Configuration File Generator for RL78 Motor Control Sample Software

User's Manual

Summary

This application note explains how to use the Configuration File Generator for the RL78 motor control sample code. Read the document carefully in order to use the software correctly. This tool is made for the purpose of supporting the redesign of various parameters of the sample software, but it does not completely guarantee the operation. Please use it with great care. No liability shall be accepted for any consequences arising from the use of this tool.

Contents

1. Overview of the Configuration File Generator for the RL78 motor control sample code

The Configuration File Generator (CFG) for the RL 78 motor control sample software sets fixed points and various parameters for inverters and motors, which are evaluation environments for the RL 78 family motor control microcomputer (RL 78/G 14, G1F) sample software. CFG is a tool that supports parameter setting in conjunction with changes in the motors and inverters.

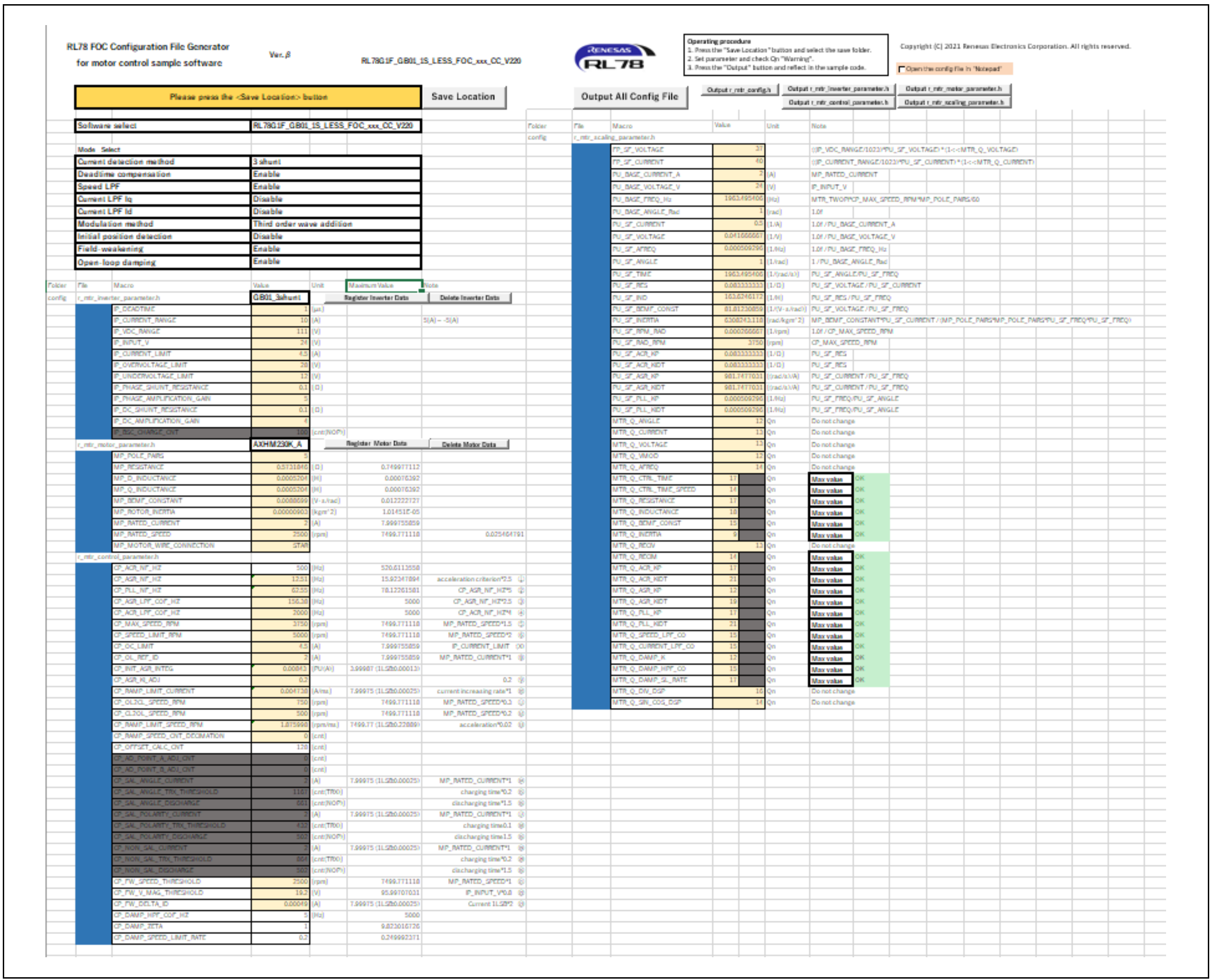


Figure 1-1 RL78 FOC Configuration File Generator Display Screen

1.1 Functions

CFG has the following functions.

● Registering motor inverter characteristic parameters

● Setting control parameters for the target sample code and calculating scaling parameters (Fixed point)

● Creating configuration files for the target sample code

CFG is a tool for motor control sample code released on our website. Download and use the sample code from the RL78 Motor Control Solutions page.

(RL78 Motor Control Solutions | Renesas)

The sample code has various types of parameters set in the following files for specific motors and inverters. When changing motors or inverters, it is necessary to reset each type of parameter in these files.

● r_mtr_config.h: Configuration definition file

● r_mtr_control_parameter.h: Control parameter definition file

● r_mtr_inverter_parameter.h: Inverter parameter definition file

● r_mtr_motor_parameter.h: Motor parameter definition file

● r_mtr_scaling_parameter.h: Scaling parameter definition file

CFG is a tool that supports the creation of these files.

This tool cannot create microcontroller setting of register and pin assignments. Please set appropriately according to the specifications of your system.

1.2 System requirements

The system requirements needed for operating CFG are shown below.

Table 1-1 System requirements

Item	Content
OS	Windows 10
Software	Microsoft Excel 2007 or later

1.3 Procedures for use of CFG

The procedures for creating configuration files and operating sample code for different motors and converters are described below.

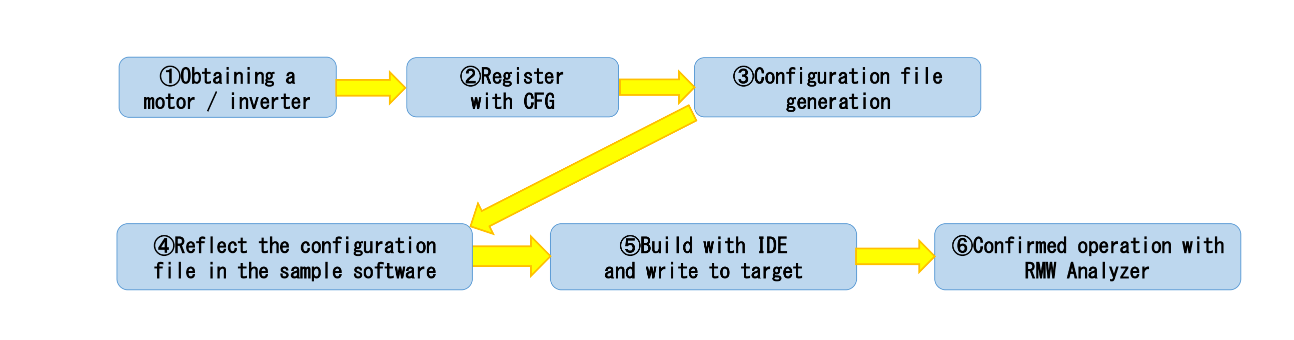


Figure 1-2 Procedures for changing motors and inverters in the sample code

1. Obtain a permanent magnetic synchronous motor and inverter.

   If the inverter does not have the same pin assignments or register settings as the evaluation board supporting the sample code, it is necessary to reconfigure the register separately.

2. Register the motor inverter characteristic parameters in the CFG.

   See the data sheet for the characteristic parameters of the motor or use the Renesas Motor Workbench (RMW) tuner function.

3. Create the configuration file.

   Sample code corresponding to the CFG is listed in Section 1.4.

4. Have the configuration file be reflected in the sample code.

   Write over the file in the sample code "config" folder.

5. Build the project in IDE and save it in the target.

   Rebuild the project by using an IDE (CS+, e^2 studio) that corresponds to the sample code, and write it to the target MCU.

6. Check the operation using the RMW Analyzer.

   The motor control sample code corresponds to the debugging tool Renesas Motor Workbench (RMW). It is possible to check the operation using the RWM Analyzer. See the relevant manual for how to operate RMW.

Detailed CFG instructions are described in Chapter 3.

1.4 CFG versions and target software

CFG are available for each sample code (control method). Use the CFG corresponding to the sample code used.

- For sensorless vector control:

  RL78 FOC Configuration File Generator for motor control sample software ver. β

  Target software:

  Sensorless vector control for RL78/G1F permanent magnet synchronous motor

  - 1 shunt current detection method

  (R01AN3992JJ0220) RL78G1F_GB01_1S_LESS_FOC_xxx_CC_V220

1.5 Reference

- Renesas Motor Workbench 2.0 User's Manual (R21UZ0004JJ0201: Renesas-Motor-Workbench-V2-0f)
- RL78/G1F CPU Card User's Manual (R12UZ0014EJ0100)
- RL78/G1F Motor Driver Board GB01 User's Manual (R12UT0012JJ0100)
- Sensorless vector control - 1 shunt current detection method for RL78/G1F permanent magnet synchronous motor (R01AN3992JJ0220)

2. CFG function descriptions

CFG is created as an Excel file using Excel macros. Here are descriptions of each of the functions on a "RL78_CFG" sheet.

2.1 Descriptions of "RL78_CFG" sheets

"RL78_CFG" sheets are used to register motor and inverter characteristic parameters, calculate control parameters and scaling parameters, and create configuration files.

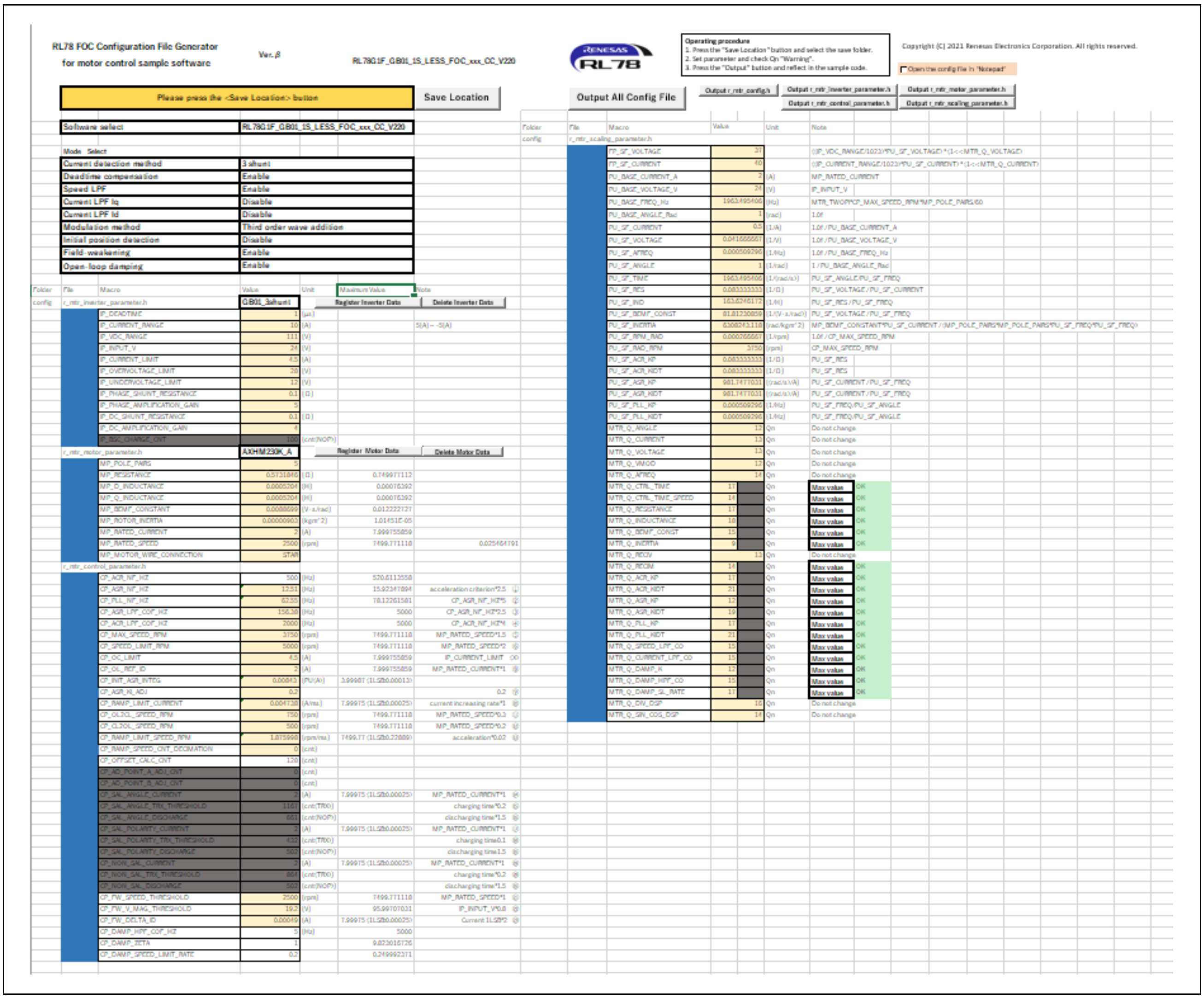


Figure 2-1 "RL78_CFG" sheets display screen

2.1.1 Setting file save location

You can set the save location of the files by clicking the "Save Location" button to open the Save Location screen.

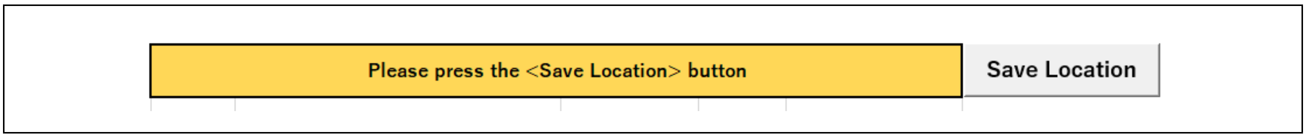


Figure 2-2 File Save Location Screen: Before the save location is specified

After you have specified the save location, the save location address is displayed in a yellow cell.

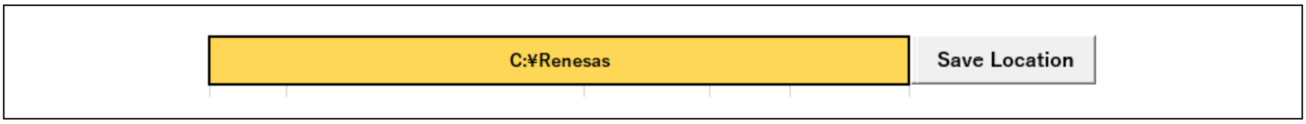


Figure 2-3 File Save Location Screen: After the save location is specified

2.1.2 File output buttons

A button to create all configuration files at once and buttons to create each file separately are available.

- "Output All Config File": Creates all 5 configuration files
- "Output r_mtr_config.h": Creates configuration definition file
- "Output r_mtr_inverter_parameter.h": Creates inverter parameter definition file
- "Output r_mtr_motor_parameter.h": Creates motor parameter definition file
- "Output r_mtr_control_parameter.h": Creates control parameter definition file
- "Output r_mtr_scaling_parameter.h": Creates scaling parameter definition file

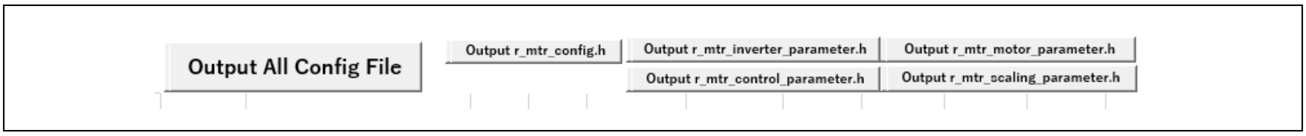


Figure 2-4 File output buttons

These buttons are enabled after the file save location is set. If a button is clicked before the file location is set, an error message is output.

Also, when the "Open the config file in 'Notepad'" check box is selected, the output file will open in Notepad.

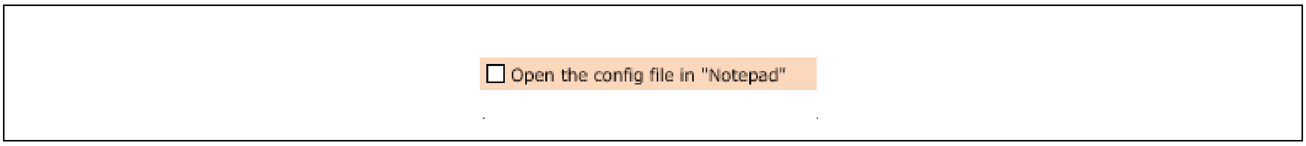


Figure 2-5 "Open the config file in 'Notepad'" check box

2.1.3 Target software selection

The type of parameters output by the sample code differ, so select the sample code you want from "Software select."

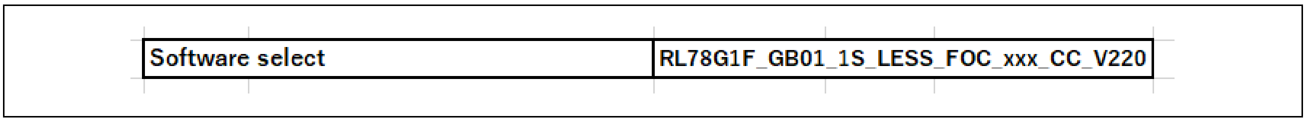


Figure 2-6 "Software select" cell

2.1.4 Control mode selection

The control mode can be selected. This setting is reflected in "r_mtr_config.h". See the target software "r_mtr_config.h" for more details about control modes. Table 2-1 shows the contents of the Mode Select items.

Mode Select

Current detection method	1 shunt
Deadtime compensation	Enable
Speed LPF	Enable
Current LPF Iq	Disable
Current LPF Id	Disable
Modulation method	Third order wave addition
Initial position detection	Disable
Field-weakening	Enable
Open-loop damping	Enable

Figure 2-7 "Mode Select" cell

Table 2-1 List of Definitions in Mode Select

Mode nme	Description	Remarks
Current detection method	Current detection method (3-shunt /1-shunt)	Default setting: 1 shunt
Deadtime compensation	Select deadtime compensation process	Default setting: Enable
Speed LPF	Select speed LPF	Default setting: Enable
Current LPF Iq	Select q-axis current LPF	Default setting: Disable
Current LPF Id	Select d-axis current LPF	Default setting: Disable
Modulation method	Modulation method (Sine wave modulation/ Third harmonic calculation)	Default setting: Third harmonic calculation
Initial position detection	Select initial position detection	Default setting: Disable
Field-weakening	Select Field-Weakening Control	Default setting: Enable
Open-loop damping	Select Openloop damping Control	Default setting: Enable

2.1.5 Setting inverter characteristic parameters

Set characteristic parameters for the inverter in "r_mtr_inverter_parameter.h".

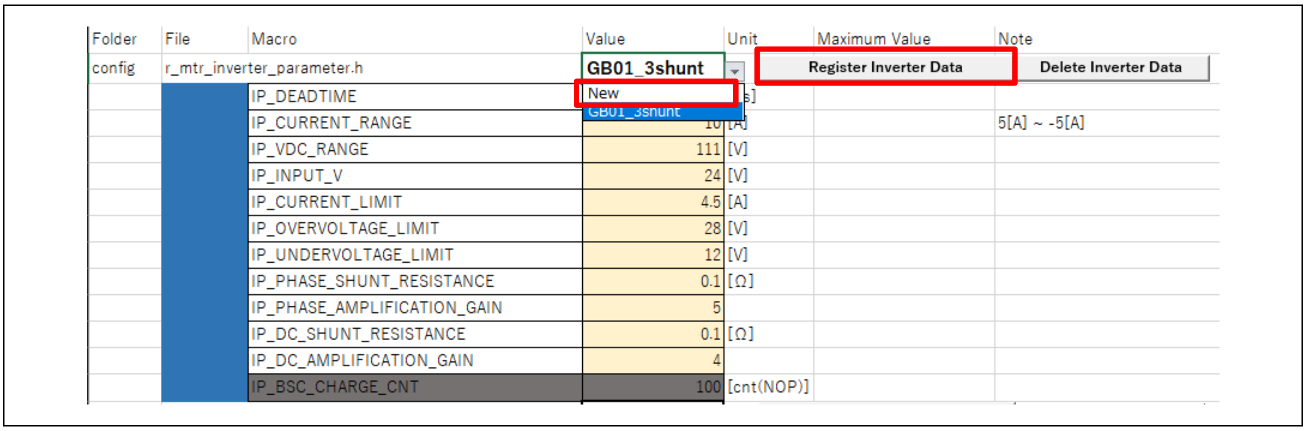


Figure 2-8 Inverter parameter setting cell

Click the "Register Inverter Data" button to edit the setting information. You can create a new registration by selecting "New" from the Inverter Name drop-down menu and clicking the "Register Inverter Data" button.

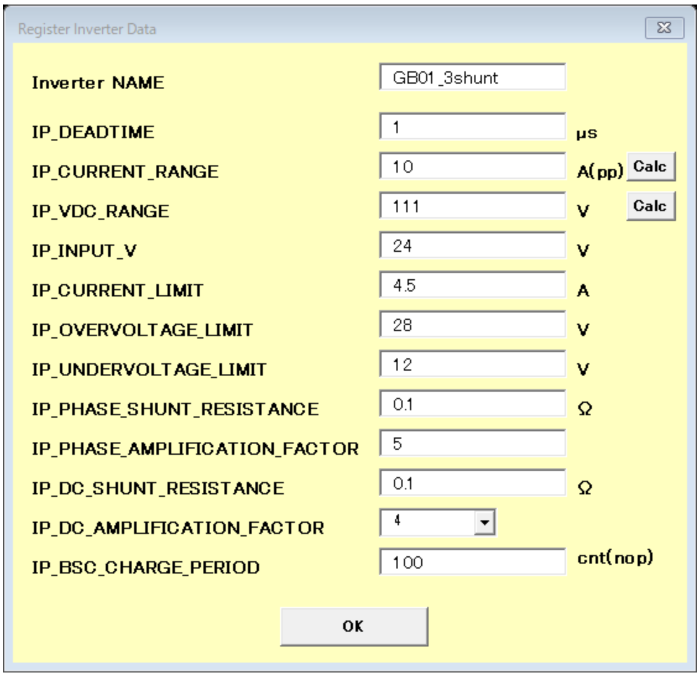


Figure 2-9 "Register Inverter Data" window

See target sample code "r_mtr_inverter_parameter.h" for details on each of the parameters.

In the "Register Inverter Data" window there are macros for converting the scaling value from AD to current ("IP_CURRENT_RANGE") and to voltage ("IP_VDC_RANGE"). When the "Calc" button to the right of these input fields is clicked, an input window for automatically calculating the scaling value is displayed.

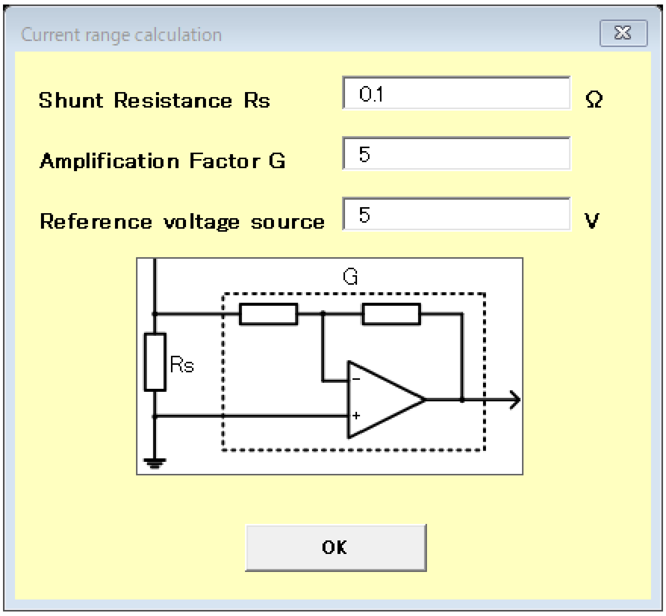


Figure 2-10 "Current range calculation" window

The "Current range calculation" window calculates the current scaling value. Input the shunt resistance value Rs, amplification gain G, and reference voltage value and perform the calculation by clicking the "OK" button.

Current scaling value [A] = reference voltage value [V]/(shunt resistance value Rs * amplification factor G)

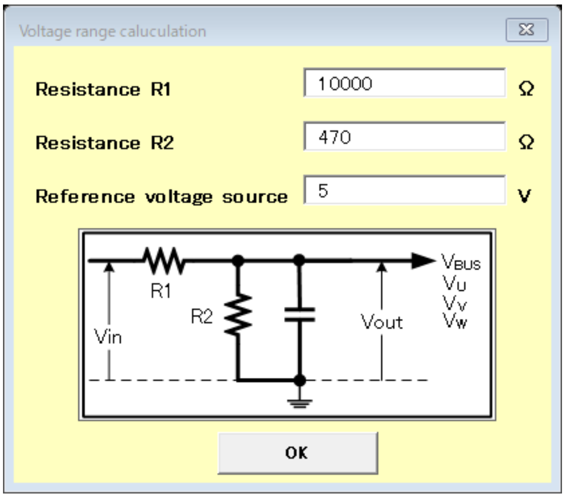


Figure 2-11 "Current range calculation" window

The "Current range calculation" window calculates the voltage scaling value. Input the divider resistances R1 and R2 and reference voltage value and perform the calculation by clicking the "OK" button.

Voltage scaling value [V] = reference voltage value [V] * (R1 + R2)/R2

If the inverter voltage and current detection circuits are different than the ones described above, set a suitable scaling value that matches the target inverter circuit.

To delete registered inverter information, click the "Delete Inverter Data" button and delete the data selected from the drop-down menu.

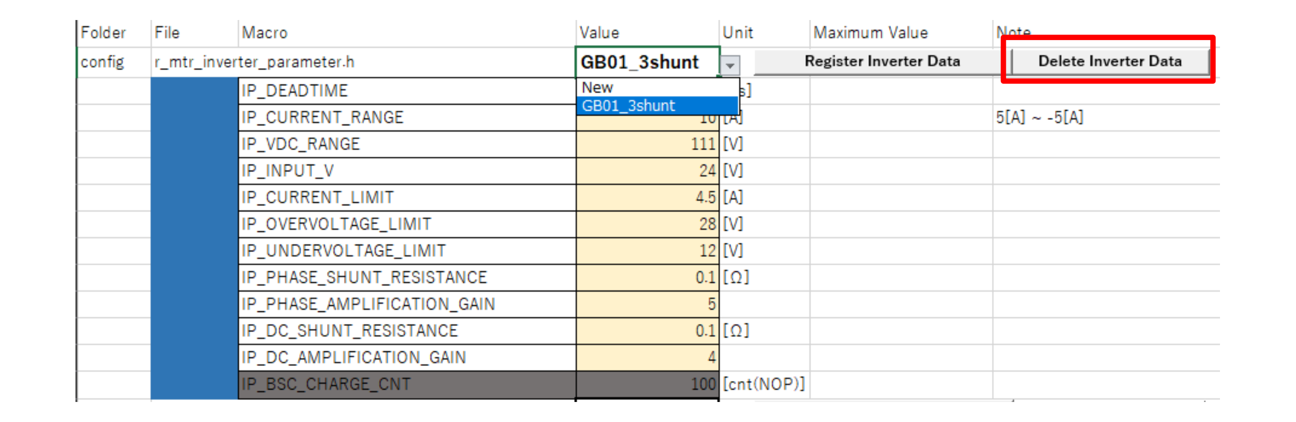


Figure 2-12 "Delete Inverter Data" button

When the "Delete Inverter Data" button is clicked, a "Verification" window displaying "Yes (Y)" and "No (N)" opens to prompt you to confirm that you want to delete the data. If "Yes (Y)" is clicked, the selected inverter information is deleted. If "No (N)" is clicked, the deletion is canceled.

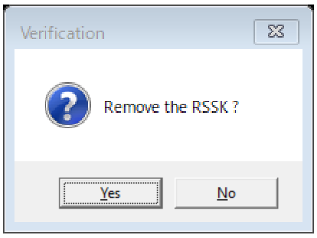


Figure 2-13 "Verification" window

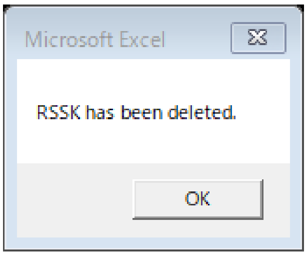


Figure 2-14 Window displayed when data is deleted

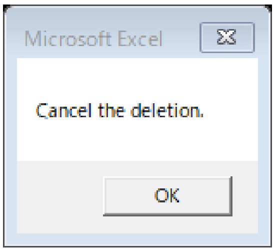


Figure 2-15 Window displayed when data deletion is canceled

2.1.6 Setting motor characteristic parameters

Set motor characteristic parameters in "r_mtr_motor_parameter.h".

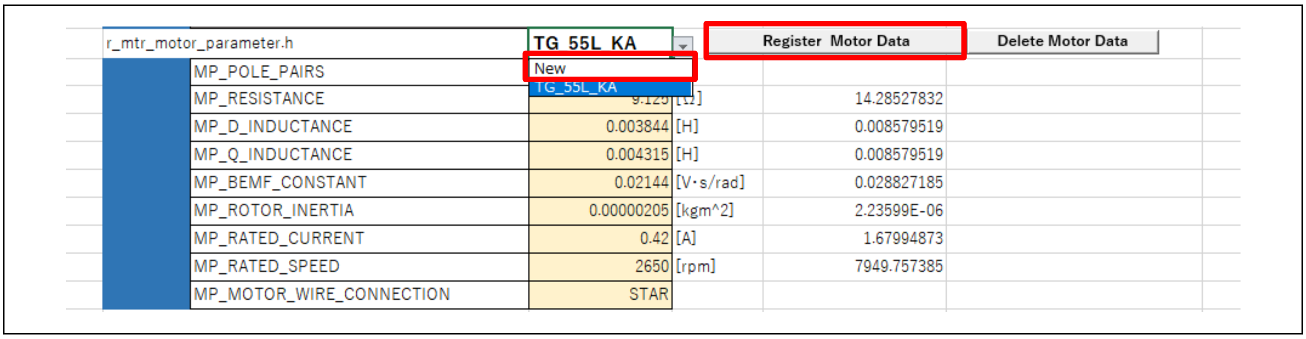


Figure 2-16 Motor parameter setting cell

Click the "Register Motor Data" button to edit the setting information. You can create a new registration by selecting "New" from the motor name drop-down menu and clicking the "Register Motor Data" button.

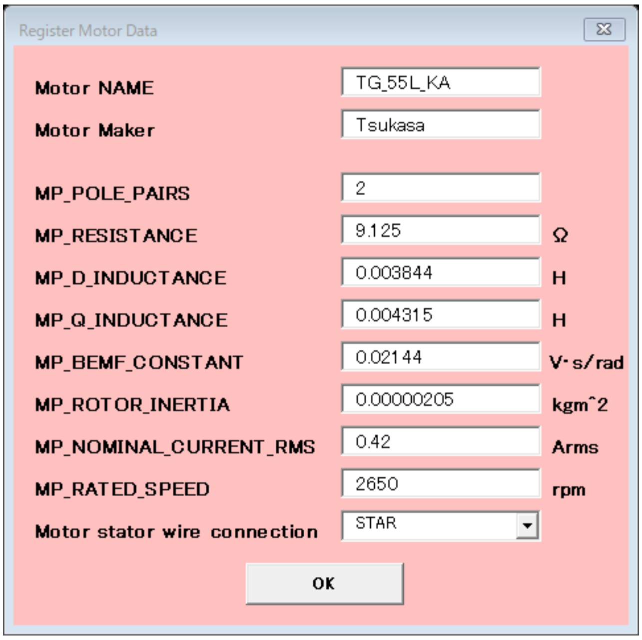


Figure 2-17 "Register Motor Data" window

See target sample code "r_mtr_motor_parameter.h" for more details on each of the parameters.

To delete registered inverter information, click the "Delete Motor Data" button and delete the data selected from the drop-down menu. The operation is the same as for "Delete Inverter Data".

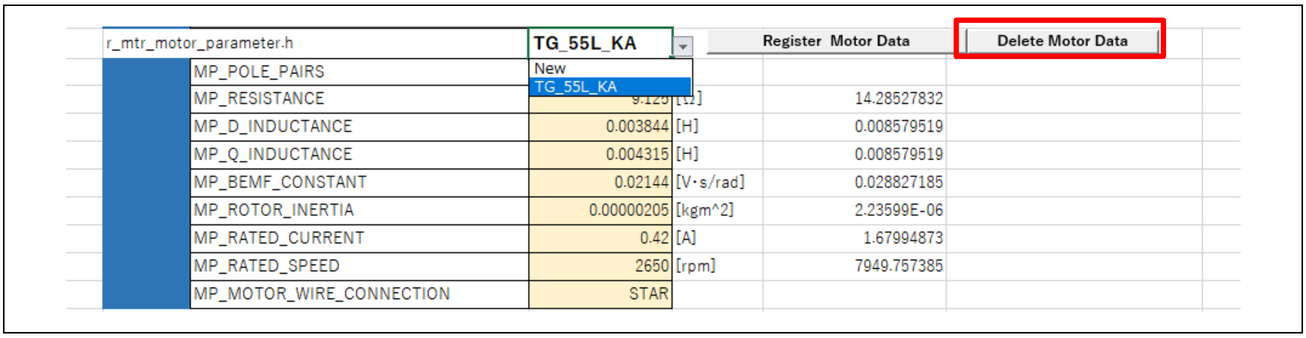


Figure 2-18 "Delete Motor Data" button

Next to each parameter is the maximum value each parameter variable can have in the sample software.

2.1.7 Setting control parameters

Set control parameters in "r_mtr_control_parameter.h".

r_mtr_control_parameter.h					
CP_ACR_NF_HZ	500	[Hz]	591.4601094		
CP_ASR_NF_HZ	11.19	[Hz]	13.43542241	acceleration criterion*2.5	①
CP_PLL_NF_HZ	55.95	[Hz]	66.24797821	CP_ASR_NF_HZ*5	②
CP_ASR_LPF_COF_HZ	139.88	[Hz]	5000	CP_ASR_NF_HZ*2.5	③
CP_ACR_LPF_COF_HZ	2000	[Hz]	5000	CP_ACR_NF_HZ*4	④
CP_MAX_SPEED_RPM	3975	[rpm]	7949.757385	MP_RATED_SPEED*1.5	⑤
CP_SPEED_LIMIT_RPM	5300	[rpm]	7949.757385	MP_RATED_SPEED*2	⑥
CP_OC_LIMIT	1.47	[A]	1.67994873	MP_RATED_CURRENT*3.5	⑦
CP_OL_REF_ID	0.42	[A]	1.67994873	MP_RATED_CURRENT*1	⑧
CP_INIT_ASR_INTEG	0.04402	[PU(A)]	3.99987 (1LSB:0.00013)		
CP_ASR_KI_ADJ	0.2			0.2	⑨
CP_RAMP_LIMIT_CURRENT	0.00084	[A/ms]	1.67994 (1LSB:0.00006)	current increasing rate*1	⑩
CP_OL2CL_SPEED_RPM	795	[rpm]	7949.757385	MP_RATED_SPEED*0.3	⑪
CP_CL2OL_SPEED_RPM	530	[rpm]	7949.757385	MP_RATED_SPEED*0.2	⑫
CP_RAMP_LIMIT_SPEED_RPM	1.677845	[rpm/ms]	7949.75 (1LSB:0.24262)	acceleration*0.02	⑬
CP_RAMP_SPEED_CNT_DECIMATION	0	[cnt]			
CP_OFFSET_CALC_CNT	128	[cnt]			
CP_AD_POINT_A_ADJ_CNT	0	[cnt]			
CP_AD_POINT_B_ADJ_CNT	0	[cnt]			
CP_SAL_ANGLE_CURRENT	0.42	[A]	1.67994 (1LSB:0.00006)	MP_RATED_CURRENT*1	⑭
CP_SAL_ANGLE_TRX_THRESHOLD	2329	[cnt(TRX)]		charging time*0.2	⑮
CP_SAL_ANGLE_DISCHARGE	1046	[cnt(NOP)]		discharging time*1.5	⑯
CP_SAL_POLARITY_CURRENT	0.42	[A]	1.67994 (1LSB:0.00006)	MP_RATED_CURRENT*1	⑰
CP_SAL_POLARITY_TRX_THRESHOLD	739	[cnt(TRX)]		charging time0.1	⑱
CP_SAL_POLARITY_DISCHARGE	811	[cnt(NOP)]		discharging time1.5	⑯
CP_NON_SAL_CURRENT	0.42	[A]	1.67994 (1LSB:0.00006)	MP_RATED_CURRENT*1	⑲
CP_NON_SAL_TRX_THRESHOLD	1477	[cnt(TRX)]		charging time*0.2	⑳
CP_NON_SAL_DISCHARGE	811	[cnt(NOP)]		discharging time*1.5	⑯
CP_FW_SPEED_THRESHOLD	2650	[rpm]	7949.757385	MP_RATED_SPEED*1	㉑
CP_FW_V_MAG_THRESHOLD	19.2	[V]	95.99707031	IP_INPUT_V*0.8	㉒
CP_FW_DELTA_ID	0.000104	[A]	1.67994 (1LSB:0.00006)	Current 1LSB*2	㉓
CP_DAMP_HPF_COF_HZ	5	[Hz]	5000		
CP_DAMP_ZETA	1		17.84156928		
CP_DAMP_SPEED_LIMIT_RATE	0.2		0.249992371		

Figure 2-19 Control parameter setting cell

See target sample code "r_mtr_control_parameter.h" for more details on each of the parameters.

Uncolored cells are user editable.

Next to each parameter is the maximum value that each parameter variable can have in the sample software and the formula that uses the Adjustment parameter of each automatically calculated parameter.

Each parameter described in Adjustment parameter is used in the calculation formula of each parameter in r_mtr_control_parameter.h. You can adjust the calculated value of each parameter in r_mtr_control_parameter.h by changing the corresponding parameters from 1 to 23 in the Adjustment parameter value column.

Adjustment parameter

	parameter	Value
①	ASR parameter magnification	2.5
②	PLL parameter magnification	5
③	ASR LPF parameter magnification	2.5
④	ACR LPF parameter magnification	4
③	Maximum Speed parameter magnification	1
④	Speed limit parameter magnification	1.5
⑤	Maximum Speed parameter magnification for Field-weakening control	1.5
⑥	Speed limit parameter magnification for Field-weakening control	2
⑦	OC limit parameter magnification	3.5
⑧	OL reference current parameter magnification	1
⑨	ASR Ki adjustment parameter magnification	0.2
⑩	Current increasing rate magnification	1
⑪	OL to CL speed parameter magnification	0.3
⑫	CL to OL speed parameter magnification	0.2
⑬	Acceleration parameter magnification	0.02
⑭	Threshold current magnification of angle detection for salient motor	1
⑮	Threshold TRX counts magnification of angle detection for salient motor	0.2
⑯	Wating discharge time magnification	1.5
⑰	Threshold current magnification of polarity detection for salient motor	1
⑱	Threshold TRX counts magnification of polarity detection for salient motor	0.1
⑲	Threshold current magnification of angle detection for non-salient motor	1
⑳	Threshold TRX counts magnification of angle detection for non-salient motor	0.2
㉑	Swiching threshold speed parameter magnification for Field-weaking control	1
㉒	Threshold voltage magnitude parameter magnification for Field-weaking control	0.8
㉓	Delta Id magnitude parameter magnification for Field-weaking control	2

Figure 2-20 “Adjustment parameter” setting cell

2.1.8 Setting scaling parameters

Set scaling parameters in "r_mtr_scaling_parameter.h".

Folder	File	Macro	Value	Unit	Note	
config	r_mtr_scaling_parameter.h					
		FP_SF_VOLTAGE	37		((IP_VDC_RANGE/1023)*PU_SF_VOLTAGE) * (1<<MTR_Q_VOLTAGE)	
		FP_SF_CURRENT	190		((IP_CURRENT_RANGE/1023)*PU_SF_CURRENT) * (1<<MTR_Q_CURRENT)	
		PU_BASE_CURRENT_A	0.42	[A]	MP_RATED_CURRENT	
		PU_BASE_VOLTAGE_V	24	[V]	IP_INPUT_V	
		PU_BASE_FREQ_Hz	832.5220523	[Hz]	MTR_TWOPI*CP_MAX_SPEED_RPM*MP_POLE_PAIRS/60	
		PU_BASE_ANGLE_Rad	1	[rad]	1.0f	
		PU_SF_CURRENT	2.380952381	[1/A]	1.0f / PU_BASE_CURRENT_A	
		PU_SF_VOLTAGE	0.041666667	[1/V]	1.0f / PU_BASE_VOLTAGE_V	
		PU_SF_AFREQ	0.001201169	[1/Hz]	1.0f / PU_BASE_FREQ_Hz	
		PU_SF_ANGLE	1	[1/rad]	1 / PU_BASE_ANGLE_Rad	
		PU_SF_TIME	832.5220523	[1/(rad/s)]	PU_SF_ANGLE/PU_SF_FREQ	
		PU_SF_RES	0.0175	[1/Ω]	PU_SF_VOLTAGE / PU_SF_CURRENT	
		PU_SF_IND	14.56913591	[1/H]	PU_SF_RES / PU_SF_FREQ	
		PU_SF_BEMF_CONST	34.68841884	[1/(V・s/rad)]	PU_SF_VOLTAGE / PU_SF_FREQ	
		PU_SF_INERTIA	14310892.35	[rad/kgm^2]	MP_BEMF_CONSTANT*PU_SF_CURRENT / (MP_POLE_PAIRS*MP_POLE_PAIRS*PU_SF_FREQ*PU_SF_FREQ)	
		PU_SF_RPM_RAD	0.000251572	[1/rpm]	1.0f / CP_MAX_SPEED_RPM	
		PU_SF_RAD_RPM	3975	[rpm]	CP_MAX_SPEED_RPM	
		PU_SF_ACR_KP	0.0175	[1/Ω]	PU_SF_RES	
		PU_SF_ACR_KIDT	0.0175	[1/Ω]	PU_SF_RES	
		PU_SF_ASR_KP	1982.195363	[(rad/s)/A]	PU_SF_CURRENT / PU_SF_FREQ	
		PU_SF_ASR_KIDT	1982.195363	[(rad/s)/A]	PU_SF_CURRENT / PU_SF_FREQ	
		PU_SF_PLL_KP	0.001201169	[1/Hz]	PU_SF_FREQ/PU_SF_ANGLE	
		PU_SF_PLL_KIDT	0.001201169	[1/Hz]	PU_SF_FREQ/PU_SF_ANGLE	
		MTR_Q_ANGLE	12	Qn	Do not change	
		MTR_Q_CURRENT	13	Qn	Do not change	
		MTR_Q_VOLTAGE	13	Qn	Do not change	
		MTR_Q_VMOD	12	Qn	Do not change	
		MTR_Q_AFREQ	14	Qn	Do not change	
		MTR_Q_CTRL_TIME	18	Qn	Max value	OK
		MTR_Q_CTRL_TIME_SPEED	15	Qn	Max value	OK
		MTR_Q_RESISTANCE	17	Qn	Max value	OK
		MTR_Q_INDUCTANCE	18	Qn	Max value	OK
		MTR_Q_BEMF_CONST	15	Qn	Max value	OK
		MTR_Q_INERTIA	10	Qn	Max value	OK
		MTR_Q_RECIV	13	Qn	Do not change	
		MTR_Q_RECIM	14	Qn	Max value	OK
		MTR_Q_ACR_KP	17	Qn	Max value	OK
		MTR_Q_ACR_KIDT	19	Qn	Max value	OK
		MTR_Q_ASR_KP	12	Qn	Max value	OK
		MTR_Q_ASR_KIDT	19	Qn	Max value	OK
		MTR_Q_PLL_KP	15	Qn	Max value	OK
		MTR_Q_PLL_KIDT	21	Qn	Max value	OK
		MTR_Q_SPEED_LPF_CO	15	Qn	Max value	OK
		MTR_Q_CURRENT_LPF_CO	15	Qn	Max value	OK
		MTR_Q_DAMP_K	12	Qn	Max value	OK
		MTR_Q_DAMP_HPF_CO	15	Qn	Max value	OK
		MTR_Q_DAMP_SL_RATE	17	Qn	Max value	OK
		MTR_Q_DIV_DSP	16	Qn	Do not change	
		MTR_Q_SIN_COS_DSP	14	Qn	Do not change	

Figure 2-21 Scaling parameter setting cell

The scaling parameters are automatically calculated from the inverter and motor characteristic parameters and control parameters that have already been set.

Q values are automatically set to fit into 15 bits. To change a Q value, change the "Max value" drop-down to the right of that Q value to "User input".

MTR_Q_AFREQ		14	Qn	Do not change	
MTR_Q_CTRL_TIME	18	20	Qn	User input	Warning
MTR_Q_CTRL_TIME_SPEED	15	13	Qn	User input	OK
MTR_Q_RESISTANCE	17		Qn	Max value	OK
MTR_Q_INDUCTANCE	18		Qn	Max value	OK
MTR_Q_BEMF_CONST	15		Qn	Max value	OK
MTR_Q_INERTIA	10		Qn	Max value	OK
MTR_Q_RECIV		13	Qn	Do not change	
MTR_Q_RECIM	14		Qn	Max value	OK
MTR_Q_ACR_KP	17		Qn	Max value	OK
MTR_Q_ACR_KIDT	19		Qn	Max value	OK
MTR_Q_ASR_KP	12		Qn	Max value	OK
MTR_Q_ASR_KIDT	19		Qn	Max value	OK
MTR_Q_PLL_KP	15		Qn	Max value	OK
MTR_Q_PLL_KIDT	21		Qn	Max value	OK
MTR_Q_SPEED_LPF_CO	15		Qn	Max value	OK
MTR_Q_CURRENT_LPF_CO	15		Qn	Max value	OK
MTR_Q_DAMP_K	12		Qn	Max value	OK
MTR_Q_DAMP_HPF_CO	15		Qn	Max value	OK
MTR_Q_DAMP_SL_RATE	17		Qn	Max value	OK
MTR_Q_DIV_DSP		16	Qn	Do not change	
MTR_Q_SIN_COS_DSP		14	Qn	Do not change	

Figure 2-22 Changing scaling parameter Q values

If the cell to the right of the drop-down displays "Warning", adjust the value until the display shows "OK".

2.2 Descriptions of "Checker" sheets

"Checker" sheets are used to the Q value set in the "RL 78 _ CFG" sheet is used to actually calculate the PU unit fixed-point values of the characteristic parameters and control parameters of the motor and inverter. Checks whether the calculation result is within 15 bits. "OK" is displayed if there is no change, and "Warning" is displayed if there is no change.

Checker				
	Value	Value in PU system	Fixed-point data	Judgment
Resistance	9.125	0.1596875	20930	OK
Inductance(d-axis)	0.003844	0.056003758	14681	OK
Inductance(q-axis)	0.004315	0.062865821	16479	OK
Magnetic flux	0.02144	0.7437197	24370	OK
Inertia	0.00000205	29.33732932	30041	OK
Nominal current	0.42	1	8192	OK
Control period	0.0001	0.083252205	21824	OK
Speed control period	0.001	0.832522052	27280	OK
1/Vdc	0.041666667	1	1	OK
Inverse of magnetic flux	46.64179104	1.344592593	22029	OK
Over voltage limit	28	1.166666667	9557	OK
Over current limit	1.47	3.5	28672	OK
Speed limit	1110.029403	1.333333333	21845	OK
Max speed	832.5220523	1	16384	OK
Iq limit	0.727461336	1.7320508	14188	OK
ACR(d-axis) Kp (1st order)	7.245769288	0.126800963	16620	OK
ACR(d-axis) KiT (1st order)	1.720021976	0.030100385	31562	OK
ACR(q-axis) Kp (1st order)	8.133583371	0.142337709	18656	OK
ACR(q-axis) KiT (1st order)	1.720021976	0.030100385	31562	OK
ASR Kp (1st order)	0.001680657	3.331390162	13645	OK
ASR KiT (1st order)	2.3633E-05	0.046845238	24560	OK
PLL Kp (1st order)	351.5442175	0.422264151	13836	OK
PLL KiT (1st order)	2.471666738	0.00296889	6226	OK
Speed LPF coefficient	0.080788739	0.080788739	2647	OK
Speed LPF coefficient	0.919211261	0.919211261	30120	OK
Current LPF coefficient	0.429868798	0.429868798	14085	OK
Current LPF coefficient	0.570131202	0.570131202	18682	OK
Damp k	148.5250028	4.281688465	17537	OK
Damp HPF coefficient	0.969540972	0.969540972	31769	OK
Damp speed limit rate	0.2	0.2	26214	OK

Figure 2-23 "Checker" sheets display screen

3. CFG operational procedures

This section describes detailed procedures for using CFG to change motors and inverters.

3.1 Preparations

Download the corresponding sample code from our website and install Renesas Motor Workbench (RMW).
Obtain the required information, such as the specs for the target inverter and motor parameter.

3.2 Changing inverters and motors

Here are the procedures for changing inverters and motors that are not targets for operation by the sample code. Keep in mind the following precautions when making changes.

- CFG cannot set for device setting information. Set pin assignments and AD connections as appropriate.
- This tool is made for the purpose of supporting the redesign of various parameters of the sample software, but it does not completely guarantee the operation. Please use it with great care.

3.3 Operation with FOC version

This section describes how to operate the CFG for sensorless vector control, "RL78 FOC Configuration File Generator for motor control sample software Ver.β".

3.3.1 Launch CFG

Start "RL78_FOC_Configuration_File_Generator.xlsm". Excel macros are used to implement the tool functions. Click "Enable contents" in the security warning that will be displayed toward the top of the screen.

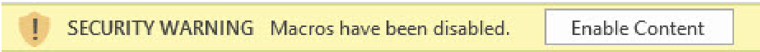


Figure 3-1 Security warning

First, click the "Save Location" button and set the output address for the configuration file to be output.

Figure 3-2 File Save Location Screen: Before the save location is specified

When the save location is set, the specified address is displayed in the yellow box to the left of the button.

Figure 3-3 File Save Location Screen: After the save location is specified

This action enables the configuration file to be output to the specified address.

3.3.2 Inverter registration

Register the inverter. The Renesas evaluation board "GB01" inverters are already registered. If you are using a Renesas evaluation board, select the target board name and move on to the next section.

Register the new inverter information. Select "New" from the inverter name drop-down menu and click the "Register Inverter Data" button.

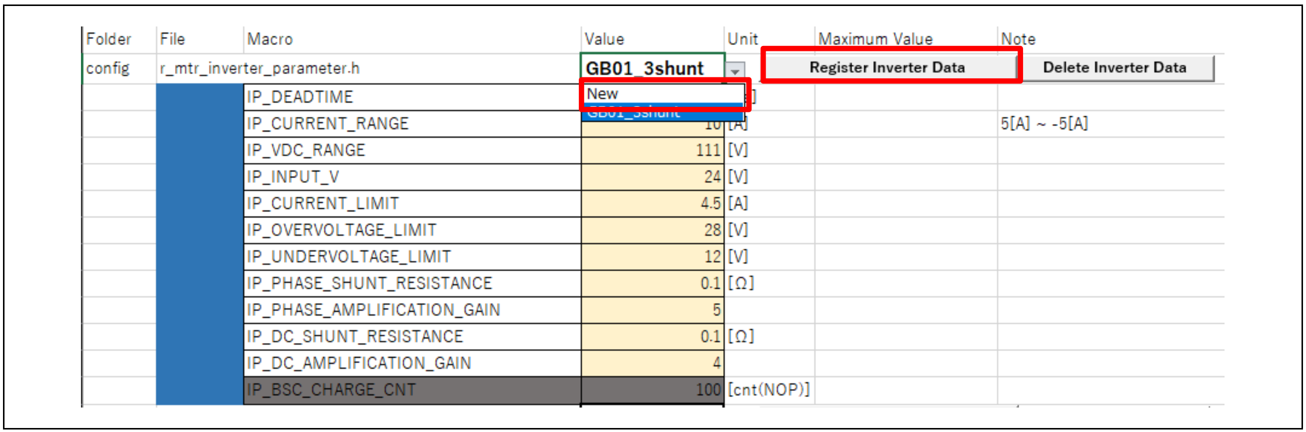


Figure 3-4 Inverter parameter setting cell

The "Register Inverter Data" window will open. Input the inverter information. To calculate the detection ranges for voltage and current, click the "Calc" button, and an information input screen for calculating the values will be displayed.

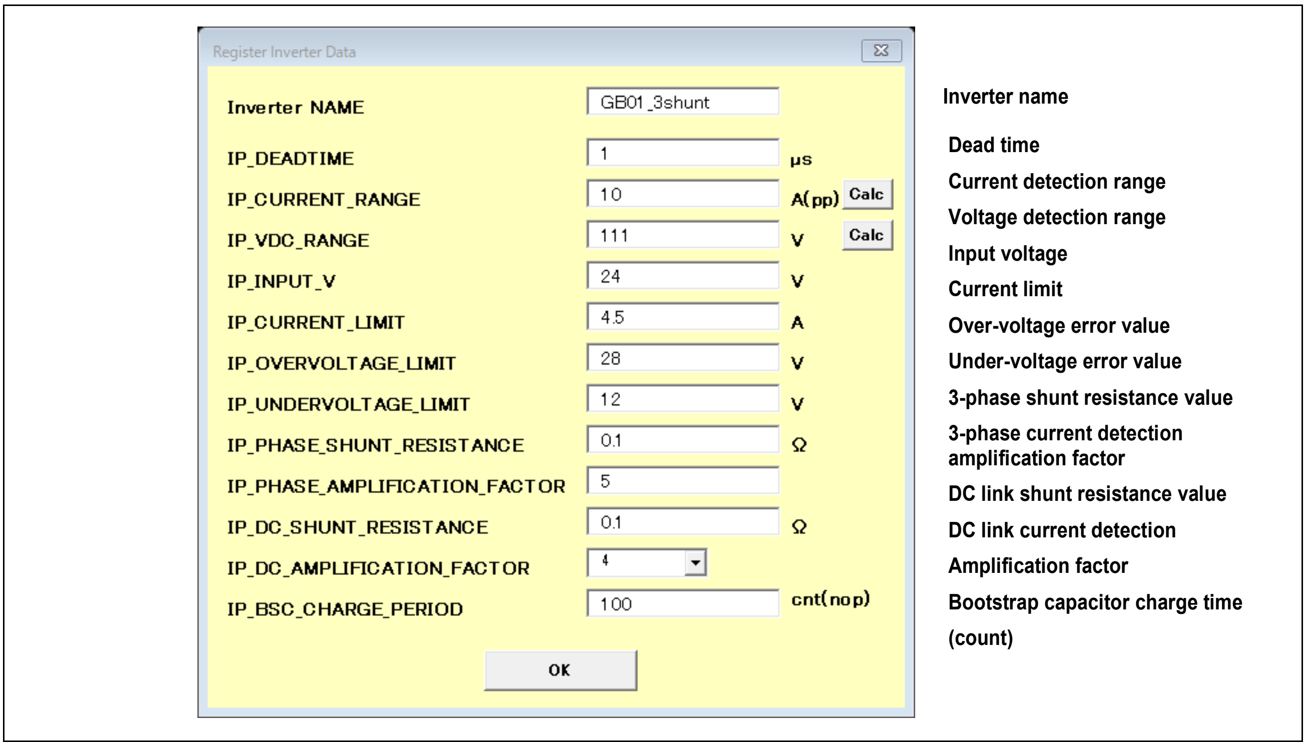


Figure 3-5 "Register Inverter Data" window

Click the "OK" button to register the data. Select the inverter name, which will have been added to the drop-down menu.

3.3.3 Motor registration

Register the motor. The motor used for the Renesas sample code is already registered. If you are using the sample code environment, move on to the next section.

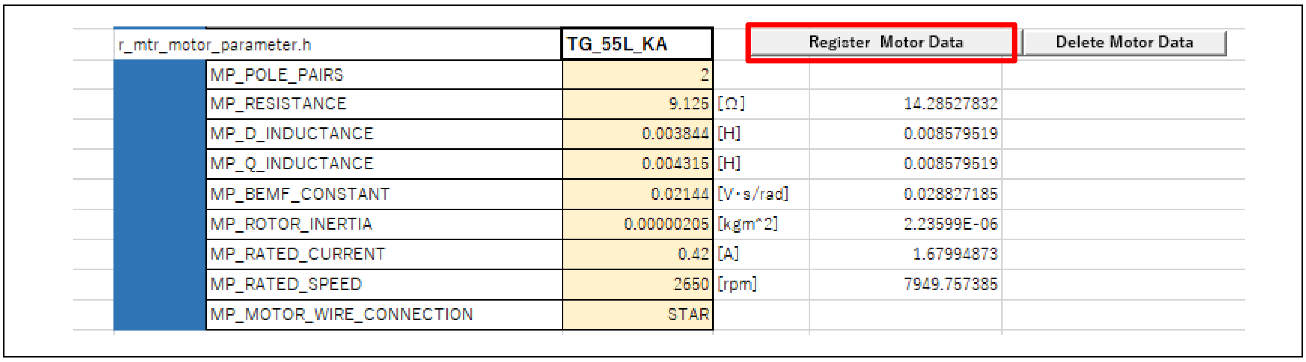


Figure 3-6 Motor parameter setting cell

Register a new motor. Select "New" from the motor name drop-down menu and click the "Register Motor Data" button.

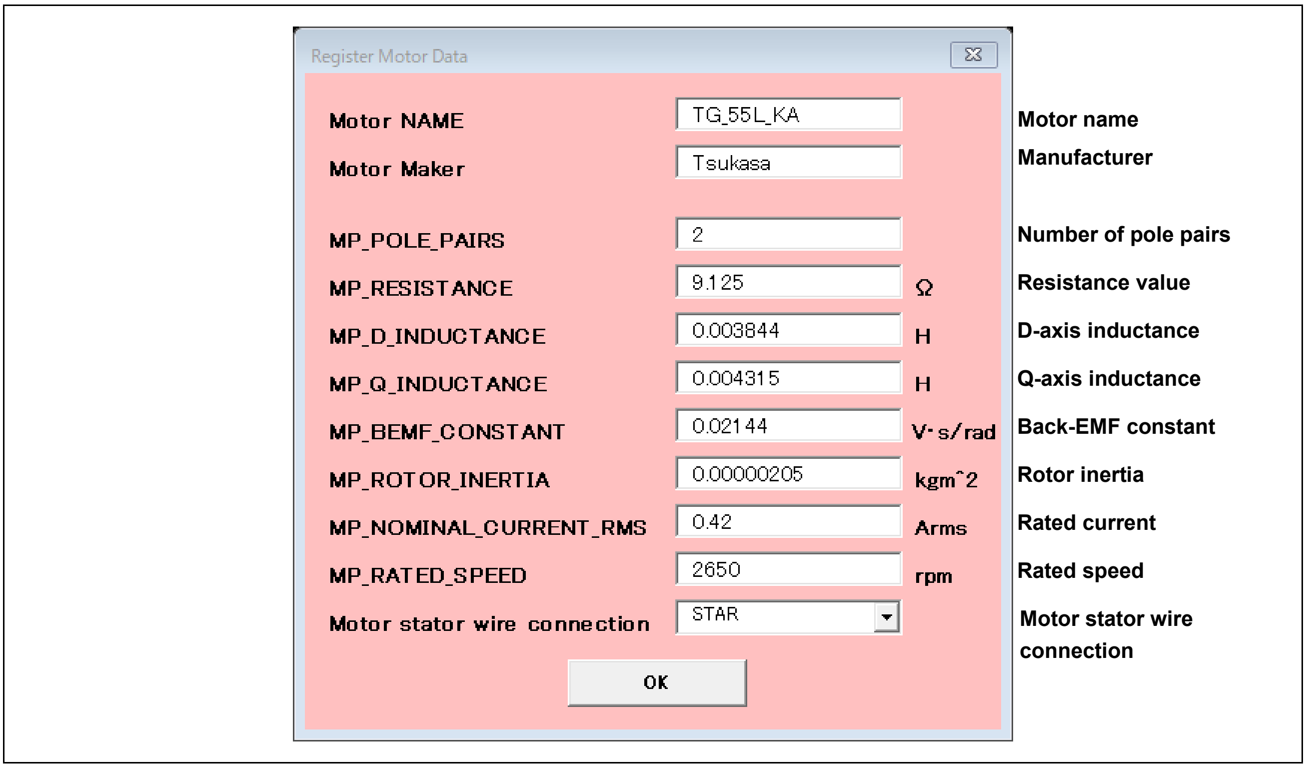


Figure 3-7 "Register Motor Data" window

Click the "OK" button to register the data. Select the motor name, which will have been added to the drop-down menu.

3.3.4 Creating configuration files

The scaling parameters are automatically calculated from the selected inverter and motor information, so click the "Output All Config File" button to create the file.

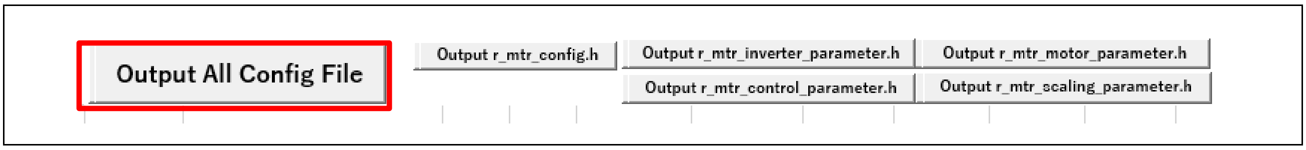


Figure 3-8 File output buttons

When the "Output All Config File" button is clicked, the following 5 files are output.

- r_mtr_config.h: Configuration definition file
- r_mtr_control_parameter.h: Control parameter definition file
- r_mtr_inverter_parameter.h: Inverter parameter definition file
- r_mtr_motor_parameter.h: Motor parameter definition file
- r_mtr_scaling_parameter.h: Scaling parameter definition file

Click the buttons next to the "Output All Config File" button to output each file individually.

3.3.5 Reflection in sample code

Overwrite the created file to the "config" folder of the corresponding sample code.

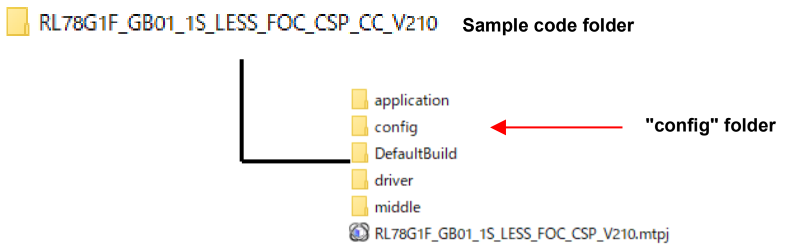


Figure 3-9 Reflection of the configuration file

After the file is reflected in the sample code, start the IDE (CS +, e[2] studio), write it to the MCU according to the sample code execution method, and execute the program.

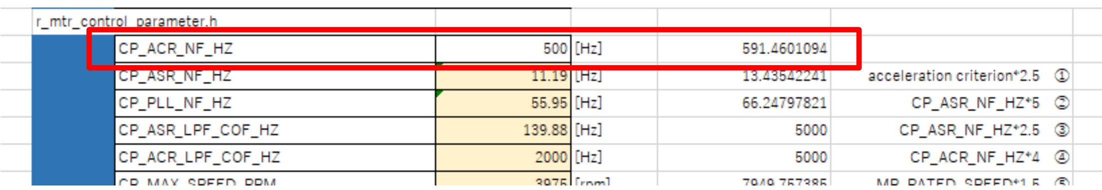
3.3.6 Changing parameter settable range

When the characteristics parameters and control parameters of the motor and inverter are set, the Q values are calculated with a scaling parameter of 15 bits to maximize the resolution of the decimals. The control parameters, etc., that might change after writing the software to the MCU must be suitably adjusted so that the variable values do not overflow.

This section describes how to adjust the range of each variable.

●Changing settable range by rewriting parameters

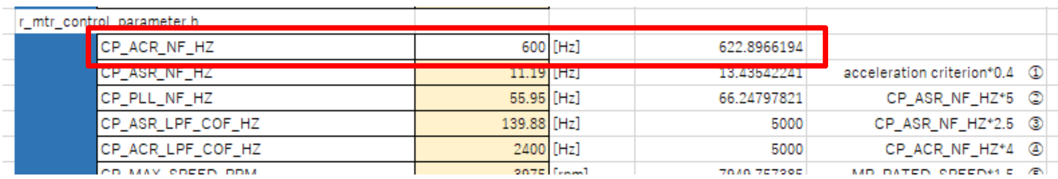
The parameters of the r_mtr_control_parameter.h are described as an example. As shown in the figure below, when the natural frequency of ACR is 500, the upper limit value that can be set is displayed in the cell on the right. After the code is written, values higher than this upper limit value cannot be set.



r_mtr_control_parameter.h					
CP_ACR_NF_HZ	500	[Hz]	591.4601094		
CP_ASR_NF_HZ	11.19	[Hz]	13.43542241	acceleration criterion*2.5	①
CP_PLL_NF_HZ	55.95	[Hz]	66.24797821	CP_ASR_NF_HZ*5	②
CP_ASR_LPF_COF_HZ	139.88	[Hz]	5000	CP_ASR_NF_HZ*2.5	③
CP_ACR_LPF_COF_HZ	2000	[Hz]	5000	CP_ACR_NF_HZ*4	④

Figure 3-10 Upper limit values for settings when ACR natural frequency is 500

If you wish to set a value greater than the upper limit value, The Q value is recalculated so that the range can be expanded by rewriting "CP_ACR_NF_HZ" in CFG. Setting the natural frequency to 600 will expand the parameter setting range as illustrated in the figure below.



r_mtr_control_parameter.h					
CP_ACR_NF_HZ	600	[Hz]	622.8966194		
CP_ASR_NF_HZ	11.19	[Hz]	13.43542241	acceleration criterion*0.4	①
CP_PLL_NF_HZ	55.95	[Hz]	66.24797821	CP_ASR_NF_HZ*5	②
CP_ASR_LPF_COF_HZ	139.88	[Hz]	5000	CP_ASR_NF_HZ*2.5	③
CP_ACR_LPF_COF_HZ	2400	[Hz]	5000	CP_ACR_NF_HZ*4	④

Figure 3-11 Upper limit values for settings when ACR natural frequency is 600

●Changing settable range by rewriting the Q value

The Q value is calculated automatically, but it is possible to expand the settable range by readjusting. Q value of the PI gain of ACR the "MTR_Q_ACR_KP" and "MTR_Q_ACR_KIDT" and described as an example. For example, if "CP_ACR_NF_HZ" is set to 300, it will be as shown in the figure below.

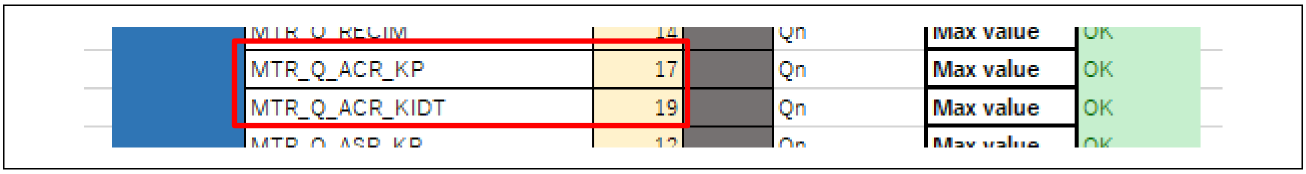


Figure 3-12 PI Q values when ACR natural frequency is 500

To change the Q value, select “User input” from the pull-down menu on the right to edit the Q value. Here, as an example, change “MTR_Q_ACR_KP” from 17 to 16.

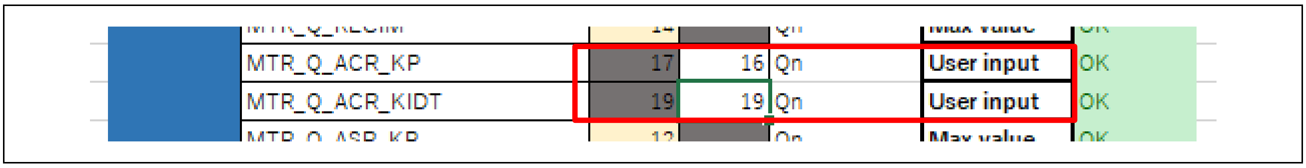


Figure 3-13 Manually inputting a PI Q value to change a value

In this case, the parameter setting range expands while "CP_ACR_NF_HZ" stays at 500.

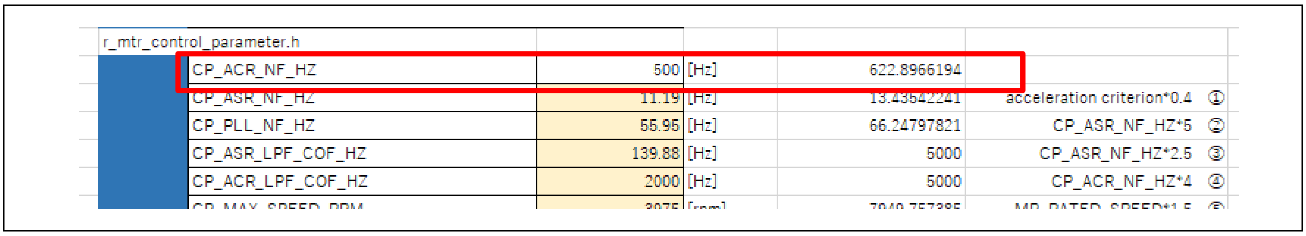


Figure 3-14 Manual input of PI Q values when ACR natural frequency is 500

Revision record

Rev.	Date	Description	
		Page	Summary
1.00	Jun. 21. 2021	-	First edition issued
1.10	Dec. 24. 2021	-	Version upgrade due to motor sample software update

General Precautions in the Handling of Microprocessing Unit and Microcontroller Unit Products

The following usage notes are applicable to all Microprocessing unit and Microcontroller unit products from Renesas. For detailed usage notes on the products covered by this document, refer to the relevant sections of the document as well as any technical updates that have been issued for the products.

1. Precaution against Electrostatic Discharge (ESD)

   A strong electrical field, when exposed to a CMOS device, can cause destruction of the gate oxide and ultimately degrade the device operation. Steps must be taken to stop the generation of static electricity as much as possible, and quickly dissipate it when it occurs. Environmental control must be adequate. When it is dry, a humidifier should be used. This is recommended to avoid using insulators that can easily build up static electricity. Semiconductor devices must be stored and transported in an anti-static container, static shielding bag or conductive material. All test and measurement tools including work benches and floors must be grounded. The operator must also be grounded using a wrist strap. Semiconductor devices must not be touched with bare hands. Similar precautions must be taken for printed circuit boards with mounted semiconductor devices.
2. Processing at power-on

   The state of the product is undefined at the time when power is supplied. The states of internal circuits in the LSI are indeterminate and the states of register settings and pins are undefined at the time when power is supplied. In a finished product where the reset signal is applied to the external reset pin, the states of pins are not guaranteed from the time when power is supplied until the reset process is completed. In a similar way, the states of pins in a product that is reset by an on-chip power-on reset function are not guaranteed from the time when power is supplied until the power reaches the level at which resetting is specified.
3. Input of signal during power-off state

   Do not input signals or an I/O pull-up power supply while the device is powered off. The current injection that results from input of such a signal or I/O pull-up power supply may cause malfunction and the abnormal current that passes in the device at this time may cause degradation of internal elements. Follow the guideline for input signal during power-off state as described in your product documentation.
4. Handling of unused pins

   Handle unused pins in accordance with the directions given under handling of unused pins in the manual. The input pins of CMOS products are generally in the high-impedance state. In operation with an unused pin in the open-circuit state, extra electromagnetic noise is induced in the vicinity of the LSI, an associated shoot-through current flows internally, and malfunctions occur due to the false recognition of the pin state as an input signal become possible.
5. Clock signals

   After applying a reset, only release the reset line after the operating clock signal becomes stable. When switching the clock signal during program execution, wait until the target clock signal is stabilized. When the clock signal is generated with an external resonator or from an external oscillator during a reset, ensure that the reset line is only released after full stabilization of the clock signal. Additionally, when switching to a clock signal produced with an external resonator or by an external oscillator while program execution is in progress, wait until the target clock signal is stable.
6. Voltage application waveform at input pin

   Waveform distortion due to input noise or a reflected wave may cause malfunction. If the input of the CMOS device stays in the area between V_{IL} (Max.) and V_{IH} (Min.) due to noise, for example, the device may malfunction. Take care to prevent chattering noise from entering the device when the input level is fixed, and also in the transition period when the input level passes through the area between V_{IL} (Max.) and V_{IH} (Min.).
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8. Differences between products

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(Rev.5.0-1 October 2020)

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