Japan MathWorks Automotive Advisory Board

(J-MAAB)

Simulink StyleGuide

Version 1.0

March, 2003

J-MAAB Simulink System Working Group

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Introduction

Background

In order to develop control system design effectively, MATLAB/Simulink has become widely used in automotive industry. However, it is also noted that control system design process are still ineffective due to lack of MATLAB/Simulink functionality.

To realize desired functionality that MATLAB/Simulink do not have, MAAB (MathWorks Automotive Advisory Board) was organized to discuss control system design process, to discuss necessary functions and to prioritize them. World major OEMs, ECU suppliers, tool vendors and TMW who utilize MATLAB/Simulink are participating in MAAB, discussing about the above-mentioned subjects, requesting TMW, the developer of MATLAB/Simulink.

J-MAAB is its Japanese board, and the guidelines are compiled based on what has been agreed on by the following participating companies of J-MAAB sub-working group, "J-MAAB Simulink System Working Group".

The members of "J-MAAB Simulink System Working Group" are as follows.

- Toyota, Nissan, Honda, Mazda, Denso, Hitachi, Hitachi Unisia, Aisin, and JATCO.

Objectives of Simulink System Guidelines

The Guidelines are designed to facilitate common understanding of the specification between the author and the user by using this guideline for automotive control system.

Organization of Simulink System Guidelines

Simulink System Guidelines are organized as follows.

1. J-MAAB Style Guide: Rules of Simulink System description.
2. Data Dictionary (under consideration)
3. Function Guide (under consideration)

* "Convenient combinations of Simulink Blocks" is planned to be published separately from "Simulink System Guidelines".

Handling of Simulink System Guidelines

- Disclosure of Guidelines.

    Version 1.0 is planned to be released in March, 2003.

- Maintenance of Guidelines.

    Revision Period: Revised once a year. (On demand basis)

    Revision Method: Toyota will collect feedback from the members, and pass them to Cybernet for revision.

    Maintenance: Cybernet is responsible for the maintenance.

    Feedback: Toyota is responsible for the collection of feedback from the members.

- English Translation

    Cybernet is responsible for the translation from Japanese to English.

CHAPTER 1

J-MAAB StyleGuide

1. Outline

1.1 About J-MAAB StyleGuide

This is designed as J-MAAB standard to facilitate common understanding of Simulink model as specification between the author and the user in its operation of Simulink System Guidelines based upon the MAAB StyleGuide (Simulink description Guideline) which has been released by MAAB, upper organization of J-MAAB.

1.2 J-MAAB StyleGuide Policy

In order to formulate the J-MAAB StyleGuide, the policies have been observed.

- Compliance with the MAAB StyleGuide in general.
- Provision of the standard description of automotive control specification document.
    - Provision of the Simulink model hierarchy.
    - Clarification of Input and Output.
        1. Signal Line
        2. Constant
        3. Variable
    - Clarification of process timing and calculation cycle.
- If not specifically described, compliance with the “MAAB StyleGuide” or “Company specific description rules”.

2. General Rules

2.1 General Rules

- Simulink model should be executable, or able to be run when an appropriate input is given.
- Error and warning are not observed when simulated with an appropriate input.
- Inport and outport of each block (subsystems) are easily comprehensive.

2.2 Structure

The following files are prepared.

- Simulink model (Logic itself)
- File for setting workspace variables

2.3 Naming Guidelines

- Naming files

Japanese characters are not to be used. Only available characters shown on Table 1 should be used. Either capital letter or small letter should be used in separately consideration of multi platforms. Subsystems names and Inport/Outport block names must be filled out. (Avoid leaving them as default)

- Only available characters shown on Table 1 should be used for block names.

2.4 Format Guidelines

2.4.1 Colors

The following colors are used as default. However, conformance to the company specific guidelines, if any, is acceptable.

- White is used as Screen color.
- White is used as Block's background color.
- Black is used as Block's foreground color.

2.4.2 Fonts

- Fonts used in a model need to be the same and the size of 10pt or bigger is used.
- Font color setting should be Black. However, conformance to the company specific guidelines, if any, is acceptable.

Table 1 Available or unavailable characters

Available	Alphabet(A-Z a-z), Numeric(0-9), Special characters (under score, period)
Unavailable	Characters not mentioned above. (Double byte characters, etc.)

3 Model Architecture

Control Design Model is described in the following hierarchical architecture.

- Top Layer: is the page describing model I/O and model trigger.
- *Trigger Layer: provides the execution timing of each subsystems using trigger.
- Structured Layer: describes Control Logic Structure by each function (parts). It is possible to describe across multiple hierarchies.
- Data Flow Layer: describes Control Logic (Data Flow) directly. It is possible to describe across multiple hierarchies the same as structured layer.
- *Procedure Timing description: describes procedure timing in case trigger layer is not set.

(Supplementary)

1. When trigger layer is used, procedure timing should not be defined on the layer below this.
2. The format that uses trigger layer is called “Format A”, one does not use trigger layer is called “Format B”
3. Either Format A or Format B needs to be described in the model, and they should not be mixed.

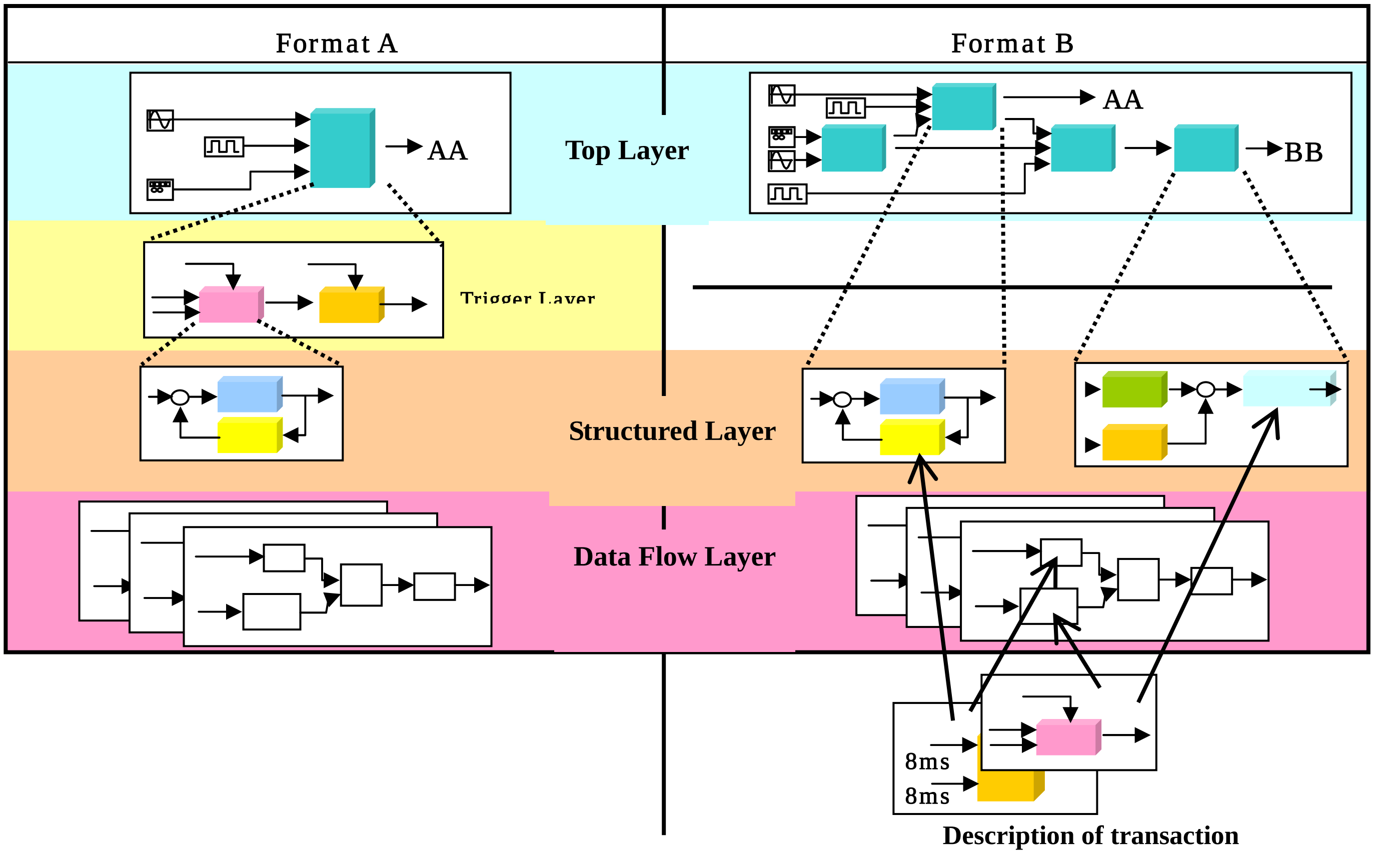


Figure 1: Model Structure

3.1 Description of each Layer

3.1.1 Top Layer (Common Format A and Format B)

The items described on the cover page are as follows.

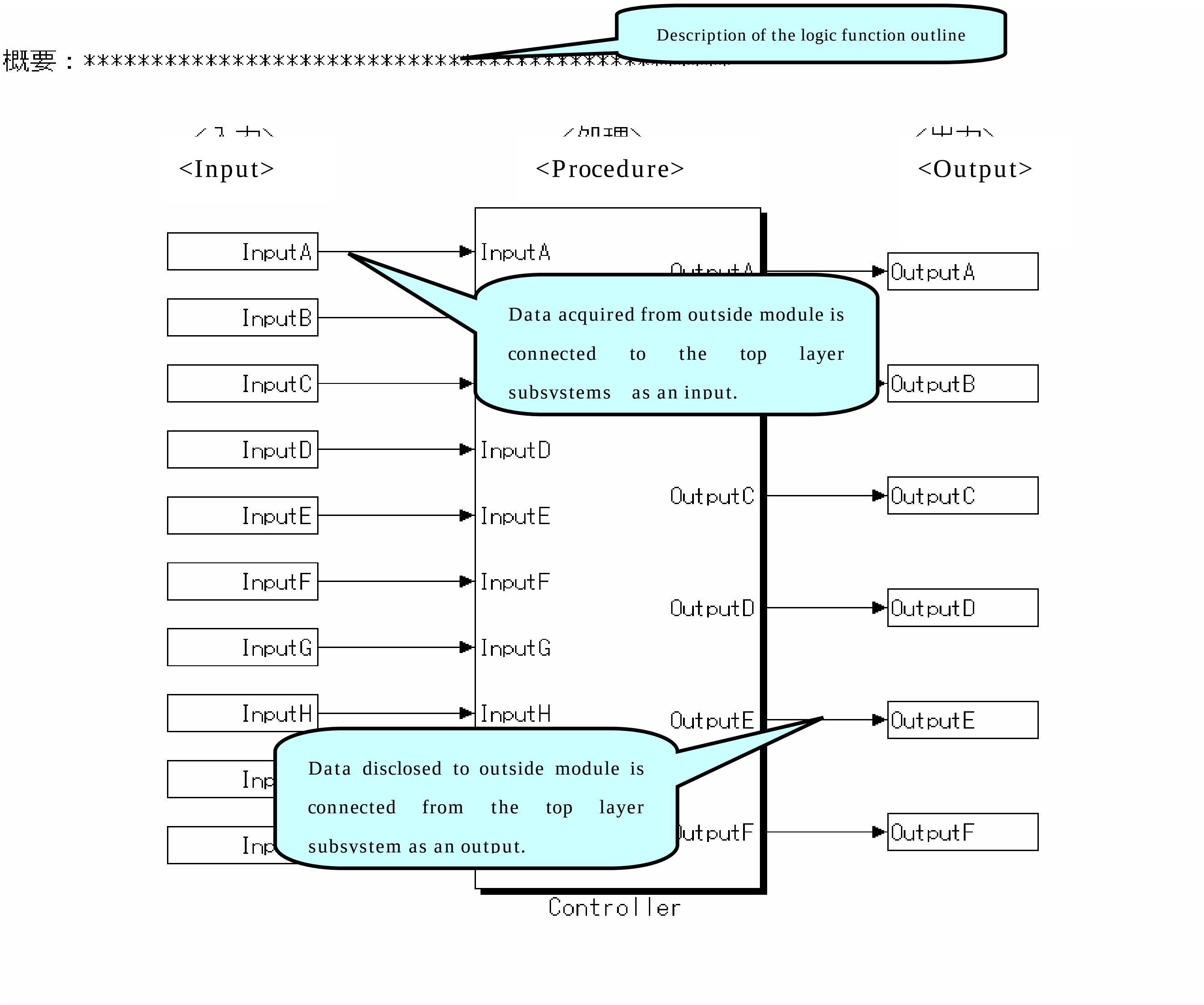
- Outline: Explanation of model function outline.

- Input: Input variables

With simulation input	Given as input signal
Without simulation input	Names of I/O variables are described in an easily understandable manner, conforming to company specific rules.

- Output: Output variables

- Procedure: Whole ECU or other related sub parts are described with Simulink model.



Description of the logic function outline

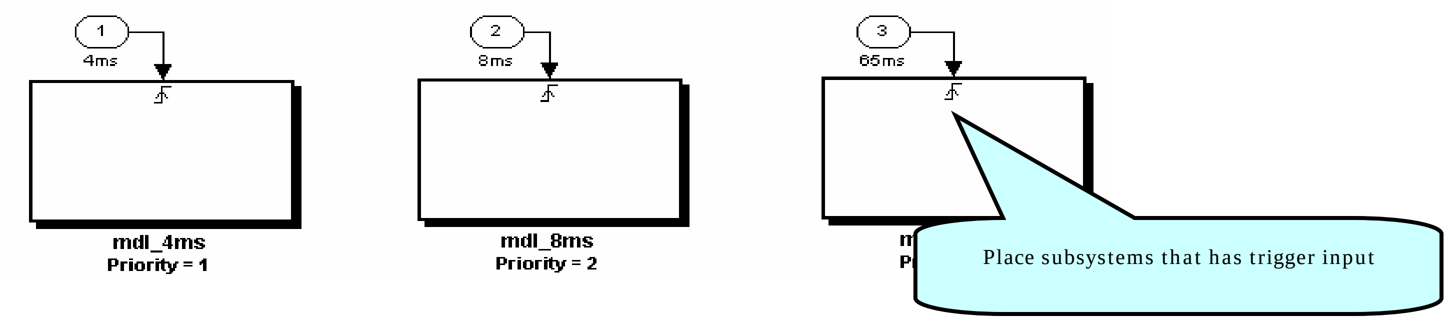
Data acquired from outside module is connected to the top layer subsystems as an input.

Data disclosed to outside module is connected from the top layer subsystem as an output.

Figure 2: Cover Page example (With simulation input)

3.1.2 Trigger Layer (Format A)

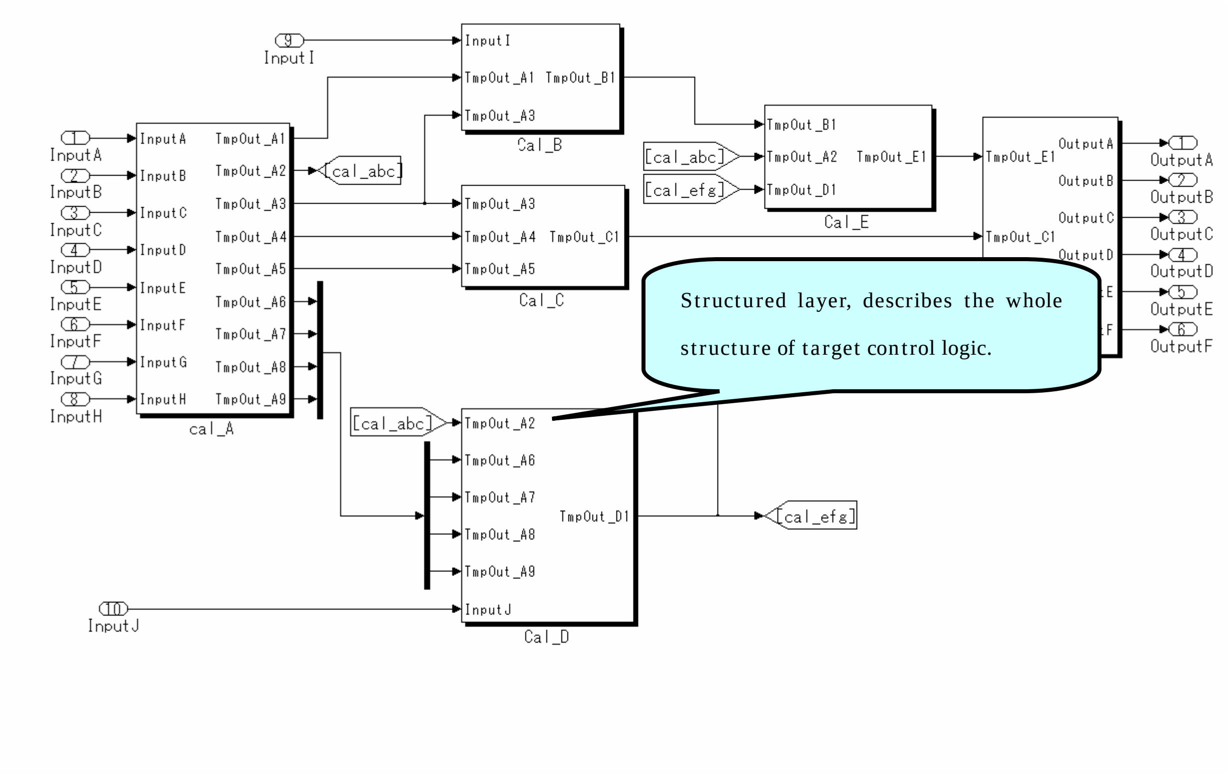
Trigger Layer should be described like a description example as follows. However, when specifying the calculation timing with trigger layer, do not use Format B process timing description on the layer below this.



Place subsystems that has trigger input

Figure 3: Trigger Layer description example

3.1.3 Structured Layer (A/B common)



Structured layer, describes the whole structure of target control logic.

Figure 4: Structured Layer example

3.1.4 Data Flow Layer example (A/B Common)

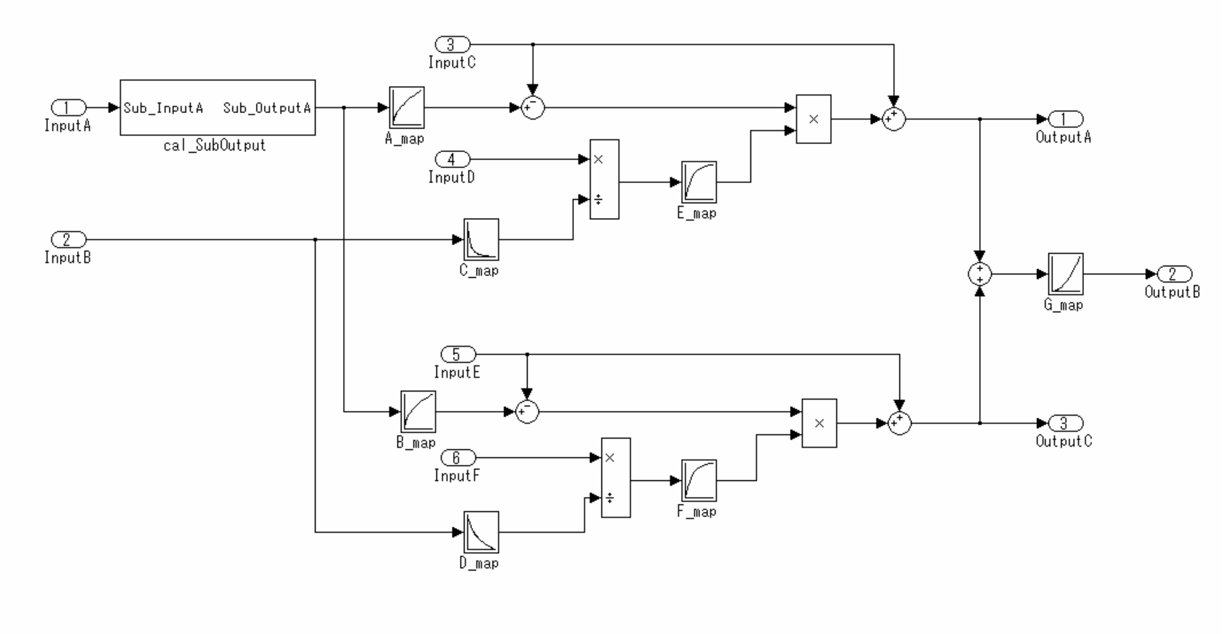
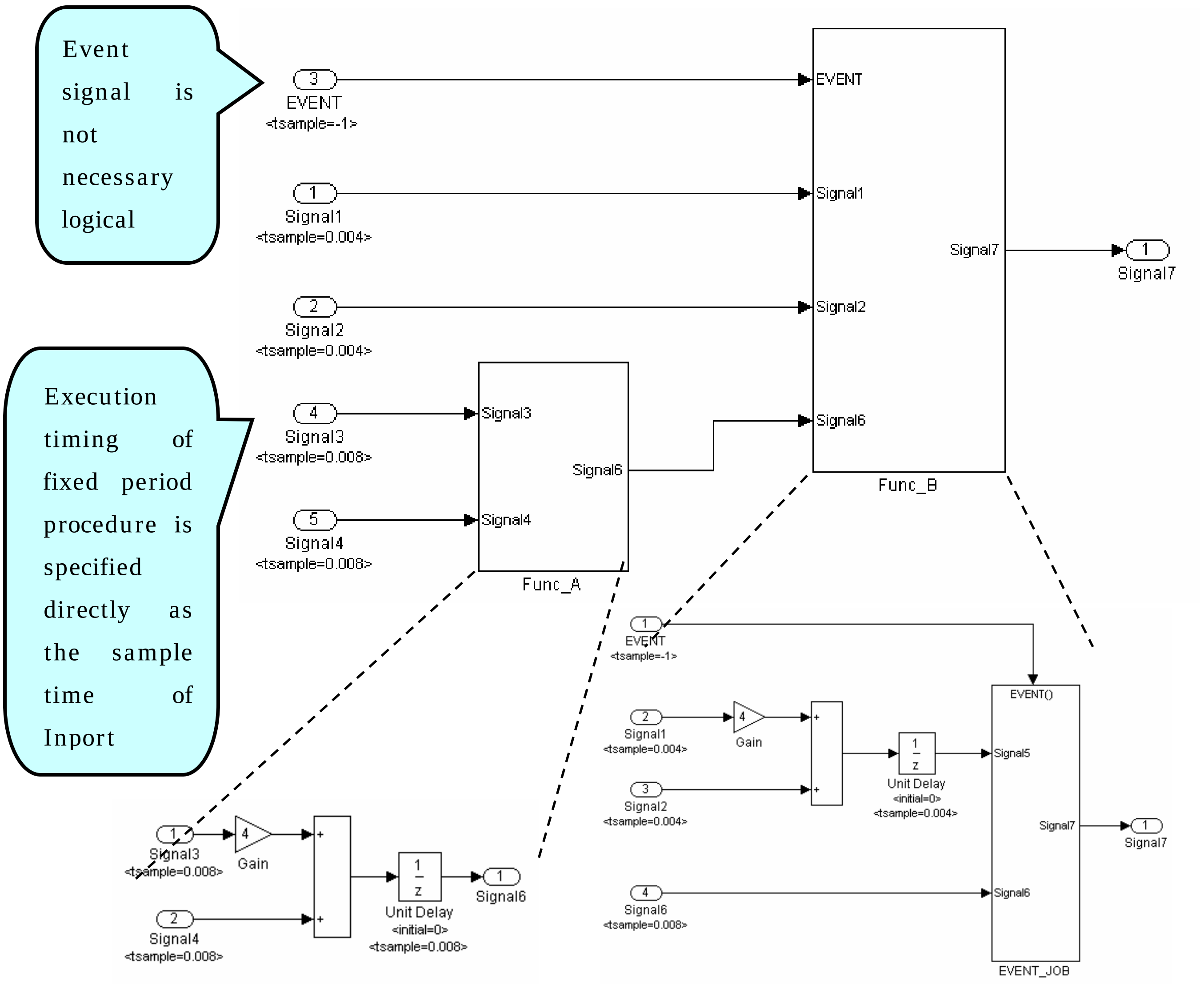


Figure 5: Data Flow Layer example

3.1.5 Process Timing (Format B)

If trigger is not used, the following standardized method is used to describe process timing.



Event signal is not necessary logical

Execution timing of fixed period procedure is specified directly as the sample time of Inport

Figure 6: Process Timing description example

3.2 Description of initialization process

The following two cases can be mainly considered to describe initialization process.

1. When using a block of UnitDelay etc., set Initial Condition inside the block as initial value. In this case, company specific description rules are to be observed.

2. Perform initialization in the using certain processing results as initial values.

In such a case, describe in the following methods.

(1) Organize initialization process in subsystems.

(2) Give a name, which specifies that it is initialization process, to subsystems name.

3.2.1 Initialization description method 1 (Format A/Format B Common)

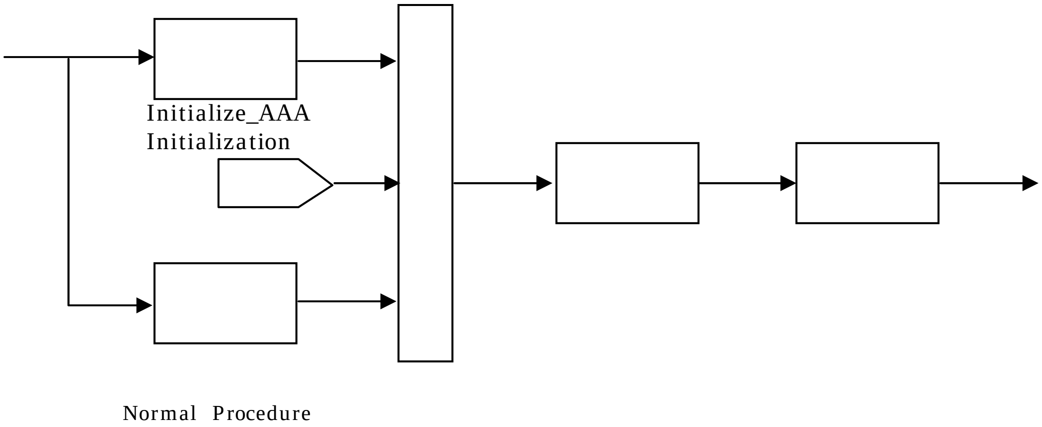


Figure 7-1 : Initialization process description example (FormatA/FormatB common)

3.2.2 Initialization description method 2 (Format A)

Set triggered subsystem for trigger layer that controls initialization process. In that case, a name indicates it is initialization process is given to the name of a triggered system.

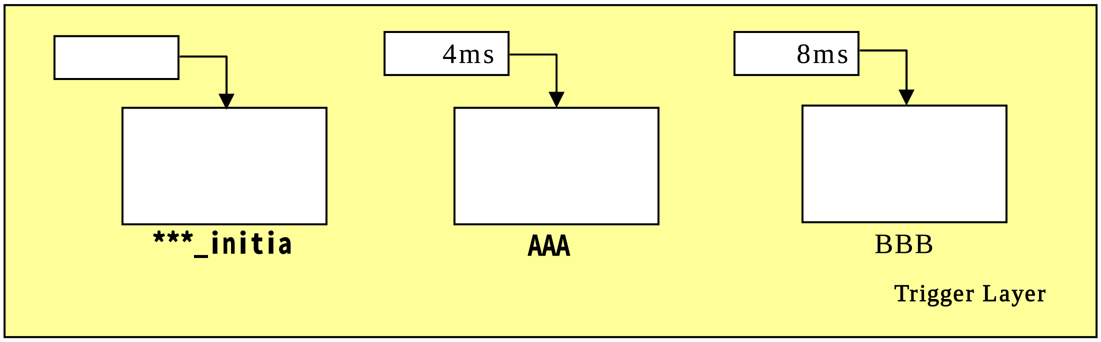


Figure 7-2 : Initialization processing description example of trigger layer (Format A only)

4. Method of drawing signal lines

- Do not draw one upon the other.

- Avoid crossing of lines as much as possible.

- Signal lines should be drawn either vertically or horizontally. (It does not draw aslant)

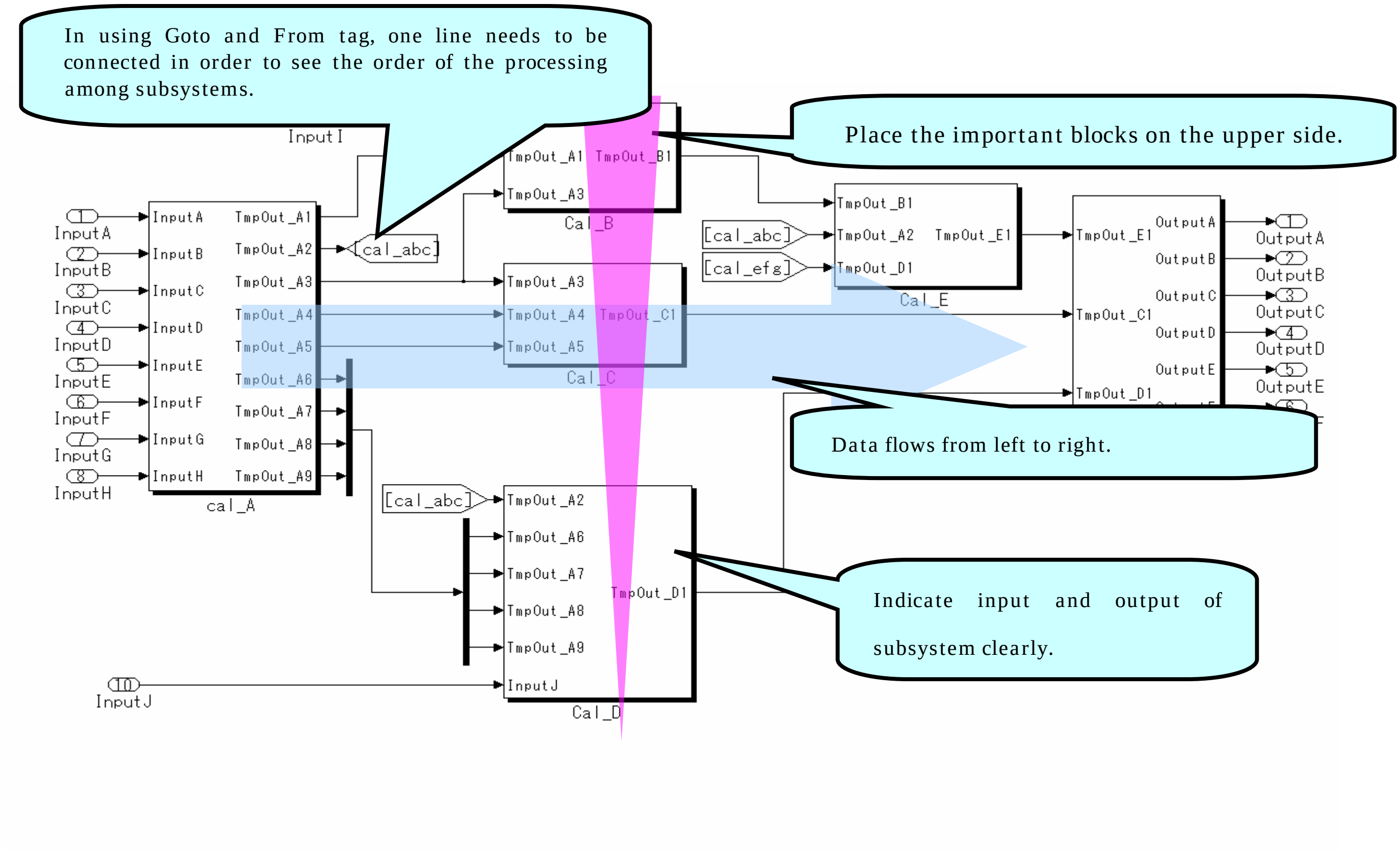
- Data should flow from left to right unless otherwise specified.

- Do not use Goto and From tag as much as possible. When using it, only LOCAL is allowed in the “Tag Visibility” of Goto Block. However, if scope block is used to view simulation results for monitoring purpose only, it can be set to Global.

- In using Goto and From tag, at least one line needs to be connected in order to see the order of the processing among subsystems.

- Describe that the input and output of subsystems in each layer are indicated as clearly as possible.

- Algebra loop must not be used.


In using Goto and From tag, one line needs to be connected in order to see the order of the processing among subsystems.

Place the important blocks on the upper side.

Data flows from left to right.

Indicate input and output of subsystem clearly.

Figure 8: Method of drawing signal lines

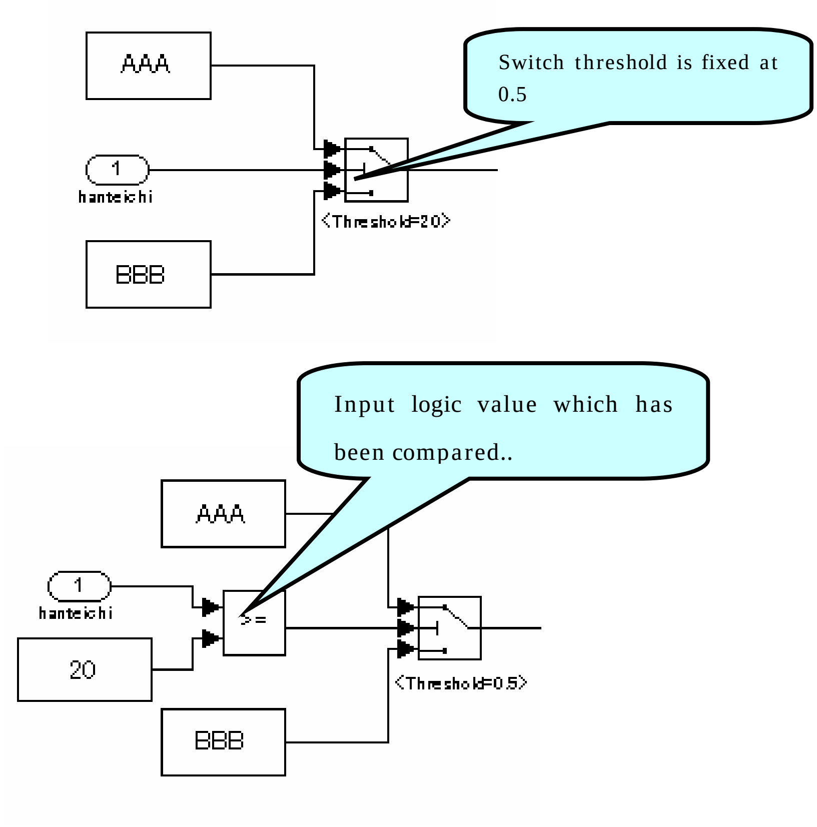
5. Data type

Data type should be defined strictly in Simulink, and operation with other data types should be avoided.

- Real number data: Real numerical value used for calculation. It usually treated as “double”.
- Integer data: Integer value used for calculation.
- Logic value: Either 0 or 1. Enable signal, value showing On/Off, relational operation results, etc.

5.1 Description example in consideration of data type.

For example, "I want to execute this subsystems when OO is more than XX", Signal (real number data) should not be connected directly to Enabled port, but relational operator block should be placed to generate logical value and connect to that port..



(Wrong)

Switch threshold is fixed at 0.5

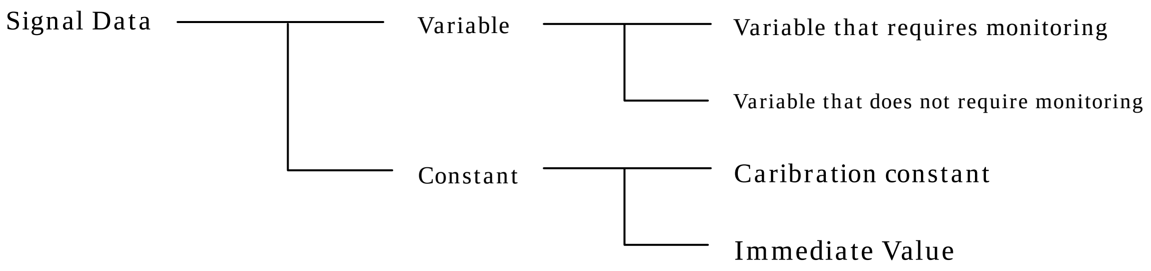
(Correct)

Input logic value which has been compared..

Figure 9: Example of data and logic value mix

5.2 Identifying Signal Data Type (variable / constant)

The following signal data types are used for Simulink model. Description method is determined to identify these types.


Signal Data
Variable
Variable that requires monitoring
Variable that does not require monitoring
Constant
Caribration constant
Immediate Value

Signal Data	Description Method	Variables, Constant Name, and Naming Rules
Require monitoring	Variable Names are allocated to the Signal Label （Signal Line Label） Or company specific rules, if any, are to be observed.	-Add a prefix and a suffix to a variable name and enable it to distinguish a monitoring variable. - Company specific rules, if any, are to be observed.
Do not require monitoring	No Rules	
Caribration constant	A work space variable defines the value of the parameter of Constant, Gain, Saturation, Look-up Table, etc.	-Add a prefix and a suffix to a variable name and enable it to distinguish conformity constant. - Company specific rules, if any, are to be observed.
Immediate value	A numerical value is described directly.	

Description example

The following example uses Signal Label that adds “b” to conformity constant, “a” to a variable that requires monitoring as a prefix.

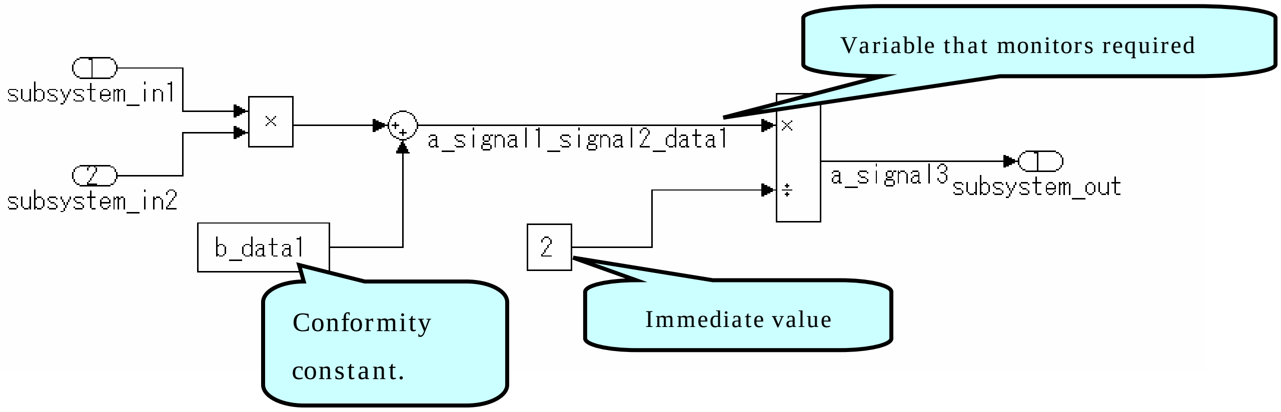


Figure 10: Example of identifying Variables / Constants Description