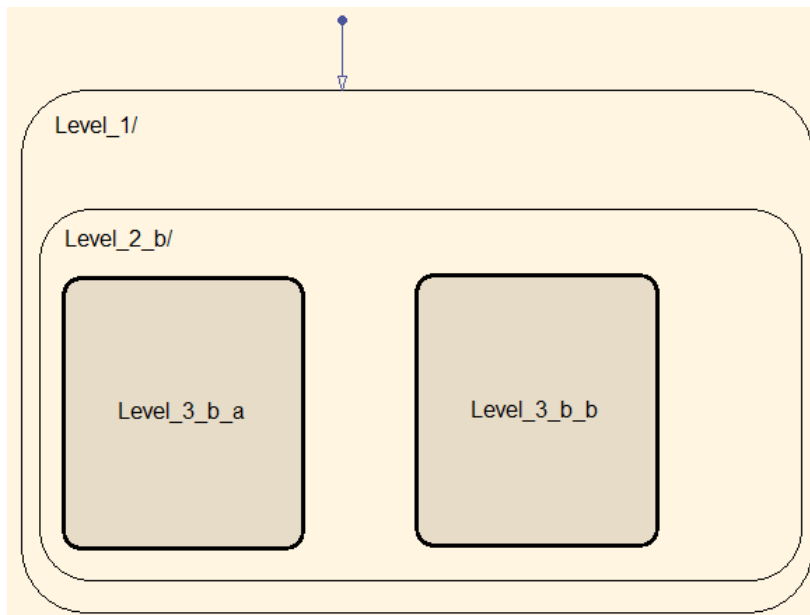
|   |  |
|---|--|
| <p>One transition action.</p> <pre>action;</pre>  |  |
| <p>Two or more transition actions, multiline form<br/>(Two or more transition actions in one line are not allowed.)</p> <pre>action1;<br/>action2;<br/>action3;</pre> |  |

## jc\_0321 Limiting State Layering

Within a single viewer (subviewer), multiple layering shall be limited by defining constraints for a single view (subview). Subcharts shall be used to switch the screen when defined constraint goals are exceeded.

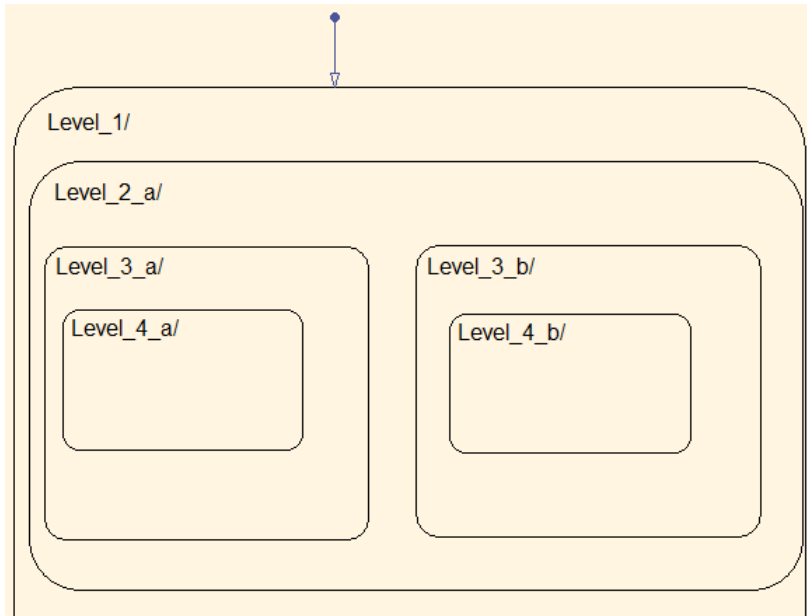
### Example — Recommended

The fourth level is encapsulated in a subchart.



### Example — Not Recommended

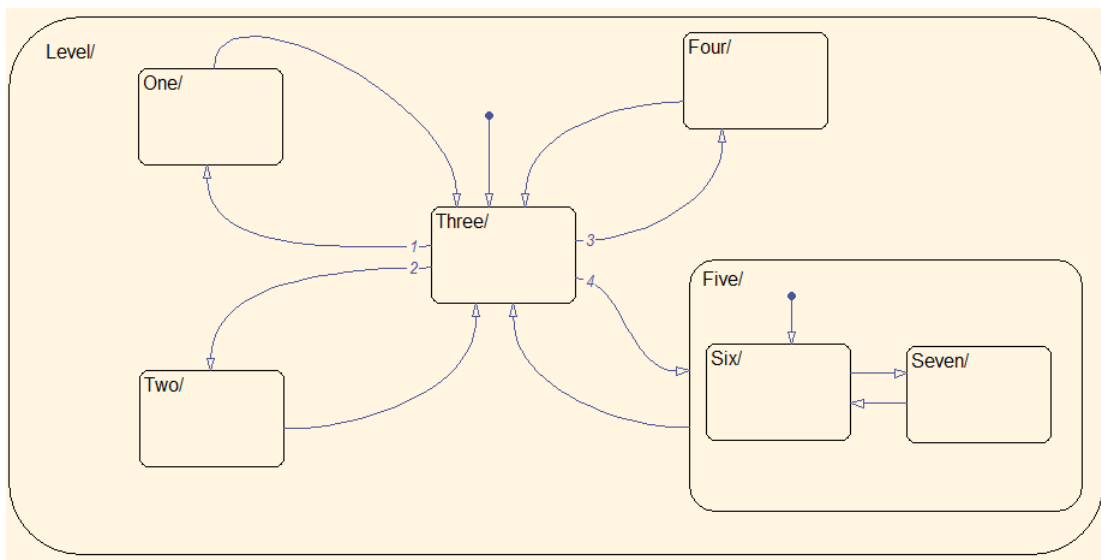
The constraint goal is set to three levels, but Level\_4\_a and Level\_4\_b have more than three levels



and are nested.

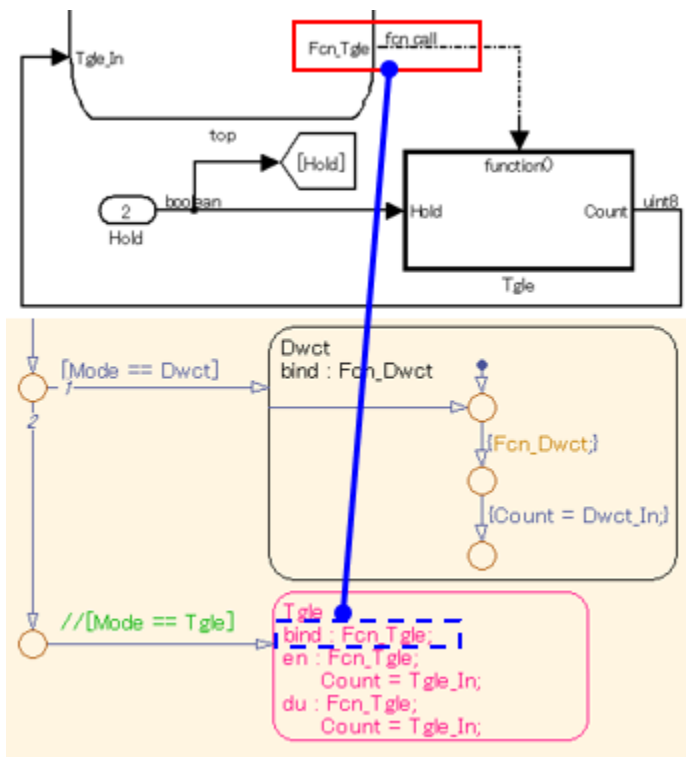
### Number of States per Stateflow Container

The number of states per Stateflow container shall be determined by the number of states that can be viewed in the diagram. All states should be visible and readable.



### Function Call from Stateflow

If a state exists in the Function-Call Subsystem of the call target, and a “reset” of the state is required when the state of the caller becomes inactive, the caller shall use a bind action.



## Function Types Available in Stateflow

The functions types used in Stateflow shall be dependent on the required processing.

For graphical functions, use:

- If, elseif, else logic

For Simulink functions, use:

- Transfer functions
- Integrators
- Table look-ups

For MATLAB functions, use:

- Complex equations
- If, elseif, else logic





# Glossary

## Atomic Subsystem

A subsystem block that executes the structural subsystem as a single unit. Conditional subsystems, Stateflow Chart, and MATLAB Function blocks are considered atomic subsystems.

## Basic Blocks

Built-in blocks in the standard Simulink library. Blocks with undefined internal processing, such as subsystems, are not considered basic blocks

Basic blocks can include:

- Inport
- Outport
- Ground
- Terminator
- Constant
- Scope
- Saturation
- Unit Delay
- Delay
- Discrete-Time Integrator
- Switch
- Gain
- Product
- Relational Operator
- Logical Operator

## Block

All blocks (type=block), including:

- Subsystems
- Models
- Charts (unless otherwise stated).

Standard Simulink library blocks are divided into two categories:

- Basic blocks
- Structural subsystems

**Built-in MATLAB functions**

MATLAB functions and scripts.

**Combined State Action Type**

A combination of two or more of these basic state action types:

- entry (en), during (du)
- during (du), exit (ex)
- entry (en), exit (ex)
- entry (en), during (du), exit (ex)

**Conditional Input Block**

Includes Trigger, Enable, Function-Call Subsystem, Reset blocks.

**Conditional Subsystem**

A subsystem with conditional input ports.

**Delay Block**

Two meanings:

- 1 The previous value reference block that is placed in the loop route to specify the execution order in an algebraic loop (circular reference). Uses Unit Delay and Memory blocks.  
  
(As of R201b at later) The Delay block can also be used
- 2 A block that retains past values. Uses Unit Delay, Memory blocks, Delay, and Tapped Delay blocks.

**Calculation Block**

Blocks whose block type is "sum" that carry out addition and subtraction operations. Includes Add, Subtract, Sum, Sum of Elements blocks.

**Flow Chart**

The part of a model that describes the action for the transition condition by using transition conditions and condition actions. The start point is the default transition line or internal transition line. The end point is the connective junction. Does not include states that are between the start and end points. Graphical functions and the inside of states can be modelled as flow charts

**Machine Level**

The root subsystem of a Simulink model with Stateflow blocks.

**Multiplication and Division Block**

Blocks whose block type is "product" that carry out division and multiplication operations. Includes Product, Divide, and Product of Elements blocks.

**Parameters**

When modifications have not been made, this term refers to constants that are defined in the base workspace and/or model workspace.

**Port Label Name**

The input and output port labels of a structural subsystem.

The names of Inport and Outport blocks are placed in a subsystem by default. Names of Stateflow input and output data are displayed by default.

The display option can be changed when masking a subsystem.

**Reserved MATLAB words**

MATLAB keywords and built-in MATLAB functions.

**State**

An atomic subchart is considered a state.

**State Action Type**

Basic state action types and combined state action types.

**Stateflow Block**

Includes Chart, State Transition Table, and Truth Table blocks.

**Subsystem**

A subsystem that can be internally modeled by using Simulink basic projection.

Even when the block type is "subsystem", blocks that describe the inside (other than Simulink basic projection) of a model, such as Chart, MATLAB Function blocks, are not included. The Model block also is not included.

