Handbook of Plant Modeling I/F Guidelines -Compatible Model (Thermal Performance Model) for Vehicle Development (Ver. 1.1)

Revision History

Rev.	Date	Revised contents	Company	Approver
1.0	Mar, 2019	New issued	AZAPA	Ichihara
1.1	Nov, 2019	Modified contents	AZAPA	Ichihara

Contents

1. Preface

1.1. Purpose of the guidelines-compatible model

The guidelines-compatible model is based on the Plant Modeling I/F Guidelines for Vehicle Development 2.0, which promote the distribution of models between businesses. Actual use of this model will lead to a deeper understanding of these Guidelines. In addition, by replacing and running the subsystem models with your own models, the guidelines-compatible model is expected to be used as a preemptive Guidelines checker and problem identifier when changing models.

1.2. Requirements of the guidelines-compatible model

For beginners function and structure of vehicle are abstracted.
The scope of this handbook are motion system such as rotation or translation, electric system and thermal system. *Other domains will be defined in the future.
The model assumes that the engine displacement of the vehicle is 1.5[L] and the drive system is CVT.
All of the models in this handbook is based on Matlab® Simulink®.

The guidelines-compatible model is generally based on “Handbook of Plant Modeling I/F Guidelines-Compatible Model for Vehicle Development (Ver. 1.0)” and was created by modifying “Plant Modeling I/F Guidelines-Compatible Model for Vehicle Development”, both publicly available. In consideration of this, references will be provided for items that have not been modified from “Handbook of Plant Modeling I/F Guidelines-Compatible Model for Vehicle Development (Ver. 1.0)”. Items that have been modified or added to will be noted in this text.

1.3. Functions of the guidelines-compatible model

The modified and the added items are shown below. Refer to section 1.3 of “Handbook of Plant Modeling I/F Guidelines-Compatible Model for Vehicle Development (Ver. 1.0)” for other items.

●Controller
- ･Idling stop (modification)
- ･Idling control (modification)
- ･Fuel injection control (addition)
- ･Water pump control (addition)
- ･Radiator fan control (addition)
- ･CVTF warmer thermal resistance control (addition)

●Plant (Add the function to the existing system.)
- ･Engine (modification)
- ･CVT (modification)
- ･Differential gear (modification)
- ･P/T thermal (addition)
- ･Ambient temperature (addition)

2. Operating/Usage environment

The operating requirement and usage environment of the guidelines-compatible model is shown below.

2.1. Operating requirement

Refer to chapter 2.1 of "Handbook of Plant Modeling I/F Guidelines-Compatible Model for Vehicle Development (Ver. 1.0)". Please note that the model usage environment is changed as follows;

＜Model requirement＞

Tool	MATLAB/Simulink
Tool ver.	R2015a (64bit)
Types	.slx
Library （Except for Simulink standard library）	METI_Lib_vehicle_model

2.2. Usage environment

Refer to chapter 2.2 of "Handbook of Plant Modeling I/F Guidelines-Compatible Model for Vehicle Development (Ver. 1.0)". Please note that the file composition of the guidelines-compatible model is changed as follows;

＜File composition of the guidelines-compatible model＞

No.	File Name	Description
1	METI_CVT_Thermal_ver01_20190213_2015a.slx	Simulator of thermal performance
2	METI_Lib_vehicle_model	METI Library
3	init_setting.m	Script for initial setting / setting parameter data / setting pass
4	（subfolder）param	Parameter data folder
5	（subfolder）picture	Block image data folder

3. Usage

Refer to chapter 3 of "Handbook of Plant Modeling I/F Guidelines-Compatible Model for Vehicle Development (Ver. 1.0)".

4. Basic structure of guidelines-compatible model

The structures of the guidelines-compatible model's 1st (top) and 2nd layers, as well as the systems of the two layers is described below (those separated by Simulink's subsystem into each function).

4.1. Model structure of first-layer

Refer to chapter 4.1 of “Handbook of Plant Modeling I/F Guidelines-Compatible Model for Vehicle Development (Ver. 1.0)”.

4.2. Model structure of second-layer

The structure of the first-layer each system of the guidelines-compatible model is shown below.

4.2.1. Structure of [A: Driver] system

Refer to chapter 4.2.1 of “Handbook of Plant Modeling I/F Guidelines-Compatible Model for Vehicle Development (Ver. 1.0)”.

4.2.2. Structure of [B: Vehicle] system

The structure of the second-layer vehicle system of the guidelines-compatible model is shown below.

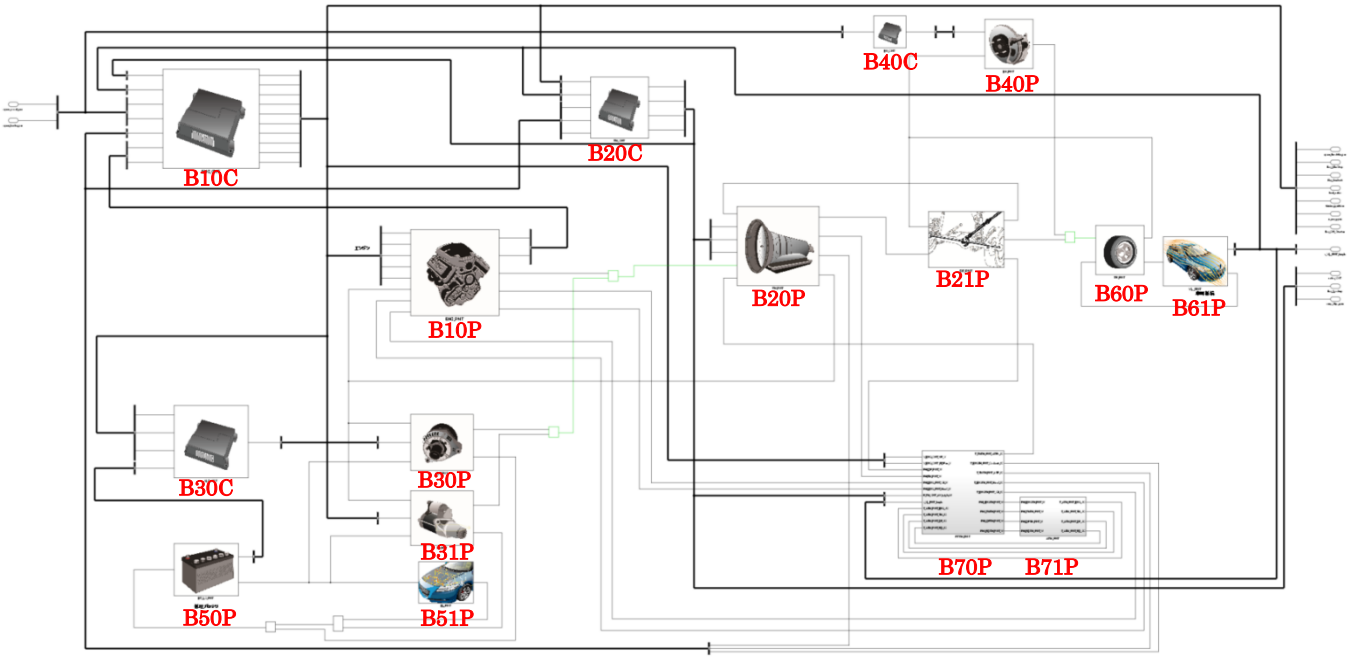


Fig.4.2.2. Structure of second-layer vehicle system

The functional specifications of the second-layer vehicle system of the guidelines-compatible model are described.

The numbered elements in the figure represent the system shown in Fig 4.2.2. The C at the end of B10C stands for Controller, and the P at the end of B10P stands for Plant.

Table 4.2.2 Each system name of second-layer vehicle system and function overview

No.	System Name	Function Overview
B10C	ENG_CNT	Engine and Starter control.
B20C	TM_CNT	CVT and lock-up clutch control.
B30C	ALT_CNT	Refer to chapter 4.2.2 of “Handbook of Plant Modeling I/F Guidelines-Compatible Model for Vehicle Development (Ver. 1.0)”.
B40C	BK_CNT	Refer to chapter 4.2.2 of “Handbook of Plant Modeling I/F Guidelines-Compatible Model for Vehicle Development (Ver. 1.0)”.
B10P	ENG_PNT	Generate engine shaft torque and calculating fuel consumption and amount of heat generation.
B20P	TM_PNT	Transmitting and calculating amount of heat generation toward engine rpm and torque.
B21P	DF_PNT	Decelerating and calculating from T/M output to drive shaft and amount of heat generation.
B30P	ALT_PNT	Refer to chapter 4.2.2 of “Handbook of Plant Modeling I/F Guidelines-Compatible Model for Vehicle Development (Ver. 1.0)”.
B31P	ST_PNT	Refer to chapter 4.2.2 of “Handbook of Plant Modeling I/F Guidelines-Compatible Model for Vehicle Development (Ver. 1.0)”.
B40P	BK_PNT	Refer to chapter 4.2.2 of “Handbook of Plant Modeling I/F Guidelines-Compatible Model for Vehicle Development (Ver. 1.0)”.
B50P	BT_PNT	Refer to chapter 4.2.2 of “Handbook of Plant Modeling I/F Guidelines-Compatible Model for Vehicle Development (Ver. 1.0)”.
B51P	EL_PNT	Refer to chapter 4.2.2 of “Handbook of Plant Modeling I/F Guidelines-Compatible Model for Vehicle Development (Ver. 1.0)”.
B60P	TR_PNT	Refer to chapter 4.2.2 of “Handbook of Plant Modeling I/F Guidelines-Compatible Model for Vehicle Development (Ver. 1.0)”.
B61P	VL_PNT	Refer to chapter 4.2.2 of “Handbook of Plant Modeling I/F Guidelines-Compatible Model for Vehicle Development (Ver. 1.0)”.
B70P	PTTH_PNT	Calculating temperature of engine, T/M, radiator and D/F.
B71P	AMT_PNT	Receiving radiation amount from P/T thermal.

4.2.3. Structure of [C: External environment] system

Refer to chapter 4.2.3 of "Handbook of Plant Modeling I/F Guidelines-Compatible Model for Vehicle Development (Ver. 1.0)".

4.2.4. Structure of [D: Monitor] system

The structure of the second-layer monitor system of the guidelines-compatible model is shown below.

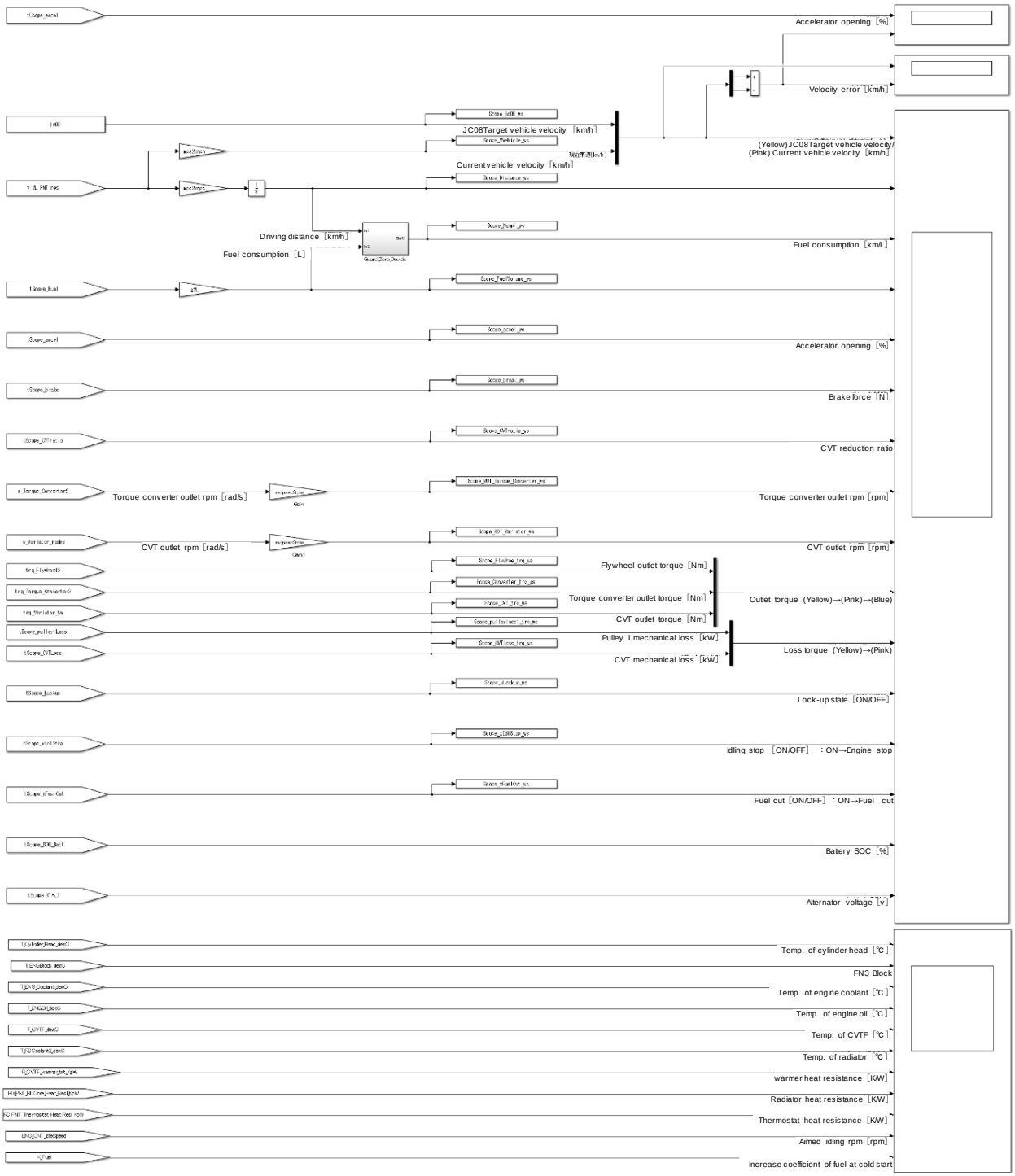


Fig.4.2.4. Structure of second-layer monitor system

This system monitors the signals calculated from the driver, vehicle (and external environment) systems. It does not have any deeper system layers.

5. Functional Specifications of guidelines-compatible model

5.1. Functional specification of first-layer model

The functional specifications of the first-layer (entire model) of the guidelines-compatible model are described.

5.1.1. Abstract

Refer to chapter 5.1.1 of "Handbook of Plant Modeling I/F Guidelines-Compatible Model for Vehicle Development (Ver. 1.0)".

5.1.2. Data flow diagram

Refer to chapter 5.1.2 of "Handbook of Plant Modeling I/F Guidelines-Compatible Model for Vehicle Development (Ver. 1.0)".

5.1.3. Input/output specification

Refer to chapter 5.1.3 of "Handbook of Plant Modeling I/F Guidelines-Compatible Model for Vehicle Development (Ver. 1.0)".

5.1.4. Parameter specification

The added items to “Handbook of Plant Modeling I/F Guidelines-Compatible Model for Vehicle Development (Ver. 1.0)” are shown below.

Variable Name	Setting value	Unit	Description
T_ENGCoodant	[25,80,90]	℃	Fuel injection amount additional coefficient map x-temp. of coolant
K_Fuel	[2,1,1]	-	Fuel injection amount additional coefficient map
T_ENGCoodant_T_ENGCoodant	<1x4>	℃	Target idling engine speed rpm map x-temp. of coolant
ENG_CNT_IdleSpeed	<1x4>	rpm	Target idling engine speedrpm map
ENG_CNT_IdleStop_flag_const	80	℃	Idling stop restricted temp. of coolant
ENG_CNT_acc_idlestop	0.5	%	Accelerator condition that idling stop is turned ON (if value is 0.5 or more, OFF)
ENG_PNT_FuelCon_gps_map_x_pri_rpm	<1x13>	rpm	Fuel consumption rate map x-engine rpm
ENG_PNT_FuelCon_gps_map_y_trq_Nm	<1x8>	Nm	Fuel consumption rate map y-engine shaft torque
ENG_PNT_FuelCon_gps_map	<8x3>	g/sec	Fuel consumption rate map
ENG_PNT_Heatflux2Cylinder_Head_W_x_rpm	<1x2>	rpm	Cylinder head transfer heat map x-engine rpm
ENG_PNT_Heatflux2Cylinder_Head_W_y_trq	<1x2>	Nm	Cylinder head transfer heat map y-engine torque
ENG_PNT_Heatflux2Cylinder_Head_W	<2x2>	W	Cylinder head transfer heat map
ENG_PNT_Heatflux2Cylinder_Head_gain_x_T_Coolant	<1x2>	℃	Cold cylinder head transfer heat gain map x-head temp.
ENG_PNT_Heatflux2Cylinder_Head_gain	<1x2>	-	Cold cylinder head transfer heat gain map
ENG_PNT_Heatflux2ENGOil_W_x_rpm	<1x2>	rpm	Engine oil transfer heat map x-engine rpm
ENG_PNT_Heatflux2ENGOil_W_y_trq	<1x2>	Nm	Engine oil transfer heat map y-engine torque
ENG_PNT_Heatflux2ENGOil_W	<2x2>	W	Engine oil transfer heat map
ENG_PNT_Heatflux2ENGOil_gain_x_T_ENGOil	[-1 1]	℃	Cold engine oil transfer heat gain map x-temp. of oil
ENG_PNT_Heatflux2ENGOil_gain	[1 1]	-	Cold engine oil transfer heat gain map
ENG_PNT_Cold_friction_gain_x_T_ENGOil	<1x5>	℃	Cold increased friction gain map x-temp. of oil
ENG_PNT_Cold_friction_gain	<1x5>	-	Cold increased friction gain map (1=HOT)
ENG_PNT_V_Water_Pump_x_T_Coolant	<1x6>	℃	Water pump voltage map x-temp. of coolant
ENG_PNT_V_Water_Pump_V	<1x6>	V	Water pump voltage map
ENG_PNT_Qv_Water_Pump_x_V_WP	<1x5>	V	Water pump flow map x-water pump voltage
ENG_PNT_Qv_Water_Pump_m3ps	<1x5>	m^3/sec	Water pump flow map
ENG_PNT_Cylinder_Head_Temp_ini_degC	25	℃	Cylinder head initial temp.
ENG_PNT_Cylinder_Head_Heat_Capa_JpK	3000	J/K	Cylinder head heat capacity
ENG_PNT_Cylinder_Head2Coolant_Heat_Resi_x_qv_Coolant	<1x4>	m^3/sec	Heat resistance map between cylinder head and coolant x-coolant flow
ENG_PNT_Cylinder_Head2Coolant_Heat_Resi_KpW	<1x4>	K/W	Heat resistance map between cylinder head and coolant
ENG_PNT_ENGOil_Temp_ini_degC	25	℃	Engine oil initial temp.
ENG_PNT_ENGOil_Heat_Capa_JpK	3375	J/K	Engine oil heat capacity
ENG_PNT_ENGOil2Coolant_Heat_Resi_KpW	0.001	K/W	Heat resistance between engine oil and engine coolant
ENG_PNT_Coolant_Temp_ini_degC	25	℃	Engine coolant initial temp.
ENG_PNT_Coolant_Heat_Capa_JpK	39900	J/K	Engine coolant heat capacity
ENG_PNT_Coolant2ENGBlock_Heat_Resi_KpW	0.01	K/W	Heat resistance between engine coolant and engine block
ENG_PNT_ENGBlock_Temp_ini_degC	25	℃	Engine block initial temp.
ENG_PNT_ENGBlock_Heat_Capa_JpK	3000	J/K	Engine block heat capacity
ENG_PNT_ENGBlock2ENGAir_Heat_Resi_KpW	1	K/W	Heat resistance between engine block and external environment
ENG_PNT_Outtemp_degC	25	℃	Engine external environment temp.
TM_CNT_CVTFwarmer_KpW_x_T_CVTF	<1x4>	℃	Cold CVTF warmer heat resistance map x-temp. of CVTF
TM_CNT_ CVTFwarmer_KpW	<1x4>	K/W	Cold CVTF warmer heat resistance map

Variable Name	Setting value	Unit	Description
TM_CNT_ CVTFwarmer_cold_Coolant_KpW	1000	K/W	CVTF warmer heat resistance (temp. of CVTF > temp. of coolant)
TM_PNT_ CVTF_Heat_Capa_JpK	10600	J/K	CVTF heat capacity
TM_PNT_ CVTF_Temp_ini_degC	25	℃	CVTF warmer initial temp.
TM_PNT_ CVTF2TMBlock_Heat_Resi_KpW	0.001	K/W	Heat resistance between CVTF and T/M
TM_PNT_TMBlock_Temp_ini_degC	25	℃	T/M block initial temp.
TM_PNT_TMBlock_Heat_Capa_JpK	10000	J/K	T/M block heat capacity
TM_PNT_TMBlock2TMAir_Heat_Resi_KpW	1	K/W	Heat resistance between T/M block and external environment
TM_PNT_Outtemp_degC	25	℃	T/M external environment temp.
TM_PNT_ENGBlock2TMBlock_Heat_Resi_KpW	0.1	K/W	Heat resistance between engine block and T/M block
TM_PNT_eta_CVT_x_ CVTF_degC	<1x4>	℃	CVT loss map x-temp. of CVTF
TM_PNT_eta_CVT	<1x4>	-	CVT loss map
DF_PNT_DFOil_Temp_ini_degC	25	℃	D/F oil initial temp.
DF_PNT_DFOil_Heat_Capa_JpK	1000	J/K	D/F oil heat capacity
DF_PNT_DFOil2DFBlock_Heat_Resi_KpW	1	K/W	Heat resistance between D/F oil and D/F block
DF_PNT_DFBlock_Temp_ini_degC	25	℃	D/F block initial temp.
DF_PNT_DFBlock_Heat_Capa_JpK	1000	J/K	D/F block heat capacity
DF_PNT_DFBlock2DFAir_Heat_Resi_KpW	1	K/W	Heat resistance between D/F block and external environment
DF_PNT_Outtemp_degC	25	℃	D/F block external environment temp.
DF_PNT_TMBlock2DFBlock_Heat_Resi_KpW	1	K/W	Heat resistance between T/M block and D/F block
RD_PNT_V_RDFan_x_T_Coolant	<1x6>	℃	Radiator fan voltage map x-temp. of engine coolant
RD_PNT_V_RDFan_V	<1x6>	V	Radiator fan voltage map
RD_PNT_Thermostat_hys_off_Temp_degC	85	℃	Thermostat OFF temp.
RD_PNT_Thermostat_hys_on_Temp_degC	95	℃	Thermostat ON temp.
RD_PNT_Thermostat_min_Heat_Resi_KpW	0.0005	K/W	Thermostat heat resistance min. value
RD_PNT_Thermostat_Heat_Resi_KpW_T_Coolant	<1x8>	℃	Thermostat heat resistance value map x-temp. of engine coolant
RD_PNT_Thermostat_Heat_Resi_KpW	<1x8>	K/W	Thermostat heat resistance value map
RD_PNT_RDCoolant_Temp_ini_degC	25	℃	Coolant initial temp. of inside radiator
RD_PNT_RDCoolant_Heat_Capa_JpK	54000	J/K	Coolant heat capacity of inside radiator
RD_PNT_Outtemp_degC	25	℃	Engine external environment temp.
RD_PNT_v_RDFan_Wind_vel_mps_x_V_RDFan	[0 12]	V	Radiator fan wind speed map x-radiator fan voltage
RD_PNT_v_RDFan_Wind_vel_mps	[0 30]	m/s	Radiator fan wind speed map
RD_PNT_RDFan_area_m2	0.25	m^2	Radiator fan area
RD_PNT_RDGrill_area_m2	0.2	m^2	Radiator grill area
RD_PNT_RDCore_Heat_Resi_KpW_x_Wind_m3ps	<1x6>	m^3/sec	Heat resistance map between radiator and external environment x-radiator air flow
RD_PNT_RDCore_Heat_Resi_KpW	<1x6>	K/W	Heat resistance map between radiator and external environment

5.1.5. Other information

None.

5.2. Functional specification of second-layer model

5.2.1. Functional specification of [A: Driver] system

Refer to chapter 5.2.1 of "Handbook of Plant Modeling I/F Guidelines-Compatible Model for Vehicle Development (Ver. 1.0)".

5.2.2. Functional specification of [B: Vehicle] system

The functional specifications of the second-layer vehicle system of the guidelines-compatible model are described.

5.2.2.1 Abstract

The abstract of this model is shown below.

① Modelized object
The vehicle model for fuel economy evaluation

② Modelized level
The model to calculate fuel economy in the mode-driving

③ Modelized function
The Function to accelerate and decelerate by accelerator and brake input from driver.
The function to calculate fuel consumption in the mode-driving (for dealing with cold start and hot start).
Calculating the fuel injection amount of the powertrain
Calculating the loss and temp. of the powertrain

5.2.2.2 Data flow diagram

The data flow diagram of this system is shown below.

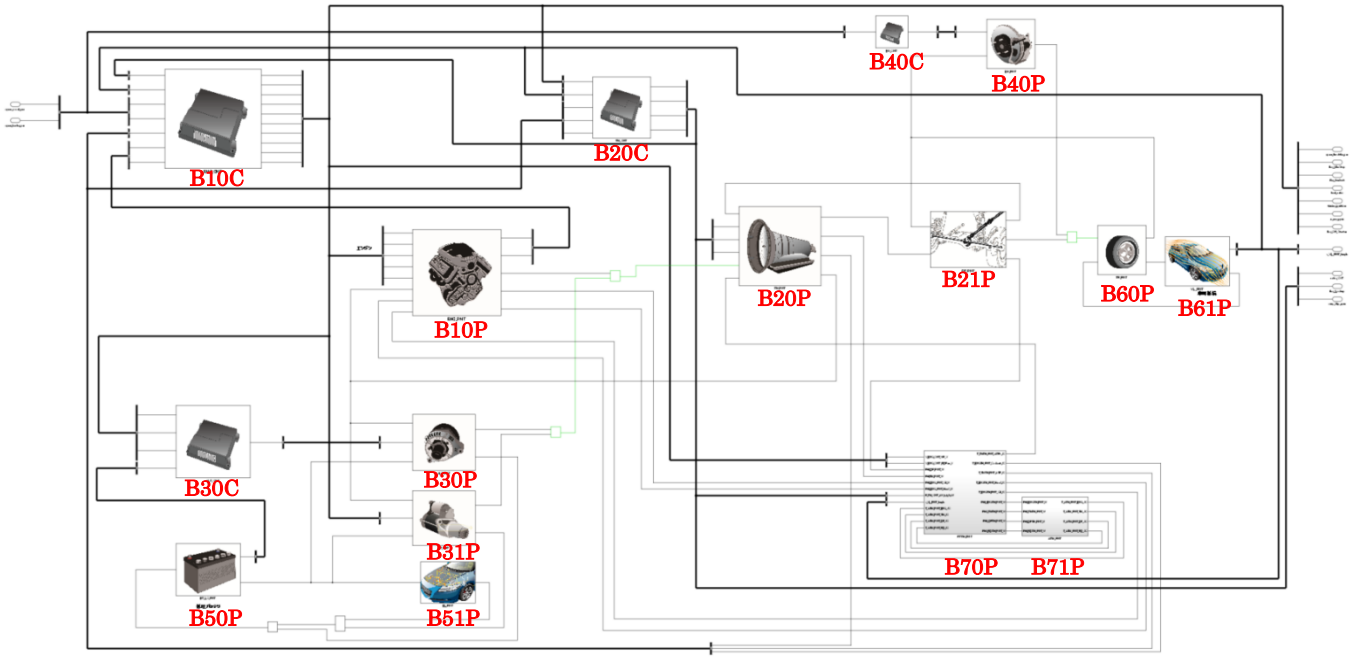


Fig.5.2.2.2. Data flow diagram：second-layer vehicle system

5.2.2.3 Input/output specification

Refer to chapter 5.2.2.3 of “Handbook of Plant Modeling I/F Guidelines-Compatible Model for Vehicle Development (Ver. 1.0)”.

5.2.2.4 Parameter specification

The added items to “Handbook of Plant Modeling I/F Guidelines-Compatible Model for Vehicle Development (Ver. 1.0)” are shown below.

Variable Name	Setting value	Unit	Description
T_ENGCoodant	[25,80,90]	℃	Fuel injection amount additional coefficient map x-temp. of coolant
K_Fuel	[2,1,1]	-	Fuel injection amount additional coefficient map
T_ENGCoodant_T_ENGCoodant	<1x4>	℃	Target idling engine speed rpm map x-temp. of coolant
ENG_CNT_IdleSpeed	<1x4>	rpm	Target idling engine speed rpm map
ENG_CNT_IdleStop_flag_const	80	℃	Idling stop controlled temp. of coolant
ENG_CNT_acc_idlestop	0.5	%	Accelerator condition that idling stop is turned ON (if value is 0.5 or more, OFF)
ENG_PNT_V_Water_Pump_x_T_Coolant	<1x6>	℃	Water pump voltage map x-temp. of coolant
ENG_PNT_V_Water_Pump_V	<1x6>	V	Water pump voltage map
RD_PNT_V_RDFan_x_T_Coolant	<1x6>	℃	Radiator fan voltage map x-temp. of engine coolant
RD_PNT_V_RDFan_V	<1x6>	V	Radiator fan voltage map
TM_CNT_CVTFwarmer_KpW_x_T_CVTF	<1x4>	℃	Cold CVTF warmer heat resistance map x-CVTF temp.
TM_CNT_CVTFwarmer_KpW	<1x4>	K/W	Cold CVTF warmer heat resistance map
TM_CNT_CVTFwarmer_cold_Coolant_KpW	1000	K/W	CVTF warmer heat resistance （CVTF temp. >temp. of coolant）
ENG_PNT_FuelCon_gps_map_x_pri_rpm	<1x13>	rpm	Fuel consumption rate map x-engine rpm
ENG_PNT_FuelCon_gps_map_y_trq_Nm	<1x8>	Nm	Fuel consumption rate map y-engine axial torque
ENG_PNT_FuelCon_gps_map	<8x3>	g/sec	Fuel consumption rate map
ENG_PNT_Heatflux2Cylinder_Head_W_x_rpm	<1x2>	rpm	Cylinder head transfer heat map x-engine rpm
ENG_PNT_Heatflux2Cylinder_Head_W_y_trq	<1x2>	Nm	Cylinder head transfer heat map y-engine torque
ENG_PNT_Heatflux2Cylinder_Head_W	<2x2>	W	Cylinder head transfer heat map
ENG_PNT_Heatflux2Cylinder_Head_gain_x_T_Coolant	<1x2>	℃	Cold cylinder head transfer heat gain map x-head temp.
ENG_PNT_Heatflux2Cylinder_Head_gain	<1x2>	-	Cold cylinder head transfer heat gain map
ENG_PNT_Heatflux2ENGOil_W_x_rpm	<1x2>	rpm	Engine oil transfer heat map x-engine rpm
ENG_PNT_Heatflux2ENGOil_W_y_trq	<1x2>	Nm	Engine oil transfer heat map y-engine torque
ENG_PNT_Heatflux2ENGOil_W	<2x2>	W	Engine oil transfer heat map
ENG_PNT_Heatflux2ENGOil_gain_x_T_ENGOil	[-1 1]	℃	Cold engine oil transfer heat gain map x-temp. of oil
ENG_PNT_Heatflux2ENGOil_gain	[1 1]	-	Cold engine oil transfer heat gain map
ENG_PNT_Cold_friction_gain_x_T_ENGOil	<1x5>	℃	Cold increased friction gain map x-temp. of oil
ENG_PNT_Cold_friction_gain	<1x5>	-	Cold increased friction gain map (1=HOT)
ENG_PNT_Qv_Water_Pump_x_V_WP	<1x5>	V	Water pump flow map x-water pump voltage
ENG_PNT_Qv_Water_Pump_m3ps	<1x5>	m^3/sec	Water pump flow map
ENG_PNT_Cylinder_Head_Temp_ini_degC	25	℃	Cylinder head initial temp.
ENG_PNT_Cylinder_Head_Heat_Capa_JpK	3000	J/K	Cylinder head heat capacity
ENG_PNT_Cylinder_Head2Coolant_Heat_Resi_x_qv_Coolant	<1x4>	m^3/sec	Heat resistance map between cylinder head and coolant x-coolant flow
ENG_PNT_Cylinder_Head2Coolant_Heat_Resi_KpW	<1x4>	K/W	Heat resistance map between cylinder head and coolant
ENG_PNT_ENGOil_Temp_ini_degC	25	℃	Engine oil initial temp.
ENG_PNT_ENGOil_Heat_Capa_JpK	3375	J/K	Engine oil heat capacity
ENG_PNT_ENGOil2Coolant_Heat_Resi_KpW	0.001	K/W	Heat resistance between engine oil and engine coolant

Variable Name	Setting value	Unit	Description
ENG_PNT_Coolant_Temp_ini_degC	25	℃	Engine coolant initial temp.
ENG_PNT_Coolant_Heat_Capa_JpK	39900	J/K	Engine coolant heat capacity
ENG_PNT_Coolant2ENGBlock_Heat_Resi_KpW	0.01	K/W	Heat resistance between engine coolant and engine block
ENG_PNT_ENGBlock_Temp_ini_degC	25	℃	Engine block initial temp.
ENG_PNT_ENGBlock_Heat_Capa_JpK	3000	J/K	Engine block heat capacity
ENG_PNT_ENGBlock2ENGAir_Heat_Resi_KpW	1	K/W	Heat resistance between engine block and external environment
ENG_PNT_Outtemp_degC	25	℃	Engine external environment temp.
TM_PNT_eta_CVT_x_CVTF_degC	<1x4>	℃	CVT loss map x-temp. of CVTF
TM_PNT_eta_CVT	<1x4>	-	CVT loss map
TM_PNT_CVTF_Heat_Capa_JpK	10600	J/K	CVTF heat capacity
TM_PNT_CVTF_Temp_ini_degC	25	℃	CVTF warmer initial temp.
TM_PNT_CVTF2TMBlock_Heat_Resi_KpW	0.001	K/W	Heat resistance between CVTF and T/M block
TM_PNT_TMBlock_Temp_ini_degC	25	℃	T/M block initial temp.
TM_PNT_TMBlock_Heat_Capa_JpK	10000	J/K	T/M block heat capacity
TM_PNT_TMBlock2TMAir_Heat_Resi_KpW	1	K/W	Heat resistance between T/M block and external environment
TM_PNT_Outtemp_degC	25	℃	T/M external environment temp.
TM_PNT_ENGBlock2TMBlock_Heat_Resi_KpW	0.1	K/W	Heat resistance between engine block and T/M block
DF_PNT_DFOil_Temp_ini_degC	25	℃	D/F oil initial temp.
DF_PNT_DFOil_Heat_Capa_JpK	1000	J/K	D/F oil heat capacity
DF_PNT_DFOil2DFBlock_Heat_Resi_KpW	1	K/W	Heat resistance between D/F oil and D/F block
DF_PNT_DFBlock_Temp_ini_degC	25	℃	D/F block initial temp.
DF_PNT_DFBlock_Heat_Capa_JpK	1000	J/K	D/F block heat capacity
DF_PNT_DFBlock2DFAir_Heat_Resi_KpW	1	K/W	Heat resistance between D/F block and external environment
DF_PNT_Outtemp_degC	25	℃	D/F block external environment temp.
DF_PNT_TMBlock2DFBlock_Heat_Resi_KpW	1	K/W	Heat resistance between T/M block and D/F block
RD_PNT_V_RDFan_x_T_Coolant	<1x6>	℃	Radiator fan voltage map x-temp. of engine coolant
RD_PNT_V_RDFan_V	<1x6>	V	Radiator fan voltage map
RD_PNT_Thermostat_hys_off_Temp_degC	85	℃	Thermostat OFF temp.
RD_PNT_Thermostat_hys_on_Temp_degC	95	℃	Thermostat ON temp.
RD_PNT_Thermostat_min_Heat_Resi_KpW	0.0005	K/W	Thermostat heat resistance min. value
RD_PNT_Thermostat_Heat_Resi_KpW_T_Coolant	<1x8>	℃	Thermostat heat resistance value map x-temp. of engine coolant
RD_PNT_Thermostat_Heat_Resi_KpW	<1x8>	K/W	Thermostat heat resistance value map
RD_PNT_RDCoolant_Temp_ini_degC	25	℃	Coolant initial temp. of inside radiator
RD_PNT_RDCoolant_Heat_Capa_JpK	54000	J/K	Coolant heat capacity of inside radiator
RD_PNT_Outtemp_degC	25	℃	Engine external environment temp.
RD_PNT_RDFan_area_m2	0.25	m^2	Radiator fan area
RD_PNT_RDGrill_area_m2	0.2	m^2	Radiator grill area
RD_PNT_RDCore_Heat_Resi_KpW_x_Wind_m3ps	<1x6>	m^3/sec	Heat resistance map between radiator and external environment x-radiator air flow
RD_PNT_RDCore_Heat_Resi_KpW	<1x6>	K/W	Heat resistance map between radiator and external environment

5.2.2.5 Other information

None.

5.2.3. Functional specification of [C: External environment] system

Refer to chapter 5.2.3 of “Handbook of Plant Modeling I/F Guidelines-Compatible Model for Vehicle Development (Ver. 1.0)”.

5.2.4. Functional specification of [D: Monitor] system

The functional specifications of the second-layer monitor system of the guidelines-compatible model are described.

5.2.4.1 Abstract

Refer to chapter 5.2.4.1 of “Handbook of Plant Modeling I/F Guidelines-Compatible Model for Vehicle Development (Ver. 1.0)”.

5.2.4.2 Data flow diagram

The data flow diagram of this system is shown below.

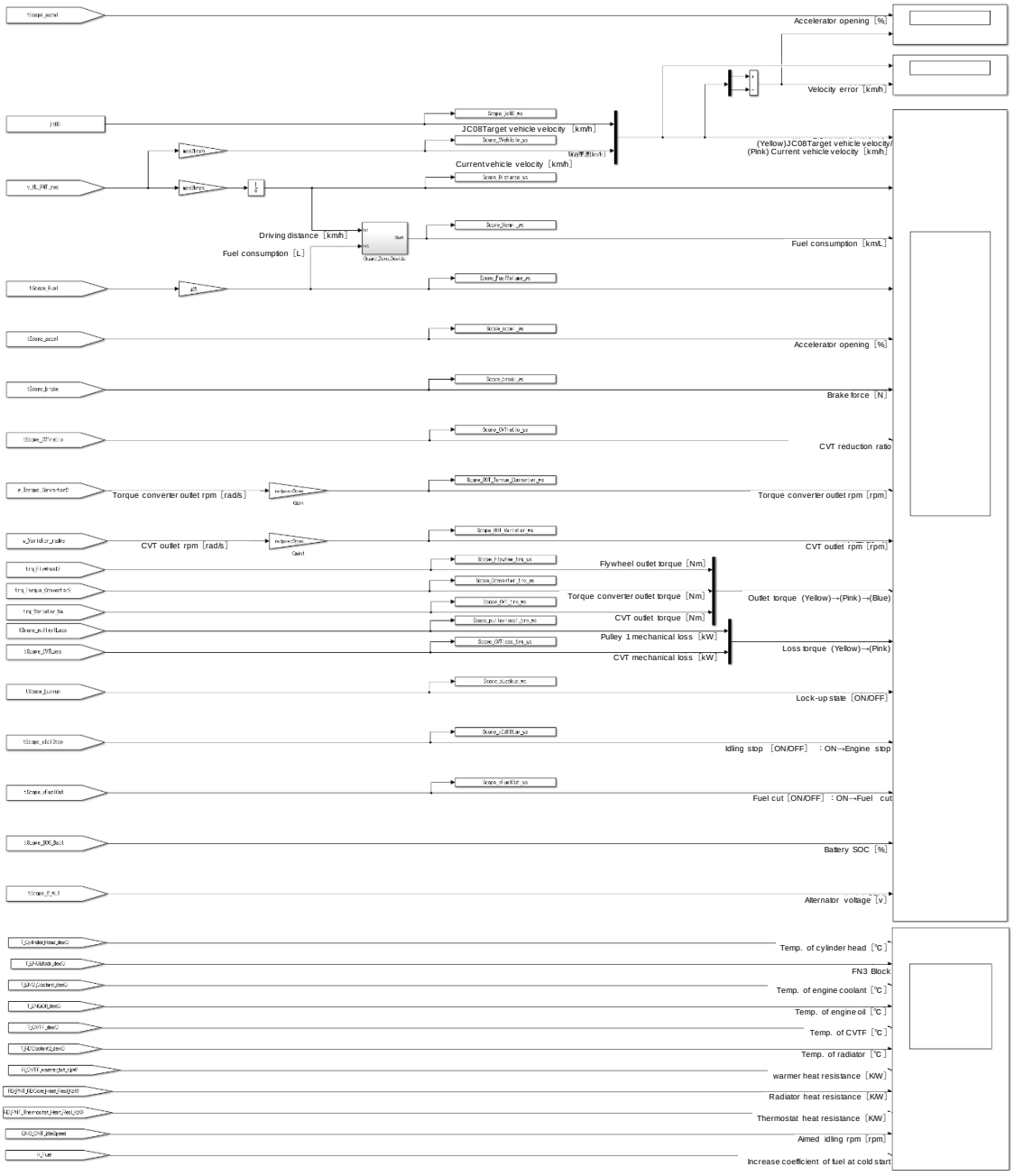


Fig.5.2.4.2. Data flow diagram：second-layer monitor system

5.2.4.3 Input/output specification

The added items to chapter 5.2.4.3 of "Handbook of Plant Modeling I/F Guidelines-Compatible Model for Vehicle Development (Ver. 1.0)" are shown below.

Input			
Name	Unit	Area	Description
T_Cylinder_Head_degC	℃	-	Temp. of cylinder head
T_ENGOil_degC	℃	-	Temp. of engine oil
T_ENG_Coolant_degC	℃	-	Temp. of engine coolant
T_RDCoolant2_degC	℃	-	Temp. of radiator
T_CVTF_degC	℃	-	Temp. of CVTF
T_ENGBlock_degC	℃	-	Temp. of engine block
R_CVTF_warmer_tgt_KpW	K/W	-	CVTF warmer heat resistance value
RD_PNT_RDCore_Heat_Resi_ KpW	K/W	-	Radiator heat resistance value
RD_PNT_Thermostat_Heat_Resi_ KpW	K/W	-	Thermostat heat resistance value
ENG_CNT_IdleSpeed	rpm	-	Target idling engine speed rpm
K_Fuel	-	-	Increase coefficient of fuel injection amount at cold start

5.2.4.4 Parameter specification

No parameter in this system.

5.2.4.5 Other information

None.

5.3. Functional specification of third-layer model

The functional specifications of third-layer of the guidelines-compatible model are described.

5.3.1. Functional specification of [A10: accelerator opening] system

Refer to chapter 5.3.1 of "Handbook of Plant Modeling I/F Guidelines-Compatible Model for Vehicle Development (Ver. 1.0)".

5.3.2. Functional specification of [A20: brake (opening)] system

Refer to chapter 5.3.2 of "Handbook of Plant Modeling I/F Guidelines-Compatible Model for Vehicle Development (Ver. 1.0)".

5.3.3. Functional specification of [B10C: ENG_CNT] system

The functional specifications of the third-layer ENG_CNT system of the guidelines-compatible model are described.

5.3.3.1 Abstract

The abstract of this model is shown below.

① Modelized object
The engine controller ECU model for fuel economy evaluation

② Modelized level
The controller model for fuel economy in the mode-driving

③ Modelized function
The engine rpm control in the idling state
The fuel cut control in the deceleration
The idling stop instruction control
The cold idling rpm control
The cold idling stop prevention control
The cold fuel injection increasing control
The water pump control
The radiator fan control

5.3.3.2 Data flow diagram

The data flow diagram of this system is shown below.

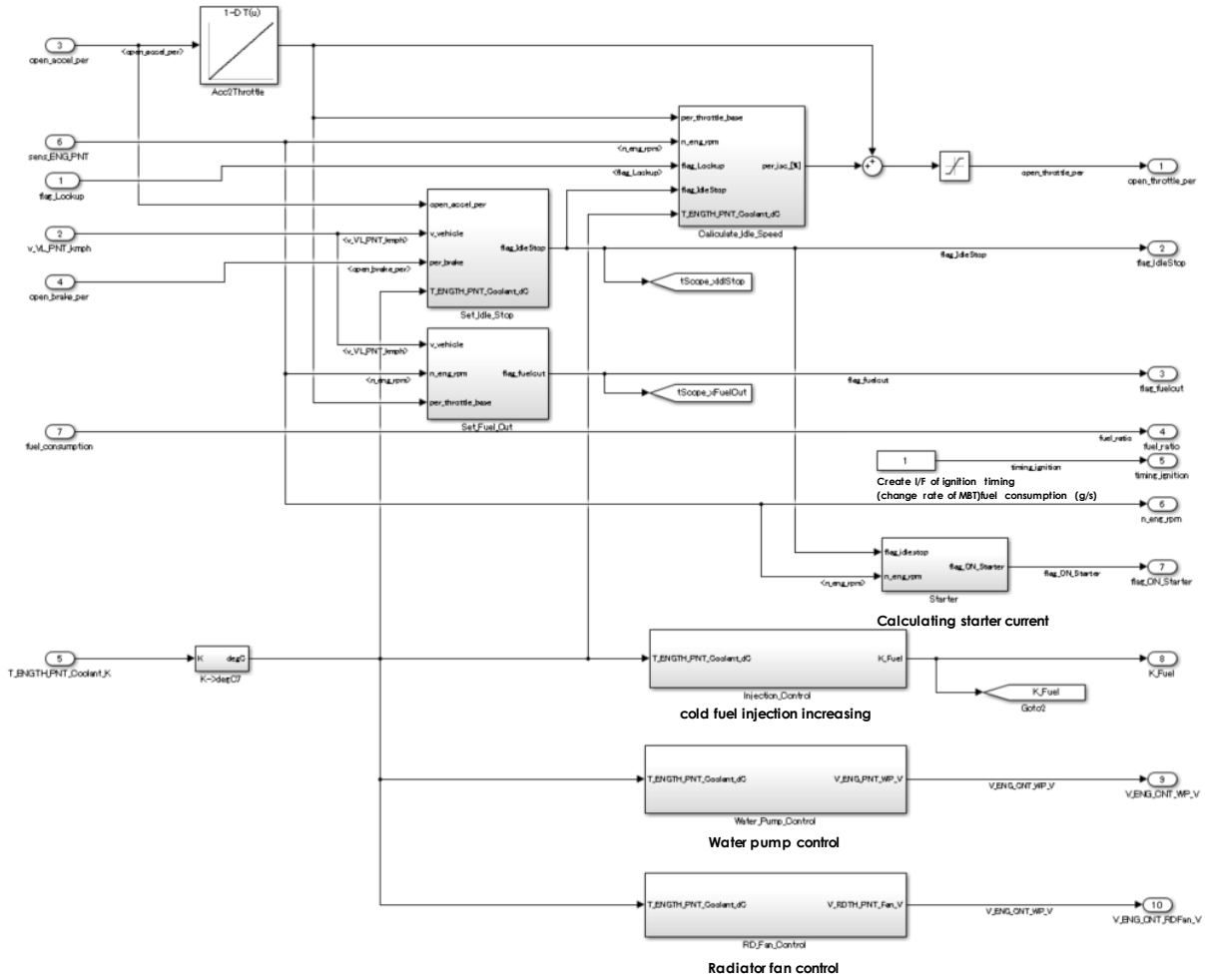


Fig.5.3.3.2. Data flow diagram：third-layer ENG_CNT system

5.3.3.3 Input/output specification

The added items to chapter 5.3.3.3 of "Handbook of Plant Modeling I/F Guidelines-Compatible Model for Vehicle Development (Ver. 1.0)" are shown below.

Input			
Name	Unit	Area	Description
T_ENGTH_PNT_Coolant_K	K	-	Temp. of engine coolant
fuel_consumption	g/s	0 or more	Fuel consumption amount
Output			
Name	Unit	Area	Description
K_Fuel	-	-	Increase coefficient of fuel injection amount at cold start
V_ENG_CNT_WP_V	V	-	Water pump controlled voltage
V_ENG_CNT_RDFan_V	V	-	Radiator fan controlled voltage

5.3.3.4 Parameter specification

The added items to chapter 5.3.3.4 of "Handbook of Plant Modeling I/F Guidelines-Compatible Model for Vehicle Development (Ver. 1.0)" are shown below.

Variable Name	Setting value	Unit	Description
T_ENGCoodant	[25,80,90]	℃	Fuel injection amount additional coefficient map x-temp. of coolant
K_Fuel	[2,1,1]	-	Fuel injection amount additional coefficient map
T_ENGCoodant_T_ENGCoodant	<1x4>	℃	Target idling engine speed rpm map x-temp. of coolant
ENG_CNT_IdleSpeed	<1x4>	rpm	Target idling engine speed rpm map
ENG_CNT_acc_idlestop	0.5	%	Accelerator condition that idling stop is turned ON (if value is 0.5 or more, OFF)
ENG_CNT_IdleStop_flag_const	60	℃	Idling stop restricted temp. of coolant
ENG_PNT_V_Water_Pump_x_T_Coolant	<1x6>	℃	Water pump voltage map x-temp. of coolant
ENG_PNT_V_Water_Pump_V	<1x6>	V	Water pump voltage map
RD_PNT_V_RDFan_x_T_Coolant	<1x6>	℃	Radiator fan voltage map x-temp. of engine coolant
RD_PNT_V_RDFan_V	<1x6>	V	Radiator fan voltage map

5.3.3.5 Other information

None.

5.3.4. Functional specification of [B20C: TM_CNT] system

The functional specifications of the third-layer TM_CNT system of the guidelines-compatible model are described.

5.3.4.1 Abstract

The abstract of this model is shown below.

① Modelized object
The transmission controller ECU model for fuel economy evaluation

② Modelized level
The transmission controller model for fuel economy in the mode-driving

③ Modelized function
The lock up clutch control
The CVT transmission ratio control
The CVT warmer heat resistance control

5.3.4.2 Data flow diagram

The data flow diagram of this system is shown below.

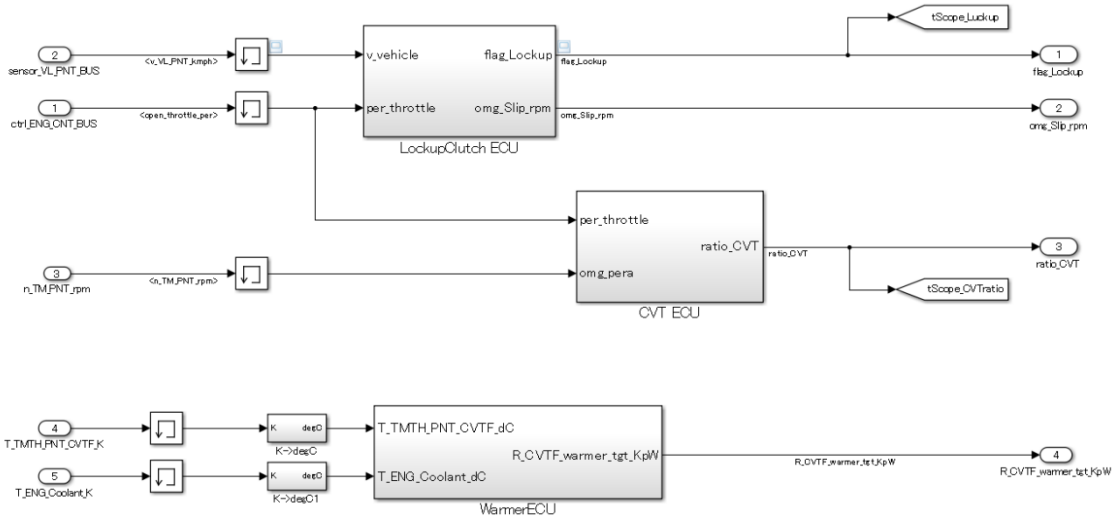


Fig.5.3.4.2. Data flow diagram : third-layer TM_CNT system

5.3.4.3 Input/output specification

The added items to chapter 5.3.4.3 of "Handbook of Plant Modeling I/F Guidelines-Compatible Model for Vehicle Development (Ver. 1.0)" are shown below.

Input			
Name	Unit	Area	Description
T_TMTH_PNT_CVTF_K	K	-	Temp. of CVTF
T_ENGTH_PNT_Coolant_K	K	-	Temp. of engine coolant
Output			
Name	Unit	Area	Description
R_CVTF_warmer_tgt_KpW	K/W	-	CVTF warmer target heat resistance

5.3.4.4 Parameter specification

The added items to chapter 5.3.4.4 of "Handbook of Plant Modeling I/F Guidelines-Compatible Model for Vehicle Development (Ver. 1.0)" are shown below.

Variable Name	Setting value	Unit	Description
TM_CNT_CVTFwarmer_KpW_x_T_ENGCoolant	<1x4>	℃	Cold CVTF warmer heat resistance map x-temp. of coolant
TM_CNT_CVTFwarmer_KpW	<1x4>	K/W	Cold CVTF warmer heat resistance map
TM_CNT_CVTFwarmer2_KpW_x_T_CVTF	<1x4>	℃	CVTF warmer heat resistance map at temp. of CVTF >temp. of coolant x-CVTF temp.
TM_CNT_CVTFwarmer2_KpW	<1x4>	K/W	CVTF warmer heat resistance map at temp. of CVTF >temp. of coolant
TM_CNT_CVTFwarmer_cold_Coolant_KpW	1000	K/W	CVTF warmer heat resistance (temp. of CVTF > temp. of coolant)

5.3.4.5 Other information

None.

5.3.5. Functional specification of [B30C: ALT_CNT] system

Refer to chapter 5.3.5 of "Handbook of Plant Modeling I/F Guidelines-Compatible Model for Vehicle Development (Ver. 1.0)".

5.3.6. Functional specification of [B40C: BK_CNT] system

Refer to chapter 5.3.6 of "Handbook of Plant Modeling I/F Guidelines-Compatible Model for Vehicle Development (Ver. 1.0)".

5.3.7. Functional specification of [B10P: ENG_PNT] system

The functional specifications of the third-layer ENG_PNT system of the guidelines-compatible model are described.

5.3.7.1 Abstract

The abstract of this model is shown below.

① Modelized object
The engine model for fuel economy evaluation

② Modelized level
The model to calculate the torque output and fuel consumption

③ Modelized function
The engine shaft torque output
Calculating the fuel consumption
Calculating the heat flow of the engine oil and cylinder head
Calculating the increase of the cold friction

5.3.7.2 Data flow diagram

The data flow diagram of this system is shown below.

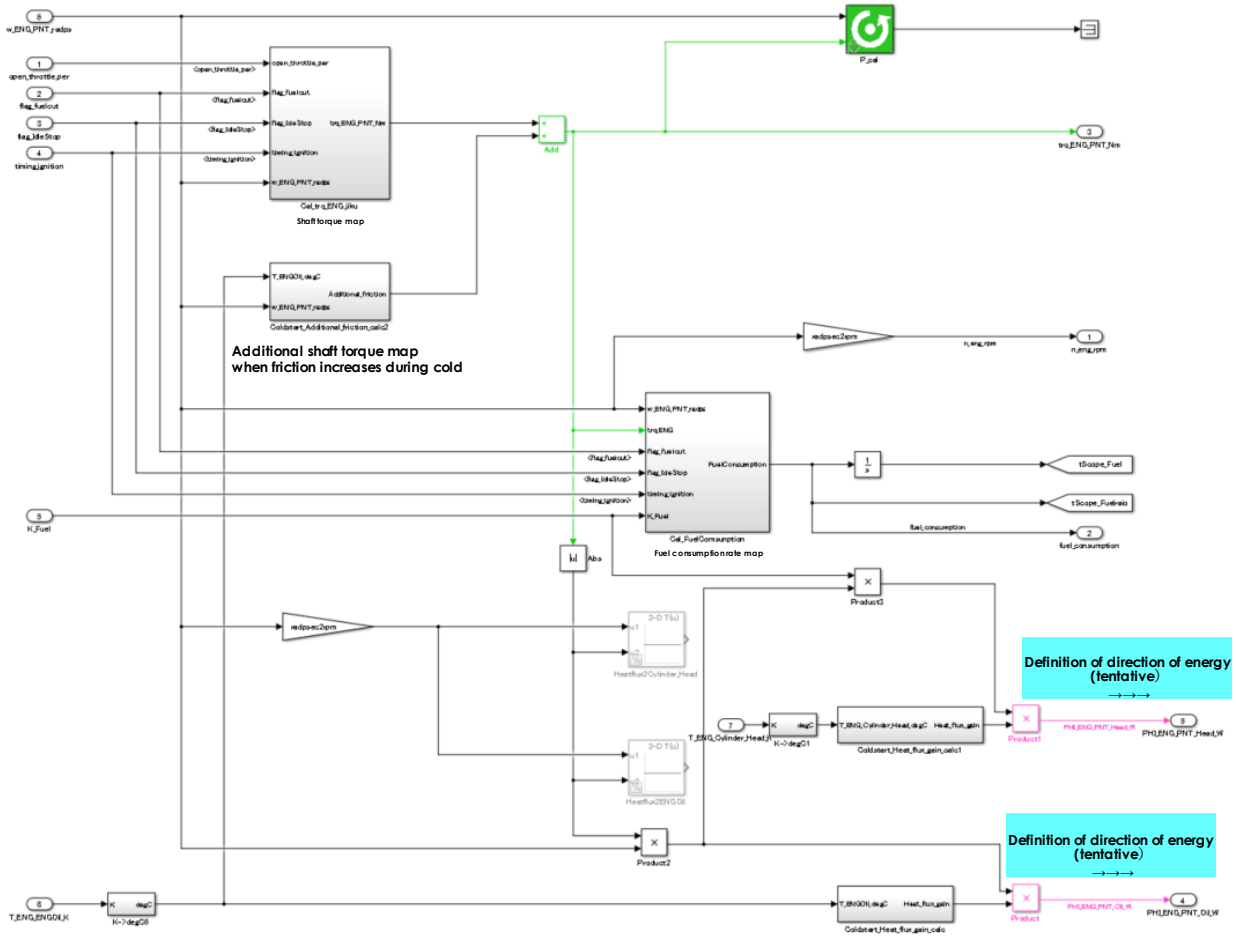


Fig.5.3.7.2. Data flow diagram：third-layer ENG_PNT system

5.3.7.3 Input/output specification

The added items to chapter 5.3.7.3 of "Handbook of Plant Modeling I/F Guidelines-Compatible Model for Vehicle Development (Ver. 1.0)" are shown below.

Input			
Name	Unit	Area	Description
K_Fuel	-	-	Increase coefficient of fuel injection amount at cold start
T_ENGTH_PNT_Head_K	K	-	Temp. of cylinder head
T_ENGTH_PNT_Oil_K	K	-	Temp. of engine oil
Output			
Name	Unit	Area	Description
fuel_consumption	g/s	0 or more	Fuel consumption
PHI_ENG_PNT_Head_W	W	-	Cylinder head heat flow
PHI_ENG_PNT_Oil_W	W	-	Engine oil heat flow

5.3.7.4 Parameter specification

The added items to chapter 5.3.7.4 of "Handbook of Plant Modeling I/F Guidelines-Compatible Model for Vehicle Development (Ver. 1.0)" are shown below.

Variable Name	Setting value	Unit	Description
ENG_PNT_Cold_friction_gain_x_T_ENGOil	<1x5>	℃	Cold increased friction gain map x-temp. of oil
ENG_PNT_Cold_friction_gain	<1x5>	-	Cold increased friction gain map (1=HOT)
ENG_PNT_Heatflux2Cylinder_Head_gain_x_T_Coolant	<1x2>	℃	Cold cylinder head transfer heat gain map x-temp. of head
ENG_PNT_Heatflux2Cylinder_Head_gain	<1x2>	-	Cold cylinder head transfer heat gain map
ENG_PNT_Heatflux2ENGOil_gain_x_T_ENGOil	[-1 1]	℃	Cold engine oil transfer heat gain map x-temp. of oil
ENG_PNT_Heatflux2ENGOil_gain	[1 1]	-	Cold engine oil transfer heat gain map

5.3.7.5 Other information

None.

5.3.8. Functional specification of [B20P: TM_PNT] system

The functional specifications of the third-layer TM_PNT system of the guidelines-compatible model are described.

5.3.8.1 Abstract

The abstract of this model is shown below.

① Modelized object
The transmission model for fuel economy evaluation

② Modelized level
The gear changing function in the inertia and transmission

③ Modelized function
The engine and D/F inertia of the transmission
The gear changing function by the torque converter
The gear changing function by the CVT
Calculating the torque loss and heat flow by the CVT efficiency
The lock-up function of the torque converter by the lock-up clutch

5.3.8.2 Data flow diagram

The data flow diagram of this system is shown below.

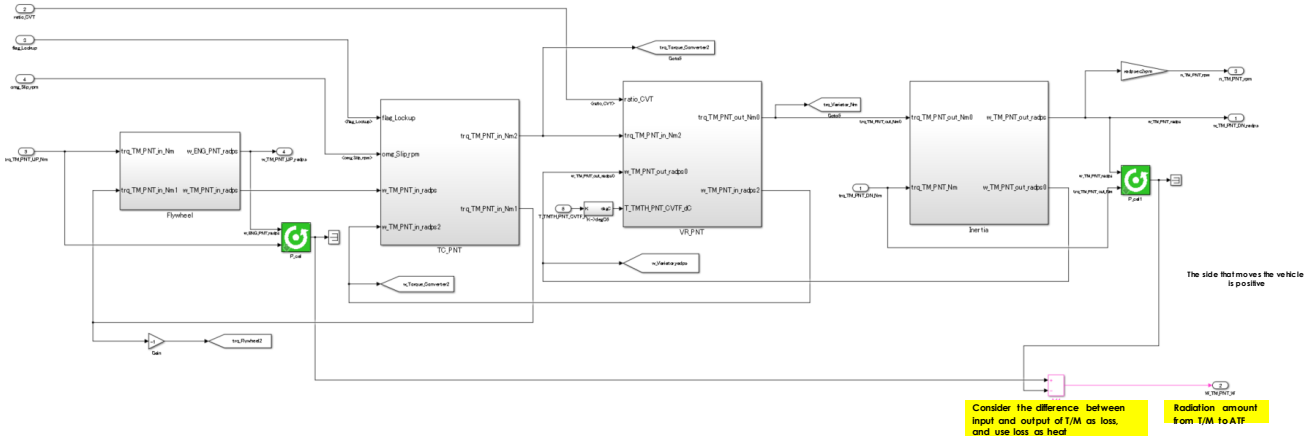


Fig.5.3.8.2. Data flow diagram：third-layer TM_PNT system

5.3.8.3 Input/output specification

The added items to chapter 5.3.8.3 of “Handbook of Plant Modeling I/F Guidelines-Compatible Model for Vehicle Development (Ver. 1.0)” are shown below.

Input			
Name	Unit	Area	Description
T_TMTH_PNT_CVTF_K	K	-	Temp. of CVTF
Output			
Name	Unit	Area	Description
PHI_TM_PNT_W	W	-	CVTF heat flow

5.3.8.4 Parameter specification

The added items to chapter 5.3.8.4 of "Handbook of Plant Modeling I/F Guidelines-Compatible Model for Vehicle Development (Ver. 1.0)" are shown below.

Variable Name	Setting value	Unit	Description
TM_PNT_eta_CVT_x_CVTF_degC	<1x4>	℃	CVT efficiency map x- temp. of CVTF
TM_PNT_eta_CVT	<1x4>	-	CVT efficiency map

5.3.8.5 Other information

None.

5.3.9. Functional specification of [B21P: DF_PNT] system

The functional specifications of the third-layer DF_PNT system of the guidelines-compatible model are described.

5.3.9.1 Abstract

The abstract of this model is shown below.

① Modelized object
The D/F gear model for fuel economy evaluation

② Modelized level
The transmission mechanism reflected the transmission efficiency in the mode-driving

③ Modelized function
The gear changing function by the D/F gear ratio
Calculating the torque loss and amount of heat generation by the D/F gear efficiency

5.3.9.2 Data flow diagram

The data flow diagram of this system is shown below.

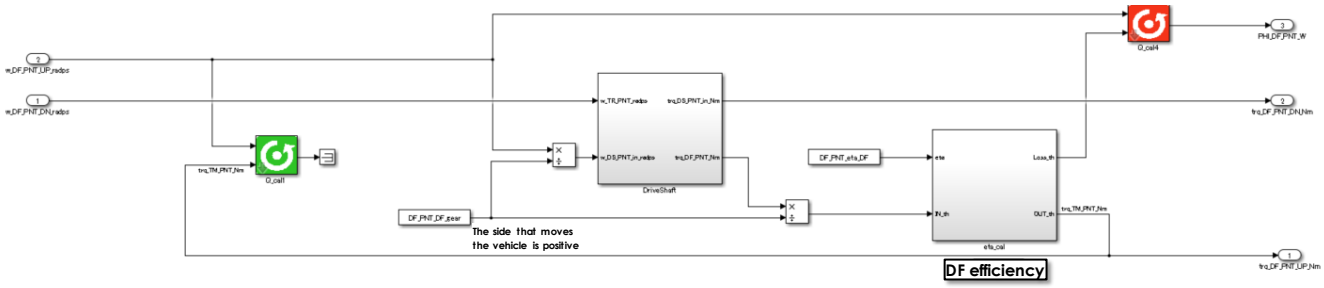


Fig.5.3.9.2. Data flow diagram：third-layer DF_PNT system

5.3.9.3 Input/output specification

The added items to chapter 5.3.9.3 of “Handbook of Plant Modeling I/F Guidelines-Compatible Model for Vehicle Development (Ver. 1.0)” are shown below.

Output			
Name	Unit	Area	Description
PHI_DF_PNT_W	W	-	D/F heat flow

5.3.9.4 Parameter specification

Refer to chapter 5.3.9.4 of “Handbook of Plant Modeling I/F Guidelines-Compatible Model for Vehicle Development (Ver. 1.0)”.

5.3.9.5 Other information

None.

5.3.10. Functional specification of [B30P: ALT_PNT] system

Refer to chapter 5.3.10 of “Handbook of Plant Modeling I/F Guidelines-Compatible Model for Vehicle Development (Ver. 1.0)”.

5.3.11. Functional specification of [B31P: ST_PNT] system

Refer to chapter 5.3.11 of “Handbook of Plant Modeling I/F Guidelines-Compatible Model for Vehicle Development (Ver. 1.0)”.

5.3.12. Functional specification of [B40P: BK_PNT] system

Refer to chapter 5.3.12 of “Handbook of Plant Modeling I/F Guidelines-Compatible Model for Vehicle Development (Ver. 1.0)”.

5.3.13. Functional specification of [B50P: BT_PNT_Lo] system

Refer to chapter 5.3.13 of “Handbook of Plant Modeling I/F Guidelines-Compatible Model for Vehicle Development (Ver. 1.0)”.

5.3.14. Functional specification of [B51P: EL_PNT] system

Refer to chapter 5.3.14 of “Handbook of Plant Modeling I/F Guidelines-Compatible Model for Vehicle Development (Ver. 1.0)”.

5.3.15. Functional specification of [B60P: TR_PNT] system

Refer to chapter 5.3.15 of “Handbook of Plant Modeling I/F Guidelines-Compatible Model for Vehicle Development (Ver. 1.0)”.

5.3.16. Functional specification of [B61P: VL_PNT] system

Refer to chapter 5.3.16 of “Handbook of Plant Modeling I/F Guidelines-Compatible Model for Vehicle Development (Ver. 1.0)”.

5.3.17. Functional specification of [B70P: PTTH_PNT] system

The functional specifications of the third-layer PTTH_PNT system of the guidelines-compatible model are described.

5.3.17.1 Abstract

The abstract of this model is shown below.

① Modelized object

The engine, transmission and high temperature cooling system model for fuel economy evaluation

② Modelized level

The heat capacity and heat resistance of the engine, transmission, D/F and high temperature cooling system

③ Modelized function

Calculating the temperature of the engine, transmission, D/F and high temperature cooling system

5.3.17.2 Data flow diagram

The data flow diagram of this system is shown below.

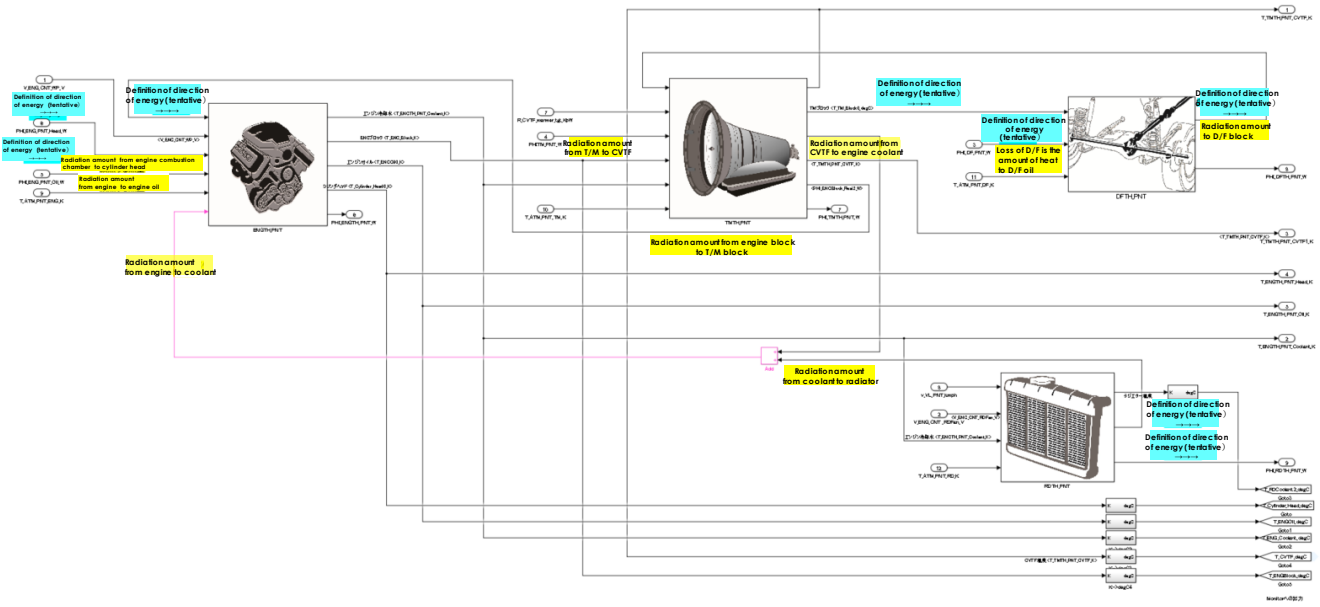


Fig.5.3.17.2. Data flow diagram：third-layer PTTH_PNT system

5.3.17.3 Input/output specification

The input/output specification of this system is shown below.

Input			
Name	Unit	Area	Description
V_ENG_CNT_WP_V	V	-	Water pump control voltage
V_ENG_CNT_RDFan_V	V	-	Radiator fan control voltage
PHI_DF_PNT_W	W	-	D/F block heat flow
PHI_TM_PNT_W	W	-	CVTF heat flow
PHI_ENG_PNT_Head_W	W	-	Cylinder head heat flow
PHI_ENG_PNT_Oil_W	W	-	Engine oil heat flow
R_CVTF_warmer_tgt_KpW	K/W	-	CVTF warmer target heat resistance
v_VL_PNT_kmph	km/h	[0 200]	Vehicle velocity
T_ATM_PNT_ENG_K	K	-	Ambient temp. around engine
T_ATM_PNT_TM_K	K	-	Ambient temp. around T/M
T_ATM_PNT_DF_K	K	-	Ambient temp. around D/F
T_ATM_PNT_RD_K	K	-	Ambient temp. around high temp. cooling system
Output			
Name	Unit	Area	Description
T_TMTH_PNT_CVTF_K	K	-	Temp. of CVTF
T_TMTH_PNT_CVTF1_dC	K	-	Temp. of CVTF
T_ENGTH_PNT_Head_K	K	-	Temp. of cylinder head
T_ENGTH_PNT_Oil_K	K	-	Temp. of engine oil
T_ENGTH_PNT_Coolant_dC	K	-	Temp. of engine coolant
PHI_ENGTH_PNT_W	W	-	Engine heat flow
PHI_TMTH_PNT_W	W	-	T/M heat flow
PHI_DFTH_PNT_W	W	-	D/F heat flow
PHI_RDTH_PNT_W	W	-	Heat flow of high temp.cooling system

5.3.17.4 Parameter specification

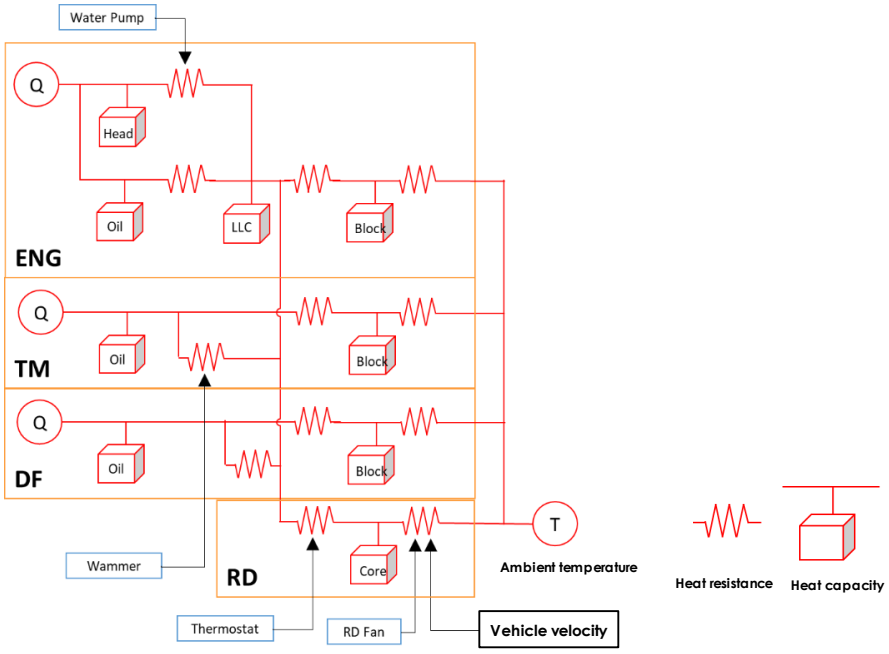
The parameter specification of this model is shown below.

Variable Name	Setting value	Unit	Description
PTTH_PNT_Temp_ini_degC	-	℃	Each part initial temp. (cold start 25, hot start 85)
ENG_PNT_Qv_Water_Pump_x_V_WP	<1x5>	V	Water pump flow map x-water pump voltage
ENG_PNT_Qv_Water_Pump_m3ps	<1x5>	m^3/sec	Water pump flow map
ENG_PNT_Cylinder_Head_Temp_ini_degC	-	℃	Cylinder head initial temp. (=PTTH_PNT_Temp_ini_degC)
ENG_PNT_Cylinder_Head_Heat_Capa_JpK	3000	J/K	Cylinder head heat capacity
ENG_PNT_Cylinder_Head2Coolant_Heat_Resi_x_qv_Coolant	<1x4>	m^3/sec	Heat resistance map between cylinder head and coolant x-coolant flow
ENG_PNT_Cylinder_Head2Coolant_Heat_Resi_KpW	<1x4>	K/W	Heat resistance map between cylinder head and coolant
ENG_PNT_ENGOil_Temp_ini_degC	-	℃	Engine oil initial temp. (=PTTH_PNT_Temp_ini_degC)
ENG_PNT_ENGOil_Heat_Capa_JpK	3375	J/K	Engine oil heat capacity
ENG_PNT_ENGOil2Coolant_Heat_Resi_KpW	0.001	K/W	Heat resistance between engine oil and engine coolant
ENG_PNT_Coolant_Temp_ini_degC	-	℃	Engine coolant initial temp. (=PTTH_PNT_Temp_ini_degC)
ENG_PNT_Coolant_Heat_Capa_JpK	39900	J/K	Engine coolant heat capacity
ENG_PNT_Coolant2ENGBlock_Heat_Resi_KpW	0.01	K/W	Heat resistance between engine coolant and engine block
ENG_PNT_ENGBlock_Temp_ini_degC	-	℃	Engine block initial temp. (=PTTH_PNT_Temp_ini_degC)
ENG_PNT_ENGBlock_Heat_Capa_JpK	3000	J/K	Engine block heat capacity

Variable Name	Setting value	Unit	Description
ENG_PNT_ENGBlock2ENGAir_Heat_Resi_KpW	1	K/W	Heat resistance between engine block and external environment
TM_PNT_CVTF_Heat_Capa_JpK	10600	J/K	CVTF heat capacity
TM_PNT_CVTF _Temp_ini_degC	-	℃	CVTF initial temp.（=PTTH_PNT_Temp_ini_degC）
TM_PNT_CVTF 2TMBlock_Heat_Resi_KpW	0.001	K/W	Heat resistance between CVTF and T/M
TM_PNT_TMBlock_Temp_ini_degC	-	℃	T/M block initial temp. （=PTTH_PNT_Temp_ini_degC）
TM_PNT_TMBlock_Heat_Capa_JpK	10000	J/K	T/M block heat capacity
TM_PNT_TMBlock2TMAir_Heat_Resi_KpW	1	K/W	Heat resistance between T/M block and external environment
TM_PNT_ENGBlock2TMBlock_Heat_Resi_KpW	0.1	K/W	Heat resistance between engine block and T/M block
DF_PNT_DFOil_Temp_ini_degC	-	℃	D/F oil initial temp.（=PTTH_PNT_Temp_ini_degC）
DF_PNT_DFOil_Heat_Capa_JpK	1000	J/K	D/F oil heat capacity
DF_PNT_DFOil2DFBlock_Heat_Resi_KpW	1	K/W	Heat resistance between D/F oil and D/F block
DF_PNT_DFBlock_Temp_ini_degC	-	℃	D/F block initial temp. （=PTTH_PNT_Temp_ini_degC）
DF_PNT_DFBlock_Heat_Capa_JpK	1000	J/K	D/F block heat capacity
DF_PNT_DFBlock2DFAir_Heat_Resi_KpW	1	K/W	Heat resistance between D/F block and external environment
DF_PNT_TMBlock2DFBlock_Heat_Resi_KpW	1	K/W	Heat resistance between T/M block and D/F block
RD_PNT_Thermostat_hys_off_Temp_degC	85	℃	Thermostat OFF temp.
RD_PNT_Thermostat_hys_on_Temp_degC	95	℃	Thermostat ON temp.
RD_PNT_Thermostat_Heat_Resi_KpW_T_Coolant	<1x8>	℃	Thermostat heat resistance value map x-temp. of engine coolant
RD_PNT_Thermostat_Heat_Resi_KpW	<1x8>	K/W	Thermostat heat resistance value map
RD_PNT_RDCoolant_Temp_ini_degC	-	℃	Coolant initial temp. of radiator inside （=PTTH_PNT_Temp_ini_degC）
RD_PNT_RDCoolant_Heat_Capa_JpK	54000	J/K	Coolant heat capacity radiator inside
RD_PNT_RDFan_area_m2	0.25	m^2	Radiator fan area
RD_PNT_RDGrill_area_m2	0.2	m^2	Radiator grill area
RD_PNT _v_RDFan_Wind_vel_mps	[0 30]	m/s	Radiator fan wind velocity map
RD_PNT _v_RDFan_Wind_vel_mps_x_V_RDFan	[0 12]	v	Radiator fan wind velocity map x-controlled voltage
RD_PNT_RDCore_Heat_Resi_KpW_x_Wind_m3ps	<1x6>	m^3/sec	Heat resistance map between radiator and external environment x-radiator air flow
RD_PNT_RDCore_Heat_Resi_KpW	<1x6>	K/W	Heat resistance map between radiator and external environment

5.3.17.5 Other information

The equivalent circuit diagram of this model is shown below as a reference.



5.3.18. Functional specification of [B71P: ATM_PNT] system

The functional specifications of the third-layer ATM_PNT system of the guidelines-compatible model are described.

5.3.18.1 Abstract

The abstract of this model is shown below.

① Modelized object
The heatsink model for fuel economy evaluation

② Modelized level
The ambient temperature around the engine compartment

③ Modelized function
The output of the ambient temperature around the engine, transmission, D/F and high temperature cooling system
The absorption of amount of the heat generation of the engine, transmission, D/F and high temperature cooling system

5.3.18.2 Data flow diagram

The data flow diagram of this system is shown below.

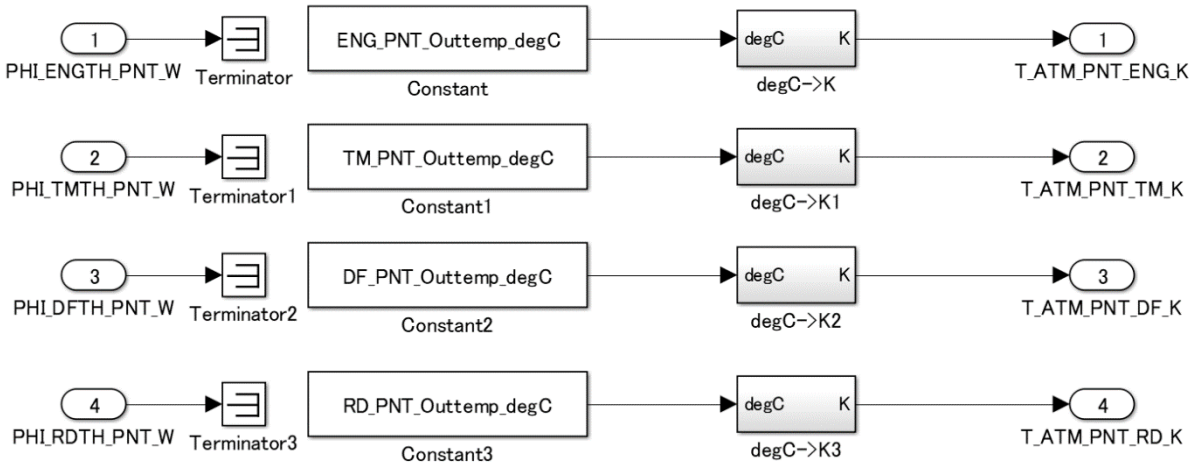


Fig. 5.3.18.2. Data flow diagram：third-layer ATM_PNT system

5.3.18.3 Input/output specification

The input/output specification of this system is shown below.

Input			
Name	Unit	Area	Description
PHI_ENGTH_PNT_ W	W	-	Engine heat flow
PHI_TMTH_PNT_ W	W	-	T/M heat flow
PHI_DFTH_PNT_ W	W	-	D/F heat flow
PHI_RDTH_PNT _W	W	-	Heat flow of high temp. cooling system
Output			
Name	Unit	Area	Description
T_ATM_PNT_ENG_K	K	-	Ambient temp. around engine
T_ATM_PNT_TM_K	K	-	Ambient temp. around T/M
T_ATM_PNT_DF_K	K	-	Ambient temp. around D/F
T_ATM_PNT_RD_K	K	-	Ambient temp. around high temp. cooling system

5.3.18.4 Parameter specification

The parameter specification of this model is shown below.

Variable Name	Setting value	Unit	Description
ENG_PNT_Outtemp_degC	25	℃	Ambient temp. around engine
TM_PNT_Outtemp_degC	25	℃	Ambient temp. around T/M
DF_PNT_Outtemp_degC	25	℃	Ambient temp. around D/F
RD_PNT_Outtemp_degC	25	℃	Ambient temp. around high temp. cooling system

5.3.18.5 Other information

None.

5.3.19. Others

Input / output whose name have been changed are shown in below.

New name	Old name	Unit	Object model
target_v_VL_kmph	V_tgt	km/h	First-layer, accelerator opening, brake opening
open_throttle_ per	per_throttle	%	First-layer, Vehicle, ENG CNT, TM_CNT, ENG_PNT
open_accel_per	per_acc	%	Vehicle, accelerator opening, brake opening, ENG_CNT
open_brake_per	per_brake	%	Vehicle, brake opening, ENG_CNT, BK_CNT, BK_PNT
target_volt_ALT_V	V_ALT_tgt	V	ALT_PNT
w_TR_PNT_UP_radps	w_DF_PNT_rad/s	rad/s	BK_PNT
I_BT_Lo_PNT_A	I_Chg_Lo_BT	A	BT_LO_PNT
trq_TR_PNT_UP_Nm	Trq_TR_Nm	Nm	TR_PNT
w_TR_PNT_UP_radps	w_TR_PNT_radps	rad/s	TR_PNT
F_TR_PNT_DN_N	F_TR_PNT_N	N	TR_PNT,VL_PNT

6. Description in this model

Refer to Chapter 6 of “Handbook of Plant Modeling I/F Guidelines-Compatible Model for Vehicle Development (Ver. 1.0)” except for 6.4 naming 6.4.2 subsystem name.

6.1. Subsystem name

The list of subsystem names is described below.

Table 6.1. Subsystem name

First-layer			Second-layer			Third-layer			Fourth-layer		
Part	Notation	abbreviation	Part	Notation	abbreviation	Part	Notation	abbreviation	Part	Notation	abbreviation
Driver	Driver										
Vehicle	Vehicle		Vehicle control	VehicleController	VC	Engine control	EngineControl	ENG_CNT			
						Transmission control	TransmissionControl	TM_CNT			
						Brake control	BrakeControl	BK_CNT			
						Alternator control	AlternatorControl	ALT_CNT			
			Vehicle plant	VehicleBody	VB	Engine	Engine	ENG_PNT			
						Transmission	Transmission	TM_PNT	Torque converter	TorqueConverter	TC_PNT
									Lock up clutch	LockUpClutch	LU_PNT
									Variator	Variator	VR_PNT
						Differential gear	DifferentialGear	DF_PNT			
						Tire	Tire	TR_PNT			
						Brake	Brake	BK_PNT			
						Load vehicle	VehicleLoad	VL_PNT			
						Power train thermal	PowerTrainThermal	PTTH_PNT	Engine thermal	EngineThermal	ENGTH_PNT
									Transmission thermal	TransmissionThermal	TMTH_PNT
									Differential gear thermal	DifferentialGearThermal	DFTH_PNT
									Radiator thermal	RadiatorThermal	RDTH_PNT
						Heatsink (atmosphere)	Atmosphere	ATM_PNT			
						Battery	Battery	BT_LO_PNT			
						Alternator	Alternator	ALT_PNT			
						Starter	Starter	ST_PNT			
						Electrical Load	ElectricalLoad	EL_PNT			
Environment Monitor	Environment Monitor										

7. Reference document

[1] “非因果モデリングツールを用いた FMI モデル接続ガイドライン Ver.1.0”(Society of Automotive Engineers of Japan) *Japanese only
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