

# **RA/RX** Family

# QE for Motor Application Development Guide

# Introduction

This application note describes how to use the motor software development support tool (QE for Motor) to install and verify motor control software.

# **Evaluation Kit to Be Operated**

RA family : MCK-RA6T2 Renesas Flexible Motor Control Kit for RA6T2 MCU Group RX family : MCK-RX26T Renesas Flexible Motor Control Kit for RX26T MCU Group



# Contents

1. Overview	3
1.1 System Overview	3
1.2 Operating Environment	4
1.3 Reference Documents	5
2. Preparation	
2.1 Installation of QE for Motor	
2.2 Installation of Renesas Motor Workbench	
2.3 Board Connection	
2.3.1 Connection when downloading a program	
2.3.2 Connection when tuning or analyzing the motor operation	12
3. Development Procedure	14
4. Operation Example	15
4.1 Preparation	
4.1.1 Start QE for Motor	
4.1.2 Project Selection	
4.1.2.1 Import of the project	
4.1.2.2 Target Project Selection	
4.1.3 Motor Software Configuration	
4.1.3.1 Software Configuration for RA Family	
4.1.3.2 Software Configuration for RX Family	
4.1.4 Tool Settings	
4.1.4.1 Install Renesas Motor Workbench	
4.1.4.2 Configure Renesas Motor Workbench path	
4.2 Tuning	
4.2.1 Prepare Tuning Program	
4.2.2 Download Tuning Program	
4.2.3 Start Tuner	
4.2.3.1 Installation of VCP driver	
4.2.3.2 Start Tuning	
4.2.3.3 Waveform Confirmation	
4.2.3.4 Output Header File	
4.3 Analyze	
4.3.1 Build Application Program	
4.3.2 Download Application Program	
4.3.3 Start Analyzer	
4.3.3.1 Start to Analyze	
5. Output Files	
6. Help and Guide Function	.47
Revision History	48



# 1. Overview

# 1.1 System Overview

QE for Motor is a software development tool for motors that allows you to develop motor control software simply by following the workflow. QE for motor support your entire development process from the implementation of motor control software to validation.

The main functions of QE for Motor are as follows.

Workflow view

By following the workflow, you can configure the middleware and driver software for motor control, and tune and analyze in conjunction with Renesas Motor Workbench.

- Motor Software Configuration View
   The parameters in motor middleware and driver can be configured on GUI.
- Linkage with Renesas Motor Workbench

It works in conjunction with Renesas Motor Workbench for motor tuning and analysis. Since the settings required for Renesas Motor Workbench are automated, you can use these functions simply by pressing a button in the workflow view.



Figure 1-1 Integrated development environment with QE for Motor



# **1.2 Operating Environment**

The operating environment of this development guide is as shown in Table 1-1 and Figure 1-2.

Items	Contents
PC OS	x64 based processor
	Windows® 10 (64-bit), Windows® 11
IDE	e <sup>2</sup> studio version 2023-07 or later
	Flexible Software Package (FSP) v4.4.0
	Renesas Motor Workbench V3.1.2
Tool chain	GNU Arm Embedded Toolchain: 10.3-2021.10 or later
	(GNU ARM Embedded 10.3.1.20210824)
QE for Motor	V1.3.0
Renesas Motor Workbench	V.1.3.2
Corresponding MCU	RA Family : RA6 Series RA6T2
	RX Family : RX200 Series RX26T
Evaluation Board	RA Family :
	MCK-RA6T2 Renesas Flexible Motor Control Kit for RA6T2 MCU Group
	[RTK0EMA270S00020BJ]
	RX Family :
	MCK-RX26T Renesas Flexible Motor Control Kit for RX26T MCU Group [RTK0EMXE70S00020BJ]
Sample Program	RA Family :
	Sensorless Vector Control for Permanent Magnet Synchronous Motor
	(RA6T2_MCILV1_SPM_LESS_FOC_E2S_Vxxx) [R01AN6839]
	RX Family :
	Sensorless Vector Control for Permanent Magnet Synchronous Motor
	(For RX26T RAM64KB Version)
	(RX26T_MCBA_MCILV1_SPM_LESS_FOC_E2S_Vxxx) [R01AN6858]

### Table 1-1 Operating Environment



Figure 1-2 Operating Environment



# **1.3 Reference Documents**

- R01UH0951 RA6T2 Group User's Manual: Hardware
- R12UZ0091 MCK-RA6T2 User's Manual
- R01UH0979 RX26T Group User's Manual: Hardware
- R12UZ0111 MCK-RX26T User's Manual
- R21UZ0004 Motor Control Development Support Tool Renesas Motor Workbench 3.1.2 User's Manual
- R21QS0011 Motor Control Development Support Tool Renesas Motor Workbench 3.1.2 Quick Start Guide
- R01AN6839 RA6T2 Sensorless vector control for permanent magnetic synchronous motor
- R01AN6858 RX26T Sensorless vector control for permanent magnetic synchronous motor



# 2. Preparation

The preparations required to control the motor with QE for Motor are as follows.

- Install e<sup>2</sup> studio
- Apply the following tools to e<sup>2</sup> studio
  - Configuration tool
  - Tool chain
  - QE for Motor
- Install Renesas Motor Workbench
- Connect to the board

This chapter describes the installation of QE for Motor and Renesas Motor Workbench, and the board connection.

### 2.1 Installation of QE for Motor

This section describes how to install QE from Renesas Software Installer of e<sup>2</sup> studio.

Select Renesas Software Installer from the e<sup>2</sup> studio menu. After the Renesas Software Installer window appears, select "Renesas QE" and click "Next".

e		😨 Renesas Software Installer 🛛 🚽	
File Edit Source Refactor Navigate Search Project	 Help	Renesas Software Installer Choose software to install	plications

Figure 2-1 Renesas Software Installer

When "Install Extensions" is displayed, check "QE for Motor" and click "Finish".

e Renesas Software Installer –	×
Install Extensions Select extensions to install. Press Finish to proceed with installation.	2
Press the information button to see a detailed overview and a link to more information. Find:	
QE for Motor (v1.3.0) Tools to assist in the configuration of motor middleware and related drivers.	^

Figure 2-2 Install Extensions



# **RA/RX** Family

Check "Renesas QE for Motor" for the item you want to install, and click "Next".

e Install		– 🗆 X
Install Check the items that you wish to install.		
Name	Version 1.0.0.v20211205-0	ld com.renesas.qe.motor.feature.feature.gro
Select All Deselect All Details		
l		A .
?	< Back	Next > Finish Cancel

Figure 2-3 QE installation

In case that the following window appears, set it as a trusted tool. Then the installation will be executed.

Trust Do you trust	these signers?		×
Туре	ld	Name	
✓ x509	1478131948	REE-SSD Eclipse; Broad-based Solution Bu	siness Unit; Renesas
<			>
		Select All	Deselect All
		Business Unit; Renesas Electronics Europe Ltd. on Business Unit; Renesas Electronics Europe Ltd.	
⊲ Details			
?		Trust selected	Cancel

Figure 2-4 Trusted tool



The installation status of QE for Motor is displayed at the bottom right of  $e^2$  studio. Installation is complete when you restart  $e^2$  studio.



**Figure 2-5 Installation Status** 



### 2.2 Installation of Renesas Motor Workbench

The tuning and the analyzer functions use Motor Control Development Support Tool Renesas Motor Workbench. The Renesas Motor Workbench needs to be installed to use these functions. There are to methods to install the Renesas Motor Workbench.

#### (1) Install from QE for Motor Workflow

The Renesas Motor Workbench can also be downloaded and installed from QE for Motor view. Refer to "4.1.4.1 Install Renesas Motor Workbench" for how to install Renesas Motor Workbench from QE for Motor workflow view.

#### (2) Download the installer manually

Download "Renesas Motor Workbench" package file from the Renesas website.

Unzip the package file, and execute "renesas\_motor\_workbench\_\*\*\*.msi" under the installer folder, and install as shown in the bellow figure.

记 Renesas Motor Workbench - 🗆 🗙	🔀 Renesas Motor Workbench - 🗆 🗙
Welcome to the Renesas Motor Workbench Setup Wizard	Select Installation Folder
The installer will guide you through the steps required to install Renesas Motor Workbench on your computer.	The installer will install Renesas Motor Workbench to the following folder. To install in this folder, click "Next". To install to a different folder, enter it below or click "Browse".
WARNING: This computer program is protected by copyright law and international treaties. Unauthorized duplication or distribution of this program, or any portion of it, may result in severe civil	Eolder: C:¥Program Files (x86)¥RenesasElectronics¥Renesas Motor Wor Disk Cost Install Renesas Motor Workbench for yourself, or for anyone who uses this computer:
or criminal penalties, and will be prosecuted to the maximum extent possible under the law.	○ Everyone ● Just me < Back Next > Cancel
Renesas Motor Workbench – C X Confirm Installation	Renesas Motor Workbench – – × Installation Complete
The installer is ready to install Renesas Motor Workbench on your computer. Click "Next" to start the installation.	Renesas Motor Workbench has been successfully installed. Click "Close" to exit.
< Back Next > Cancel	Please use Windows Update to check for any critical updates to the .NET Framework.

Figure 2-6 Installation of Renesas Motor Workbench



# 2.3 Board Connection

This section explains how to connect the PC and the evaluation board. The connection method differs between when downloading the program and when tuning or analyzing the motor operation.

### 2.3.1 Connection when downloading a program

Figure 2-7 shows the connection diagram when downloading the program. The connection of peripherals other than CPU board does not affect the program downloading.

### • MCK-RA6T2



Figure 2-7-1 Connection diagram when downloading a program (MCK-RA6T2)



### • MCK-RX26T



Figure 2-7-2 Connection diagram when downloading a program (MCK-RX26T)

This connection is used in the following operations.

- Download the tuning program to the MCU
- Download the application for analysis to the MCU



### 2.3.2 Connection when tuning or analyzing the motor operation

Figure 2-8 shows the connection diagram for tuning or analyzing the motor operation.

• MCK-RA6T2

Communication Board	CN3	Connect to PC via USB
	CN5	Connect to CPU Board with communication cable
CPU Board	CN10	Connect to Communication Board with communication cable
	CN4,CN5	Connect to Inverter Board
Inverter Board	CN3,CN4	Connect to CPU Board
	CN2	Connect to brushless DC motor
	J1 or CN1	Use J1 when supplying power from the DC jack
		Use CN1 when supplying power from the power supply
		connector



Figure 2-8-1 Connection diagram when analyzing the motor operation (MCK-RA6T2)



# • MCK-RX26T

Communication Board	CN3	Connect to PC via USB
	CN5	Connect to CPU Board with communication cable
CPU Board	CN6	Connect to Communication Board with communication cable
	CN1,CN2	Connect to Inverter Board
Inverter Board	CN3,CN4	Connect to CPU Board
	CN2	Connect to brushless DC motor
	J1 or CN1	Use J1 when supplying power from the DC jack
		Use CN1 when supplying power from the power supply
		connector



Figure 2-8-2 Connection diagram when analyzing the motor operation (MCK-RX26T)

This connection is used in the following operations.

- Tuning by starting tuner
- Analyzing the motor control by starting analyzer



# 3. Development Procedure

By operating according to the workflow of QE for Motor, you can implement and validate the motor control software.

Each item is show in Table 3-1. The chapter number in this table are linked to related chapters. Click the chapter number to see how to use it.



Figure 3-1 Development procedure of motor control software

Items		Contents	Chapter number
Preparation	Select Target Project	Prepare the project and set it as the target project	4.1.2
	Configure Motor Software	Configure the motor control software with FSP	4.1.3
	Configure Tool	Set the path of Renesas Motor Workbench	4.1.4
Tuning	Prepare Tuning Program	Copy the tuning program for the motor to be used from Renesas Motor Workbench install folder	4.2.1
	Download Tuning Program	Download tuning program to MCU	4.2.2
	Start Tuner	Start tuner function of Renesas Motor Workbench and output the tuning result to the header files.	4.2.3
Analyze	Build Application Program	Build the program	4.3.1
	Download Application Program	Download the built program to MCU	4.3.2
	Start Analyzer	Start Analyzer function of Renesas Motor Workbench and analyze the motor operation	4.3.3



# 4. Operation Example

Renesas website offers a variety of motor control sample projects.

This chapter describes the procedure for tuning and analyzing using QE for Motor. The following sample project is used in this chapter.

- RA Family :
  - RA6T2 Sensorless vector control for permanent magnetic synchronous motor (R01AN6839)
- RX Family :

RX26T RAM64KB Version Sensorless vector control for permanent magnetic synchronous motor (R01AN6858)

For details on the sample project, refer to the application note included in each sample program.

# 4.1 Preparation

Start e<sup>2</sup> studio. Create the workspace so that the folder name does not include space.

Esample :

- C:¥workSpace Good
- C:¥work Space Not Good

### 4.1.1 Start QE for Motor

Select Motor Workflow (QE) from the e<sup>2</sup> studio menu as shown below to display Motor Workflow view of QE for Motor.

File Edit Source Refactor Navigate Search P Image: Source Refactor Navigate Search P       Image: Source Navigate Search P    <	RA6T: C/C++	Help
A Decision of the second secon	Turing	
Preparation	Tuning	Analyze
Preparation -		Prepare project
	Downlo	
1.Preparation     Prepare Project		Prepare project  ad and import motor sample program  Device :
1.Preparation       Prepare Project       Introduce Related Tool       2.Tuning	Downlo	Prepare project
1.Preparation       Prepare Project       Introduce Related Tool       2.Tuning       Tuning       3.Analyze	Downlo Select target project	Prepare project  ead and import motor sample program  Device : Part Number :

Figure 4-1 Selection of Motor Workflow (QE)



# 4.1.2 Project Selection

# 4.1.2.1 Import of the project

Download the sample project from Renesas web site and import that into e<sup>2</sup>studio workspace as shown below.

QE for Motor		
Preparation	Tuning Analyze	
1.Preparation	Prepare project	ĺ
Prepare Project		
Introduce Related Tool	Download and import motor sample program	
2.Tuning	Select target project	~
Tuning	Dev	ice :
3.Analyze	Part Numb     Motor Control Syste	
Analyze		
	Software iguration	
	Open Motor Contraction	
	Select the region of the downlo for the first time.	ad site
	Select your region.	
	Americas Brazil Europe/Middle East/Africa India	









Figure 4-2 Project import



# 4.1.2.2 Target Project Selection

Select the imported project as the target project as shown in the figure below.



Figure 4-3 Target project selection



### **RA/RX** Family

### 4.1.3 Motor Software Configuration

The sample project does not need to be changed because the required software settings have already been made. This chapter describes how to check and change the software settings when the setting needs to be changed by a change in the board configuration or other reasons.

### 4.1.3.1 Software Configuration for RA Family

The sample project was created with a certain version of FSP. If FSP version you are using is different, perform the code generation in (3) even if you do not change the settings.

### (1) Viewing FSP Configuration

Click "Start Configuration" of "Configure Motor Software" as shown below to display the FSP Configuration window.

					8 - 0
A ≥ O QE for Motor					
Preparation		Tuning		Analyze	
1.Preparation		<u>∧</u> ▼	Prepare project		
Prepare Project					
Introduce Related Too	k	Select target project	oad and import motor samp	e program	- 1
2.Tuning	-	RA6T2_MCILV1_SPM_LESS_F	OC_E2S_V110	~ @	9
Tuning				Device : RA6T2	
3.Analyze	-			Number : R7FA6T2BD3CFP @ : Sensorless Vector Control @	
Analyze			Hotor condition by stern		
			Software Configuration	on	
		Open	Motor Control Software Cor	figuration	
			-		
🕼 Motor Main (QE) 🏾 🔅 *[RA6T2_M	CILV1_SPM_LESS_FOO	C_E2S_V100] FSP Configuration ×			
Motor Main (QE)	ICILV1_SPM_LESS_FOO	C_E2S_V100] FSP Configuration $\times$		Generate Project (	
Stacks Configuration	ICILV1_SPM_LESS_FOO		Ð		Content
Stacks Configuration	HAL/Common Star	icks		Generate Project ( New Stack > ≗ Extend Stack > இ R	Content
Stacks Configuration Threads New Thread Remove		icks	<ul> <li>Control (m_motor_sensorless)</li> </ul>	Generate Project ( New Stack > ≗ Extend Stack > இ R	Content
Stacks Configuration Thread	HAL/Common Star	icks		Generate Project ( New Stack > ≗ Extend Stack > இ R	Content
Stacks Configuration Thread Thread Hew Thread Hal/Common	HAL/Common Star	ncks	Control (rm_motor_sensorless)	Generate Project ( New Stack > ≗ Extend Stack > இ R	Content Remove
Stacks Configuration Thread	HAL/Common Star	Incks  Port  Motor Sensorless Vector  Motor Speed Controller	Control (rm_motor_sensorless)	Generate Project 1 New Stack >	Content Remove
Stacks Configuration Thread	HAL/Common Star	icks D Port D Motor Sensorless Vector D	Control (rm_motor_sensorless)	Generate Project ( New Stack >	Content Remove
Stacks Configuration Thread	HAL/Common Star	ccks  Port    Motor Sensorless Vector    Motor Speed Controller	Control (m_motor_sensoriess) (m_motor_speed)	Generate Project 1 New Stack >	Content Remove
Stacks Configuration Thread	HAL/Common Star	Acts  D Port  Motor Sensorless Vector  Motor Speed Controller  Motor Speed Controller	Control (m_motor_sensoriess)	Generate Project 1 New Stack >	Content Remove
Stacks Configuration	HAL/Common Star	ccks  Port    Motor Sensorless Vector    Motor Speed Controller	Control (m_motor_sensoriess) (m_motor_speed)	Generate Project I New Stack > A Strend Stack > (C) R Motor Current Controller (m_moto (D) ADC and PWM Modulation (m_mo (D)	Content Remove
Stacks Configuration Thread: New Thread Remove  Status Sta	HAL/Common Star	ccks  Port    Motor Sensorless Vector    Motor Speed Controller	Control (m_motor_sensoriess) (m_motor_speed)	Generate Project I New Stack > ≗ Extend Stack > () R	Content Remove
Stacks Configuration	HAL/Common Star	ccks  Port    Motor Sensorless Vector    Motor Speed Controller	Control (m_motor_sensoriess) (m_motor_speed)	Generate Project I New Stack > ≗ Extend Stack > iΩ R Motor Current Controller (m, moto Ф ADC and PWM Modulation (m,moto Ф Ф ADC and PWM Modulation (m,moto Ф Ф ADC and PWM Modulation (m,moto Ф)	Content Remove
Stacks Configuration	HAL/Common Star	ccks  Port    Motor Sensorless Vector    Motor Speed Controller	Control (m_motor_sensoriess) (m_motor_speed)	Generate Project New Stack > ▲ Extend Stack > (C) R Motor Current Controller (m, moto	Content Remove

Figure 4-4 FSP Configuration View



#### (2) Viewing FSP Visualization

Click the middleware "Motor Sensorless Vector Control" of FSP Configuration to display the connection diagram of the blocks that configure "Motor Sensorless Vector Control" in the FSP Visualization window. The FSP Visualization window is a configuration GUI for motor control software. You can change the setting values on GUI.



Figure 4-5 FSP Visualization view

In case that FSP Visualization is no displayed even if you click the middleware name of FSP Configuration, you can display it from the menu of e<sup>2</sup> studio as shown in the figure below.



Figure 4-6 Display FSP Visualization from the menu



### **RA/RX** Family

Click "Motor Speed Controller" of FSP Visualization to display the detailed in-block connection diagram with the setting values as shown in the figure below. With the in-block connection diagram displayed, click "Motor Sensorless Vector Control" at the top of the window to return to the block connection diagram. The same operation is performed for other blocks.

🖹 Problems 🗔 Console 🚇 Smart Browser 💷 Smart Manual 🐤 FSP Visualization 🗙
Motor Sensoriess Vector Control
Motor Speed Controller
Limit of Over Current [A] 1.67F
Limit of Over Voltage [V] 60.0F
Limit of Over Speed [rpm] 4500.0F
Limit of Low Voltage [V] 8.0F
R Problems 🗉 Con 🖓 Smart Browser 🤑 Smart Manual 🌮 FSP Visualization 🗙
Motor Sensorless Vector Control Motor Speed Controller
Motor Speed Controller Sensorless State Openloop State
Speed control period [s]         0.0005F         Limit of q-axis current [A]         1.67F
Reference Speed PI
Step of speed climbing (rpm) 0.5F Speed PI loop omega 5.0F
Max rotational speed [rpm] 2400.0F
Sensorless to Open-loop Transition
Speed at Id dimbing [rpm] 400
Low Pass Filter
Speed LPF omega (rad/s) 10.0F
Cutoff frequency of phase 10.0F
Cutoff frequency of phase

Figure 4-7 Display of the in-block connection diagram (RA family)



The settings in the FSP Visualization window correspond to the values displayed in the FSP Configuration properties. If you change one value, it will be reflected in the other value.



Figure 4-8 Linkage between FSP Visualization and FSP Configuration

### (3) Code Generation for Middleware

In case the settings are changed in the FSP Visualization window, or in the FSP Configuration properties, click "Generate Project Content" in the upper right corner of the FSP Configuration window to reflect them in your code.

_							_	
New Thread	HAL/Common Stacks						🄄 New Stack > 🐣	Extend Stack > 👔 Rei
Remove	🕀 Motor Sensorless Vecto	or Control (rm_motor_sensorle	ss)					
HAL/Common g_ioport I/O Port (r								
Motor Sensorless V	•							
g_poeg0 Port Outp		1	1		<b>A</b>			
	Motor Speed Controlle	er (rm_motor_speed)	🕀 Motor Current Controll	er (rm_motor_current)				
	G		G					
		•						
	g_timer3 Timer,	Add Position Module	+ ADC and PWM Modula	tion (rm_motor_driver)				+ g_motor_angle0
	Low-Power (r_agt)	[Optional]						Motor Angle (rm motor estimation
	i		<b>i</b>					<b>(i)</b>
		J [		[]	<b>▲</b>			, L
>			g_adc0 ADC Driver on r_adc_b	Add ADC driver2 to support 1shunt	Three-Phase PWM (r_gp	t_three_phase)		
New Object >			0	[Option]	<b>(i)</b>			
Remove						<b>^</b>		1
					🕀 g_timer0 Timer,	g_timer1 Timer,	g_timer2 Timer,	
					General PWM (r_gpt)	General PWM (r_gpt)	General PWM (r_gpt)	
					1	1	1	
								1

Figure 4-9 Code generation for modified middleware settings



# 4.1.3.2 Software Configuration for RX Family

### (1) Viewing FSP Configuration

Click "Start Configuration" of "Configure Motor Software" as shown below to display the Motor Middleware Configuration (QE) window.



Figure 4-10 Motor Middleware Configuration (QE) View



The FSP Visualization window is a configuration GUI for motor control software. You can change the setting values on GUI.

Click "Motor Speed Controller" in the Motor Middleware Configuration (QE) view to display the detailed inblock connection diagram with the setting values as shown in the figure below. With the in-block connection diagram displayed, click "Motor Sensorless Vector Control" at the top of the window to return to the block connection diagram. The same operation is performed for other blocks.

Motor Middleware Co							
Motor Sensorless Vec	or Control			Two-Shur	t -		
	Speed oller	Motor Current Controller	ADC and PWM Modulation Driver		M		
Nominal Cur Limit of Over Limit of Over Limit of Low	Voltage [V] 60 Speed [rpm] 4500						
Generate Code	1			۶			
	afire the (OE) X			P	P		
Generate Code Motor Middleware Co		lodule		2			Two-Shun
Motor Middleware Co		odule		2			Two-Shun
Motor Middleware Co Motor Sensorless Vec Motor Speed Controller Sensorless State Ope	tor Control Speed M	lodule		2			Two-Shunt
Motor Middleware Co Motor Sensorless Vec	tor Control > Speed M	Speed PI Speed PI loop omoga Speed PI loop zeta	3.07 (P)	ia* weskening ig*			••
Motor Middleware Co Motor Sensorless Vec Motor Speed Controller Sensorless State Ope Speed control perio Reference Spee Rate limit of speed Max rotational spee Low Pass Filter	tor Control Speed M	Speed PI Speed PI loop omega Speed PI loop zeta	3.01 ①	ia* weskening ig*		W A	Two-Shund
Motor Middleware Co Motor Sensorless Vec Sensorless State Ope Speed Controller Speed Control perio Reference Spee Rate limit of speed c Max rotational spee	tor Control State nicop State 1 [c] 0.00057 d hange 1000.07 2 400.07 2 5.07 0	Speed PI Speed PI loop omega Speed PI loop zeta	3.01 (1) 1.01 (1)	weakaning Ar	Móter Current	ADC and PWM Modulation Driver	••
Motor Middleware Co Motor Sensorless Vec Motor Speed Controller Speed Controller Speed Controller Rate limit of speed co Max rotational spee Low Pass Fitter Speed LPF emega Cutoff thequency of error LPF [rad]	tor Control Speed M nloop State 1 [s] 0.00057 d nange 1000.07 2400.07 25.07 7	Speed PI Speed PI loop omega Speed PI loop zeta	3.01 (1) 1.01 (1)	weakaning Ar	Móter Current	ADC and PWM Modulation Driver	••
Motor Middleware Co Motor Sensorless Vec Sensorless State Speed Controller Reference Spee Rate limit of speed of Max rotational spee Low Pass Fitter Speed LPF omega Cutoff thequency of error LPF (rad)	tor Control State ntoop State a (s) 0.00057 d hange 1000.0r (1000.0r (25.07) (	Speed PI Speed PI loop omega Speed PI loop zeta	3.01 (1) 1.01 (1)	weakaning Ar	Motor Current Controller	ADC and PWM Modulation Driver	••

Figure 4-11 Display of the in-block connection diagram (RX family)



The settings in the Motor Middleware Configuration (QE) window correspond to the values of the motor specific parameters and the motor control parameters in the motor control software.

<pre>#* Includes Cystem Includes , "Project Includes"]</pre>		getmotor_cfg.h ×	 Motor Middleware Configurator (QE) ×	
	34 36 37 38 39 40 41 42 43 44 44 45 50 51 55 55 55 55 55 55 55 55 55 55 55 55	<pre>** Includes Csystem Includes) , "Project Includes"[ /* BN cotput files */ #Enclude "r_str_potor_parameter.h" #Eff(ITL_PoToR_DAWHETER != 1) #/ #Eff(ITL_PoToR_COMPADL(FC_HTR_GAZELDDBL3 // Default motor parameters : HODIS' */ * Hourd definition() /* Inorgate HotoR_COMPADL(FC_HTR_GAZELDDBL3 // Default motor parameters : HODIS' */ * Hourd definition() #Efficien HOTOR_CFG_UPALEDDBL3 // Default motor parameters : HODIS' */ * Hourd definition() #Efficien HOTOR_CFG_UPALEDDBL3 // Humber of pole pairs */ #Efficien HOTOR_CFG_UPALEDDBL3 // HealtInce(Edm) */ #Efficien HOTOR_CFG_UPALEDDBL3 // HealtInce(Edm) */ #Efficien HOTOR_CFG_UPALEDDBL3 // HealtInce(Edm) */ #Efficien HOTOR_CFG_UPALEDDBL3 */ #Efficien HOTOR_CFG_UPALEDDBL3 */</pre>	Motor Speed         4"         Motor Current         We have been been been been been been been be	Two Shurt

Figure 4-12 Correspondence between GUI and parameter values

### (2) Code Generation for Middleware

In case the settings are changed in the Motor Middleware Configuration (QE) window, click "Generate Code" to modify the source code.



Figure 4-13 Code generation for modified middleware settings (RX family)



#### (3) Viewing Motor Driver Configuration

A sample project used in this guide (Sensorless Vector Control for Permanent Magnet Synchronous Motor For RX26T RAM64KB Version : RX26T\_MCBA\_MCILV1\_SPM\_LESS\_FOC\_E2S\_Vxxx) is configured by the Motor Component of the Smart Configurator for peripheral drivers. If you need to change driver configurations such as a timer operation period or output pins, please change the settings on the Smart Configurator. Here is an example of how to change timer channels and output pins.

🏠 Project Explorer 🛛 🔚 😘 🍞 🖇 🗖	Motor Workflow (QE)     RX26T_MCBA_N	CILV1_SPM_LESS_FOC_E2S	V110.scfg ×	
RX26T_MCBA_MCILV1_SPM_LESS_FOC_E2S_V110 [Hardware & Binaries	Overview information			Generate Code Generate Report
> 🔊 Includes	✓ General Information			O
ArdwareDebug     A	Overview           Get an overview         Get an overview of the features printeduction to Smart Configurates           Wideos         Introduction to Smart Configurates           Browse related videos         What's New           Check out shaf's new in the latest see all Breases Notes.         Product Documentation           User's Guide         Application Notess           Tool news         Tool news	α.	Application Code Software Components Middleware & Drivers Device Drivers MCU Hardware	Ð
	Selected board/device: R5F526TFCxFP (ROM siz Generated location (PRO)ECT_LOC#): src¥smc_c Selected components:		Kbytes, Pin count: 100) Edit	
	Component © Board Support Packages. (r_bsp) © Compare Match Timer © Motor © Port Output Enable © Ports	Version 7.41 2.3.0 1.1.0 1.11.0 2.4.1	Configuration r_bsp(used) Config_CMT0(CMT0: used) Config_MOTOR(MTU3_MTU4: used) Config_POE(POE: used) Config_POE(POE: used)	

Selecting the Component tab and clikcing Configu\_MOTOR open the motor driver configuration.

✓ SRX26T_MCBA_MCILV1_SPM_LESS_FOC_E2S_V110 > Stanties	Software component configur	ation 😼 🚵 Generate Code Generate Repor
> 🔊 Includes > 👝 app	Components $\succeq$ $\bowtie$ $ ^{2}_{\mathbb{Z}} \boxdot$ $\textcircled{\blacksquare}$ $\textcircled{\Rightarrow}$ $$	Configure
	Components in a line in the second se	Timer Setting       A/D Converter Setting         Period setting       Imer Operation Period         Timer Operation Period       90         Counter clock division rate       1         TGRA register value       3240         Dead time       2         Upped time       2         Output Pulse and A/D Conversion Trigger Setting         A/D Conversion Trigger Sizeble skipping function         A/D Conversion Trigger Interval         20000 HHz         Image: Current Control (A/D Conversion Trigger)         Current Control (A/D Conversion Trigger)         Prins         Active Level         Up         High
		<
	Overview Board Clocks System Compor	ents Pins Interrupts

Figure 4-14 Opening Motor Driver Configuration



The timer channels can be changed as follows.

	Motor Workflow (QE)	BA_MCILV1_SPM_LESS_FOC_E2S_V110.sci	fg ×			
	Software component configura	ition		Generate Code Generate Report		
	Components 🚵 🖾 🛱 🕀 🌩 🔻	Configure		^		
	Config.512 Config.512 Config.00T Config.00T Config.00T Config.0VDT Config.0VDT Config.POE	Generate code 2 2 2 2 2 2 2 2 2 2 4 4 4 4 4 4 4 4 4 4 4 4 4	0 µs V (Actual frequency:			
	Resource Selection dialog,					
Resource		– 🗆 X	Sesource Selection			×
Resource S			Configuration setting selectio	on		
Select resou	arce from those available in the list		Configuration setting list			
Motor type:	3-Phase Brushless DC Motor	~	Confirm setting for resource change	e   Use setting below	se default	
Resource:	MTU3_MTU4	~	Setting	Value	Portable	1
	MTU3_MTU4 MTU6_MTU7		V Timer Setting	Used	Yes	
	GPT0_GPT1_GPT2		Un	Used	Yes	
	GPT4 GPT5 GPT6		Vp	Used	Yes	
	Triangle_GPT		Vn Wp	Used Used	Yes Yes	
		gle PWM mode)	Wn	Used	Yes	
	Example : Change to GPT (Trian					
	Example : Change to GPT (Trian		Up phase output	High	Yes	

Figure 4-15 Changing timer channels



An assignment of a pin function can be changed as follows.

Pin configuratio	n						Ge	nerate Code		te Report
Software Component		Jª <mark>z ය</mark> Pin	Function					2		24
		ty	pe filter tex	xt (* = any stri	ng, ? = any character)			All		~
V 📩 Ports		Er	nabled F	Function	Assignment		Pin N	umber	Directio	n ^
Config_PO				DSM0	Not assigned		/ No	t assigned	None	
V 🔬 Single Scan N				DSM1	Not assigned			t assigned	None	_
Config_S12				DST0	Not assigned			t assigned	None	_
Config_CM				ADST1 ADST2	<ul> <li>Not assigned</li> <li>Not assigned</li> </ul>			t assigned t assigned	None None	_
🗸 🚣 Watchdog Tin				DTRG0#	Not assigned			t assigned	None	_
Config_IW				DTRG1#	Not assigned			t assigned	None	
V 📩 Port Output	le			DTRG2#	Not assigned			t assigned	None	
Config Motor				N000	P40/AN000/CMPC0	0/CMPC01	/ 91	taccionad	1 None	
	TOR			N001	<ul> <li>Not assigned</li> <li>P42/AN002/CMPC2</li> </ul>	0/CMPC21	/ NO	t assigned	None	
✓ 📩 r_bs	PR-108.1			N002	P43/AN002/CMPC2		/ 88		1	_
				N100	Not assigned			t assigned	None	
				N101	Not assigned			t assigned	None	
				N102	Not assigned			t assigned	None	
				N103 N200	<ul> <li>Not assigned</li> <li>Not assigned</li> </ul>			t assigned t assigned	None	
		<								>
guration	-	Pin		tions u	used for the I	motor contro	l drive			
upin in the Assignation	Pin Function	Pin	func		used for the i	motor contro	l drive			
nponents 🕀 🕞 🖧 😹	Pin Function	Pin con	func nfigura	ation (		motor contro OR) is listed	l drivei d.			
aponents 🕀 🖻 🖓 😹	Pin Function type filter to Enabled	Pin	func figura		Config_MOT	motor contro	l drive			
ration ponents 🕑 🕞 🔩 😹 rt fig_PORT Scan Mode S12AD	Pin Function type filter t Enabled	Function AN000 AN001	func figura Assign Assign P40	nment 0/AN000/CMP	Config_MOT	FOR) is listed	l drivei d.			
ration ponents 🕑 🕞 🔩 😹 tt tfg_PORT Scan Mode \$12AD tfig_\$12AD2	Pin Function type filter to Enabled	Function AN000 AN001 AN002	Assign Assign Assign P40 Not P42	nment 0/AN000/CMP4 t assigned 2/AN002/CMP4	Config_MOT	Forest Contro FOR) is listed Pin Number 91 Not assigned 89	Direction			
ration ponents	Pin Function type filter t Enabled V V	Function AN000 AN001 AN002 AN003	Assign Assign P40 Not P42 P43	nment 0/AN000/CMP4 t assigned 2/AN002/CMP4 3/AN003	Config_MOT	Forest Contro TOR) is listed Pin Number # 91 Not assigned # 88	Direction I None I			
ration  ponents	Pin Function type filter to Enabled	Function AN000 AN001 AN002 AN003 AN100	Assign P40 Not P42 P43 Not P43 Not	nment 0/AN000/CMP4 tt assigned 2/AN002/CMP4 3/AN003 tt assigned	Config_MOT	Fin Number 91 Not assigned 91 Not assigned 88 Not assigned	Direction I None I None			
ration  ponents	Pin Function type filter t Enabled	Pin con function AN000 AN001 AN002 AN003 AN100 AN101 AN102	Assign P40 Not P42 P43 Not P43 Not P43 Not Not Not	ation ( nment 0/AN000/CMPr tassigned 2/AN002/CMPr 3/AN003 at assigned at assigned at assigned at assigned	Config_MOT	Forest Cod motor Contro OR) is listed Pin Number # 91 Not assigned # Not assigned # Not assigned	Direction I None I			
ration  ponents	Pin Function type filter t Enabled	Function AN000 AN001 AN002 AN003 AN100 AN101 AN102 AN103	Assign P 40 Not P 42 P 43 Not Not Not Not Not Not Not Not Not Not	ation ( nment 0/AN000/CMPH tassigned 2/AN002/CMPH 3/AN003 tt assigned tt assigned tt assigned tt assigned tt assigned	Config_MOT	Forest Contro TOR) is listed Pin Number 91 Not assigned Not assigned Not assigned Not assigned Not assigned	Direction I None I None None None None None			
ration  ponents	Pin Function type filter t Enabled	Function AN000 AN001 AN003 AN100 AN101 AN100 AN101 AN103 AN103	Assign Assign P40 Not P42 P43 Not Not Not Not Not Not Not Not Not Not	ation ( nment 0/AN000/CMPi trassigned 2/AN002/CMPi 3/AN003 at assigned trassigned trassigned trassigned trassigned trassigned	Config_MOT	Fin Number 91 Not assigned 88 Not assigned Not assigned Not assigned Not assigned Not assigned Not assigned	Direction I None I None None None None None None None			
ration  ponents  T  fig_PORT Scan Mode S12AD  fig_S12AD2 are Match Timer  fig_CMT0 dog Timer  fig_WDT  utput Enable  fig_POE	Pin Function type filter t Enabled Y	Function AN000 AN001 AN002 AN003 AN100 AN101 AN102 AN103 AN100 AN101 AN102 AN103 AN100 AN201	Assign P40 P40 P42 P43 Not P43 Not P43 Not Not Not Not Not Not Not Not	ation ( nment 0/AN000/CMPi at assigned 2/AN002/CMPi 3/AN003 at assigned at assigned at assigned at assigned at assigned at assigned	Config_MOT	Forest Cod motor Contro OR) is listed Pin Number # 91 # Not assigned # Not assigned # Not assigned # Not assigned # Not assigned # Not assigned	Direction I None I None None None None None None None			
ration  ponents	Pin Function type filter to Enabled V V	Function AN000 AN001 AN003 AN100 AN101 AN100 AN101 AN103 AN103	Assign P40 Not P42 P43 Not Not Not Not Not Not Not Not Not Not	ation ( nment 0/AN000/CMPi trassigned 2/AN002/CMPi 3/AN003 at assigned trassigned trassigned trassigned trassigned trassigned	Config_MOT	Fin Number 91 Not assigned 88 Not assigned Not assigned Not assigned Not assigned Not assigned Not assigned	Direction I None I None None None None None None None			
ration  ponents  P P P P P P P P P P P P P P P P P P	Pin Function type filter tr Enabled V V	Function AN000 AN000 AN001 AN002 AN003 AN100 AN101 AN102 AN103 AN101 AN102 AN103 AN100 AN201 AN200 AN201 AN203 AN204	Assign Assign P40 Not P42 P43 Not Not Not Not Not Not Not Not Not Not	ation ( nment //AN000/CMP/ t assigned 2/AN002/CMP/ 3/AN003 it assigned t assigned t assigned t assigned t assigned t assigned t assigned t assigned t assigned	Config_MOT	Forest Contro TOR) is listed Pin Number # 91 Not assigned # 88 Not assigned Not assigned	Generate B     G			
ration  ponents  P P P P P P P P P P P P P P P P P P	Pin Function type filter to Enabled	Pin con con con con con con con con con co	Assign P40 P40 P42 P43 Not P42 P43 Not Not Not Not Not Not Not Not	ation ( nment 0/AN000/CMP t assigned t assigned	Config_MOT	Figure 2 (a) Figure 2 (a) Fi	Ganacia R     Ganacia R			
ration  ponents  P P P P P P P P P P P P P P P P P P	Pin Function type filter to Enabled V V	Punction Antoio Antoi Antoio Antoio Antoio Antoi An	Assign P40 P40 P42 P43 P43 P43 P43 P43 P43 P43 P43	ation ( nment 0/AN000/CMPP 0/AN000/CMPP 3/AN003 t assigned t assigned	Config_MOT	Fin Number 91 Not assigned Not assigned	Generate R     G			
ration  ponents  P P P P P P P P P P P P P P P P P P	Pin Function type filter tv Enabled V	Pin con con con con con con con con con co	Assign P40 Not P42 P43 Not Not Not Not Not Not Not Not	ation ( nment 0/AN000/CMP t assigned t assigned	Config_MOT	Figure 2 (a) Figure 2 (a) Fi	Ganacia R     Ganacia R			
ration  ponents  P P P P P P P P P P P P P P P P P P	Pin Function type filter to Enabled V V	Punction Ant	func           Assign           P40           Not           P42           P43           Not	ation ( nment 0/AN000/CMPP t assigned 2/AN002/CMP 3/AN003 t assigned t assigned	Config_MOT	Forest Cod motor Contro OR) is listed Pin Number / 91 / Not assigned / Not assigned	Generate R     Orivel     None			
ration ponents	Pin Function  type filter tv  Enabled  V	Function AN000 AN001 AN002 AN003 AN100 AN101 AN102 AN103 AN100 AN101 AN102 AN103 AN200 AN201 AN203 AN204 AN205 AN205 AN205 AN207 AN205 AN207 AN209 AN210	Assign P4Q P4Q P4Q P42 P43 Not Not Not Not Not Not Not Not	ation ( nment 0/AN000/CMPI t assigned t assigned	Config_MOT	Forest Cod motor Contro OR) is lister Pin Number / 91 / Not assigned / Not assigned	Connector R     Direction     I     None     None			
ration ponents	Pin Function  type filter to  Fnabled	Pin Con Eunction AN000 AN001 AN001 AN001 AN001 AN001 AN102 AN100 AN100 AN100 AN100 AN100 AN100 AN100 AN100 AN100 AN100 AN201 AN200 AN200 AN205 AN206 AN205 AN206 AN207 AN208 AN209 AN210	func Assigr Not P42 Not Not Not Not Not Not Not Not Not Not	ation ( mment 0/AN000/CMPh //AN000/CMPh t assigned t	Config_MOT	Forest Contro TOR) is listed Pin Number 91 Not assigned Not assigned	Generate R     Oriection     I     Direction     I     None     None			
ration ponents	Pin Function  type filter t  Enabled  Y  U  U  U  U  U  U  U  U  U  U  U  U	Punction AN000 AN001 AN002 AN003 AN100 AN101 AN103 AN103 AN103 AN200 AN201 AN203 AN204 AN203 AN204 AN205 AN206 AN205 AN206 AN207 AN206 AN207 AN206 AN207 AN206 AN207 AN206 AN207 AN206 AN207 AN206 AN207 AN206 AN207 AN206 AN207 AN206 AN207 AN206 AN207 AN206 AN207 AN206 AN207 AN206 AN207 AN206 AN207 AN206 AN207 AN206 AN207 AN206 AN207 AN2	func           Assign           P40           P42           P42           P43           Not	ation ( nment 0/AN000/CMPP t assigned t assigned	Config_MOT	Formation Control FOR) is lister Pin Number 91 Not assigned Not assigned	Generate R     G			
ration  ponents  P P P P P P P P P P P P P P P P P P	Pin Function  type filter tv  Enabled  V	Pin Con Eunction AN000 AN001 AN001 AN001 AN001 AN001 AN102 AN100 AN100 AN100 AN100 AN100 AN100 AN100 AN100 AN100 AN100 AN201 AN200 AN200 AN205 AN206 AN205 AN206 AN207 AN208 AN209 AN210	Assign P4Q P4Q P4Q P43 P43 P42 P43 Not Not Not Not Not Not Not Not	ation ( mment 0/AN000/CMPh //AN000/CMPh t assigned t	Config_MOT co0/cmpco1 c20/cmpc21 c42	Fin Number 91 Not assigned Not assigned	Generate R     G			
ration  ponents  P P P P P P P P P P P P P P P P P P	Pin Function  type filter t  Enabled  Y  U  U  U  U  U  U  U  U  U  U  U  U	Pin           Function           AN000           AN001           AN002           AN003           AN100           AN100           AN101           AN103           AN103           AN103           AN103           AN103           AN202           AN203           AN204           AN205           AN206           AN206           AN207           AN208           AN209           AN211           AN216           AN217           GTICCOB	func           Assign           P40           P42           P42           P43           Not	ation ( nment b/AN000/CMPI t assigned t assigned	Config_MOT coo/cmpco1 c20/cmpc21 c42 Example : 0	Fin Number 91 Not assigned Not assigned	Generate R     G		for	GTIC
ration  ponents	Pin Function  type filter tv  Enabled  V  U  U  U  U  U  U  U  U  U  U  U  U	Function AN000 AN001 AN002 AN003 AN100 AN101 AN102 AN103 AN100 AN101 AN102 AN103 AN200 AN201 AN203 AN204 AN205 AN204 AN205 AN205 AN205 AN207 AN206 AN216 AN207 AN206 AN216 AN207 AN206 AN216 AN207 AN206 AN216 AN207 AN206 AN216 AN207 AN206 AN216 AN207 AN206 AN216 AN216 AN216 AN217 AN206 AN216 AN216 AN217 AN206 AN217 AN206 AN217 AN206 AN217 AN206 AN217 AN206 AN217 AN216 AN216 AN2	Assign P4Q P4Q P4Q P4Q P4Q P4Q P4Q P4Q	ation ( nment 0/AN000/CMPI t assigned t assigned	Config_MOT coo/cMPC01 c20/CMPC21 c42 C42 Example : (	Construction     Construction     Construction     Construction     Construction     Construction     Construction     Pin Number     91     Not assigned	Canaccia R     Canaccia R     Direction     I     None     No		for (	GTIC
ration  ponents	Pin Function  type filter to  Fnabled  V	Pin           Function           AN000           AN001           AN002           AN003           AN003           AN102           AN103           AN102           AN103           AN102           AN103           AN102           AN103           AN102           AN103           AN201           AN201           AN202           AN203           AN204           AN205           AN206           AN207           AN208           AN209           AN210           AN211           AN215           GTIOCCA           GTIOCCA           GTIOCCB           GTIOCCB	func           Assign           P42           Not	ation ( mment 0/AN000/CMP t assigned 2/AN002/CMP t assigned t assigned	Config_MOT coo/смрсо1 cco/смрс21 cca2 cca2 Example : 0 //sck12/sck01//txDB011/s	Construction     Construction     Construction     Construction     Construction     Construction     Construction     Pin Number     91     Not assigned	Generate R     G		for (	ĴΤΙC
ration  ponents	Pin Function  type filter t  Enabled  Y  U  U  U  U  U  U  U  U  U  U  U  U	Function AN000 AN001 AN002 AN003 AN100 AN101 AN102 AN103 AN100 AN101 AN102 AN103 AN200 AN201 AN203 AN204 AN205 AN204 AN205 AN205 AN205 AN207 AN206 AN216 AN207 AN206 AN216 AN207 AN206 AN216 AN207 AN206 AN216 AN207 AN206 AN216 AN207 AN206 AN216 AN207 AN206 AN216 AN216 AN216 AN217 AN206 AN216 AN216 AN217 AN206 AN217 AN206 AN217 AN206 AN217 AN206 AN217 AN206 AN217 AN216 AN216 AN2	func           Assign           Assign           P40           Not           Not <td>ation ( mment D/AN000/CMPP t assigned Z/AN002/CMP 3/AN003 tt assigned tt ass</td> <td>Config_MOT coo/cMPC01 c20/cMPC21 c20/cMPC21 c22 c42 c42 c42 c42 c42 c42 c42</td> <td>forest of control     motor contro     OR) is listed     Pin Number     91     Not assigned     Not assidnet     Not assigned     Not assigned     Not assigned     Not ass</td> <td>Generate R     Generate R     G</td> <td>ment</td> <td></td> <td></td>	ation ( mment D/AN000/CMPP t assigned Z/AN002/CMP 3/AN003 tt assigned tt ass	Config_MOT coo/cMPC01 c20/cMPC21 c20/cMPC21 c22 c42 c42 c42 c42 c42 c42 c42	forest of control     motor contro     OR) is listed     Pin Number     91     Not assigned     Not assidnet     Not assigned     Not assigned     Not assigned     Not ass	Generate R     G	ment		
ration ponents 🕀 🖻 🖧 😹	Pin Function  type filter t  Enabled  V  V	Pin           Function           AN000           AN001           AN002           AN003           AN100           AN103           AN103           AN103           AN103           AN103           AN103           AN103           AN202           AN203           AN204           AN205           AN206           AN206           AN207           AN208           AN209           AN211           AN216           AN217           GTIOCCA           GTIOCCA	Assign Assign P40 P42 P42 P43 Not Not Not Not Not Not Not Not	ation ( nment 0/AN000/CMPI t assigned t assigned	Config_MOT coo/смрсо1 cco/смрс21 cca2 cca2 Example : 0 //sck12/sck01//txDB011/s	Constance Contro TOR) is listed Pin Number 91 Not assigned 98 98 Not assigned Not assigned	Generate R     G	ment		

Figure 4-16 Changing a pin assignment



### (4) Code Generation for Drivers

In case the settings are changed in the Smart Configurator, click "Generate Code".

Components 🚵 🛃 🎝 🔁 🕀 🌩 ·	Configure
type filter text ✓ ➢ Startup ✓ ➢ Generic ➢ r.psp ✓ ➢ Drivers ✓ ➢ Motor ✓ Config_MOTOR ✓ ➢ A/D Converter ☑ Config_S12AD2 ✓ ➢ I/O Ports ☑ Config_PORT	Timer Setting A/D Converter Setting Master/Slave settings Master Channel GPT0 ~ Slave Channel 1 GPT1 ~ Slave Channel 2 GPT2 ~ Period setting Timer Operation Period 50 µs ~ (Actual frequency: 20.000 kHz)
Config_PORT	Counter clock division rate           GTPR register value         3000

Figure 4-17 Code generation for modified driver settings (RX family)



# 4.1.4 Tool Settings

# 4.1.4.1 Install Renesas Motor Workbench

The Renesas Motor Workbench can be installed from "Download and install Renesas Motor Workbench" button in "Introduce Related Tool". The Renesas Motor Workbench installer can be downloaded and executed by this button.

Motor Workflow (QE) ×		8 -
♠ > ▲ QE for Motor		
Preparation	Tuning	Analyze
1.Preparation -	Introduce	Related Tool
Prepare Project		
Introduce Related Tool	Download and install Re	nesas Motor Workbench 🛕
2.Tuning -	Taol	Settings
Tuning		Settings
3.Analyze 🗸	Open QE for	Motor settings
Analyze		

Figure 4-18 Install Renesas Motor Workbench



# 4.1.4.2 Configure Renesas Motor Workbench path

Click "Open QE for Motor Settings" to set the path to the Renesas Motor Workbench which is started by QE for Motor. Select "Search automatically for Renesas Motor Workbench installation" to use the Renesas Motor Workbench installed into the PC.

⊘ Prepar	ation	π	uning	$\odot$	à	Analyze	
1.Preparation	-	^	Intro	duce Related Too	al.		
Prepare Project		<b>v</b>	2.1.0.0				
<ul> <li>Introduce Relate</li> </ul>	d Tool	ſ	Download and inst	tall Renesas Motor W	orkbench	Ø	
<u> </u>		L					
2.Tuning	•			Tool Settings			
Tuning				3			
3.Analyze	-		Open	QE for Motor settings	5		
	QE for Motor			•		□ × + ↔ + %	
My Renesas Reality Al Authenticat CE for BLE QE for Motor QE for OTA	C:¥Program Files (x86)	ench location tor Workbench.exe path ¥RenesasElectronics¥Renesa		Renesas Motor Workber	¢		
My Renesas Reality Al Authenticat Renesas QE QE for BLE QE for Motor QE for OTA Renesas Toolchain Me Smart Browser	General settings for QE fo Renesas Motor Workbo O Specify Renesas Mo C:#Program Files (x86) © Search automatical	ench location tor Workbench.exe path	ench installation		¢>	C→ ▼ 8 Browse	
My Renesas Reality AI Authenticat Renesas QE QE for BLE QE for Motor QE for OTA Renesas Toolchain Ma	General settings for QE for Renesas Motor Workbo O Specify Renesas Mo C:¥Program Files (x86) Search automatical Installation found at C.VPr Settings for getting san	ench location tor Workbench.exe path ¥RenesasElectronics¥Renesa ly for Renesas Motor Workbe	ench installation ronics\Renesas Motor We		¢>	C→ ▼ 8 Browse	
My Renesas Reality AI Authenticat Renesas QE QE for BLE QE for Motor QE for OTA Renesas Toolchain Ma Smart Browser Smart Configurator Smart Demo Smart Manual	General settings for QE for Renesas Motor Workbe O Specify Renesas Mo C:¥Program Files (x86) Search automatical Installation found at C:1Pr Settings for getting san Region setting:	ench location tor Workbench.exe path ¥RenesasElectronics¥Renesa ly for Renesas Motor Workbe ogram Files (x86)!RenesasElectr mple programs and related t	ench installation ronics/Renesas Motor We tools Americas		¢>	C→ ▼ 8 Browse	
<ul> <li>My Renesas Reality Al Authenticat</li> <li>Renesas QE QE for BLE QE for Motor QE for OTA Renesas Toolchain Ma Smart Browser</li> <li>Smart Configurator Smart Demo</li> <li>Smart Manual Support Folders</li> </ul>	General settings for QE for Renesas Motor Workbe O Specify Renesas Mot C:¥Program Files (x86) Search automatical Installation found at C:Pro Settings for getting san Region setting: HTTP communication for	ench location itor Workbench.exe path ¥RenesasElectronics¥Renesa ly for Renesas Motor Workbe ogram Files (x86)/RenesasElectr mple programs and related t imeout (sec):	ench installation ronics/Renesas Motor We tools Americas 180	orkbench\Renesas Motor V	¢>	C→ ▼ 8 Browse	
My Renesas Reality AI Authenticat Renesas QE QE for BLE QE for Motor QE for OTA Renesas Toolchain Ma Smart Browser Smart Configurator Smart Demo Smart Manual	General settings for QE for Renesas Motor Workbe O Specify Renesas Mot C: YProgram Files (x86) Search automatical Installation found at C: YPr Settings for getting san Region setting: HTTP communication for Automatically check	ench location itor Workbench.exe path ¥RenesasElectronics¥Renesa ly for Renesas Motor Workbe ogram Files (x86)IRenesasElectr mple programs and related t itimeout (sec): k for the latest version of Rer	ench installation ronics/Renesas Motor We tools Americas 180 nesas Motor Workbeng	orkbench\Renesas Motor \ ch	¢>		
My Renesas Reality Al Authenticat Renesas QE QE for BLE QE for Motor QE for OTA Renesas Toolchain Me Smart Browser Smart Configurator Smart Demo Smart Manual Support Folders Tracealyzer TraceX Run/Debug	General settings for QE for Renesas Motor Workbo O Specify Renesas Mo C:#Program Files (x86) Search automatical Installation found at C:VPr Settings for getting san Region setting: HTTP communication for Automatically check Motor sample program	ench location itor Workbench.exe path ¥RenesasElectronics¥Renesa y for Renesas Motor Workbe ogram Files (x86)!RenesasElectr mple programs and related t imeout (sec): k for the latest version of Rer n save directory:	ench installation conics/Renesas Motor We tools 180 nesas Motor Workbend C:¥Downloa	ch ch ch d	¢>		
pe filter text My Renesas Reality AI Authenticat Renesas QE QE for BLE QE for Motor QE for OTA Renesas Toolchain Ma Smart Browser Smart Chofigurator Smart Demo Smart Manual Support Folders Tracealyzer Tracey Run/Debug Scripting Terminal	General settings for QE for Renesas Motor Workbo Specify Renesas Moto C: #Program Files (x86) Settings for getting san Region setting: HTTP communication for Automatically check Motor sample program Renesas Motor Workbo	ench location tor Workbench.exe path ¥RenesasElectronics¥Renesa y for Renesas Motor Workbe ogram Files (x86)RenesasElectr mple programs and related t timeout (sec): k for the latest version of Rer n save directory: ench installer save directory:	ench installation ronics/Renesas Motor We tools Americas 180 nesas Motor Workbeng	ch ch ch d	Anch.exe		
pe filter text My Renesas Reality Al Authenticat CEF for BLE QE for Motor QE for OTA Renesas Toolchain Ma Smart Browser Smart Demo Smart Demo Smart Manual Support Folders Tracealyzer TraceX Run/Debug Scripting Terminal TextMate	General settings for QE for Renesas Motor Workbe Specify Renesas Moto C:¥Program Files (x86) Search automatical Installation found at C:1Pr Settings for getting sat Region setting: HTTP communication for Automatically check Motor sample program Renesas Motor Workbe COM Port to launch Re	ench location itor Workbench.exe path ¥RenesasElectronics¥Renesa ly for Renesas Motor Workbe ogram Files (x80)RenesasElectr mple programs and related t timeout (sec): k for the latest version of Ren n save directory: ench installer save directory: nesas Motor Workbench	ench installation ronics/Renesas Motor We tools 180 nesas Motor Workbeng C:¥Downloa	ch ch ch d	¢>		
Reality Al Authenticat Reality Al Authenticat Renesas QE QE for BLE QE for Motor QE for OTA Renesas Toolchain Ma Smart Browser Smart Configurator Smart Demo Smart Manual Support Folders Tracealyzer TraceX Run/Debug Scripting	General settings for QE for Renesas Motor Workbe O Specify Renesas Moto C:¥Program Files (x86) © Search automatical Installation found at C:¥Pr Settings for getting san Region setting: HTTP communication for Automatically check Motor sample program Renesas Motor Workbe COM Port to launch Re COM Port to launch Re	ench location itor Workbench.exe path ¥RenesasElectronics¥Renesa y for Renesas Motor Workbe <i>ogram Files (x80)RenesasElectr</i> mple programs and related t timeout (sec): k for the latest version of Rer n save directory: ench installer save directory: nesas Motor Workbench te for user's guide contents a	ench installation ronics/Renesas Motor We tools 180 nesas Motor Workbeng C:¥Downloa	ch ch ch d	Anch.exe		
pe filter text My Renesas Reality Al Authenticat C Renesas QE QE for BLE QE for Motor QE for OTA Renesas Toolchain Mæ Smart Browser Smart Configurator Smart Demo Smart Manual Support Folders Tracealyzer TraceX Run/Debug Scripting Terminal TextMate Tracing	General settings for QE for Renesas Motor Workbe Specify Renesas Moto C:¥Program Files (x86) Search automatical Installation found at C:1Pr Settings for getting sat Region setting: HTTP communication for Automatically check Motor sample program Renesas Motor Workbe COM Port to launch Re	ench location itor Workbench.exe path ¥RenesasElectronics¥Renesa y for Renesas Motor Workbe <i>ogram Files (x80)RenesasElectr</i> mple programs and related t timeout (sec): k for the latest version of Rer n save directory: ench installer save directory: nesas Motor Workbench te for user's guide contents a	ench installation ronics/Renesas Motor We tools 180 nesas Motor Workbeng C:¥Downloa	ch ch ch d	Anch.exe		

Figure 4-19 Setting the path to Renesas Motor Workbench



# 4.2 Tuning

### 4.2.1 Prepare Tuning Program

The tuning program which exists in Renesas Motor Workbench install folder is copied into the project folder, and is used. The copied files will be stored in QE\_Motor¥Tuner¥<Device Name>\_Sensorless in the project folder.

See Chapter 5 for the files that QE for Motor copies.

Follow the steps below to prepare the tuning program.

- Open "Motor Workflow(QE)" view
- Click "Select Tuning Program"
- Click "Finish" when Tuning Program Selection window appears. The name of Motor Control System is automatically named according to the target project.
- Click "Generate Tuning Program" to copy the tuning program. The tuning program is automatically copied from the Renesas Motor Workbench install folder.



Figure 4-20 Preparation of tuning program



### **RA/RX Family**

### 4.2.2 Download Tuning Program

Download the tuning program to MCU on the CPU Board.

The PC and evaluation board must be connected to download the tuning program. Refer to the picture displayed on the workflow view and chapter 2.3.1 for the connection method when downloading the program.

Follow the steps below to download the tuning program.

- Connect your PC to the evaluation board.
- Click "Download" to download the tuning program.

When downloading finishes, the debugger is disconnected.

0	Preparation	$\geq$	Tuning	$\langle \odot \rangle$	Analyze
.Preparat	ion	- <u>^</u>	Pro	epare Tuning Progra	m
Prepare	e Project				
🕗 Introdi	ice Related Tool			Select tuning program	]
2.Tuning		- Tuning		uner¥RA6T2_Sensorl C TUNER E2S V100.	ess¥RA6T2_MCILV1_SPM_LES
Tuning			5_100		nex
<u> </u>			Please connect the C	PU board to your PC he program to MCU.	
.Analyze		-		Communication board	
🕗 Analyze	2				
				PC USB CPU board Inv	erter board
				Download tuning program	
				Launch tuner	
				Launen tuner	
CK-RA6	T2 :				

Figure 4-21 Download of tuning program



### 4.2.3 Start Tuner

To start tuner, it is necessary to connect the PC and the evaluation board via the communication board. Refer to the picture displayed on the workflow view and chapter 2.3.2 for the connection method when checking the motor operation by Tuner.

Click "Launch Tuner" as shown below to launch the Renesas Motor Workbench Tuner. The settings required for tuning with Renesas Motor Workbench are automatically loaded from the Tuner configuration file. If Tuner does not start and an error is displayed, see Section 4.2.3.1.

For the first time use of Tuner in the target project, a Tuner configuration file (.rmt) corresponding to the sample project is copied form the Renesas Motor Workbench install folder to QE\_Motor¥Tuner¥<Device Name>\_Senorles in the project folder by "Use Default Configuration(xxx.rmt)". From the second time onward, a Tuner configuration file copied into the project can be selected.

	A > @ QE for Moto	-	8			
		paration	$\odot$	Tuning	$\odot$	Analyze
	1.Preparation	-	<u>^</u>			, morped
	· · · · · · · · · · · · · · · · · · ·		~	Prep	re Tuning Program	
	Prepare Project			e	lect tuning program	
	<ul> <li>Introduce Relat</li> </ul>		Tuning Progra			s¥RA6T2_MCILV1_SPM_LES
	2.Tuning	-	5 5		UNER_E2S_V100.he	
	🕢 Tuning			Renesas Flexible M	otor Control Kit	
	3.Analyze	-		Please connect the CPU be before downloading the pr	Communication	
	🕢 Analyze			P	USB CPU based Events	
				Dov	nload tuning program	
					Launch tuner	
			Tuner Configu			
			Use Default Conf	iguration(RA6T2_MCI	V1_SPM_LESS_FOC_T	UNER_V100.mmt) V
2_MCILV1_SPM_LE					The state of the second	
RX26T: iT_MCBA_MCILV1_S	SPM_LESS_FC	C_TUNER_\		The Barner and the applied of the second sec	esas Motor Workbench tr	uner
			/xxx.rmt	Tuner¥RA6T2_Sensorless¥		
T_MCBA_MCILV1_S	ers¥a5087695¥e2_studio¥workspace_20	23-10_4_3¥RA6T2_MCILV1_SPM_LES	/xxx.rmt	Tuner¥RA6T2_Sensorless¥		×
T_MCBA_MCILV1_S  © Renesas Motor Workbench  «RMT File»=CRUs File Help © Parameter Input Please Input Parameter	ers¥a5087695¥e2,studio¥workspace,20 Easy	23-10,4,3¥RA6T2,MCILV1,SPM_LE9 Anatyzer	/xxx.rmt	Tuner¥RA6T2_Sensorless¥		×
T_MCBA_MCILV1_S	ers¥a5087695¥e2,studio¥workspace,20 Easy	23-10,4 3#RA672,MCIU/1 SPM_LES Analyzer Tuner Navigation Window Tuner Select from Navigation Bit.	/xxx.rmt	Tuner¥RA6T2_Sensorless¥		×
T_MCBA_MCILV1_S	en¥#5087695¥e2,studio¥workspace.20 Easy Input Value Unit 1.67 (A)	23-10,4 3#RA672,MCIU/1 SPM_LES Analyzer Tuner Navigation Window Tuner Select from Navigation Bit.	/xxx.rmt	Tuner¥RA6T2_Sensorless¥		×
T_MCBA_MCILV1_S	en¥#5087695¥e2,studio¥workspace.20 Easy Input Value Unit 1.67 (A)	23-10,4 3#RA672,MCIU/1 SPM_LES Analyzer Tuner Navigation Window Tuner Select from Navigation Bit.	/xxx.rmt	Tuner¥RA6T2_Sensorless¥	in Window	×
C_MCBA_MCILV1_S  Reneas Motor Workbench  RMT File>C/RU  File Help  Plesse Input Parameter Input Parameter Select Parameter S	en¥#5087695¥e2,studio¥workspace.20 Easy Input Value Unit 1.67 (A)	22-10, 4.34RA672, MCLV1 SPM, LEE Analyzer Turer Navigation Window Select from Navigation list.	/xxx.rmt	Tuner¥RA6T2_Sensorless¥	in Window	
T_MCBA_MCILV1_S	en¥#5087695¥e2,studio¥workspace.20 Easy Input Value Unit 1.67 (A)	22-10, 4, 3HRA672, MCLV1 SPM, LEE Analyzer Turer Navigation Window Select from Navigation list.	/xxx.rmt	Tuner¥RA6T2_Sensorless¥	in Window	
T_MCBA_MCILV1_S	en¥a3087695¥e2,ttudio¥workspace,20 Easy Input Value Unit 1.67 (A) 4 -	22-10, 4, 3HRA672, MCLV1 SPM, LEE Analyzer Turer Navigation Window Select from Navigation list.	/xxx.rmt	Tuner¥RA6T2_Sensorless¥	in Window	
C_MCBA_MCILV1_S  Comparison	en/4/3087695¥e2_ttudio¥workspace_20 Easy Input Value Unit 1.67 [A] 4 Set	22-10, 4, 3HRA672, MCLV1 SPM, LEE Analyzer Turer Navigation Window Select from Navigation list.	/xxx.rmt	Tuner¥RA6T2_Sensorless¥	in Window	

Figure 4-22 Start Tuner

For details on the Tuner function of Renesas Motor Workbench, refer to "R21UZ0004 Motor Control Development Support Tool Renesas Motor Workbench 3.1.2 User's Manual".



# 4.2.3.1 Installation of VCP driver

If the error shown below is displayed, the virtual COM port (VCP) driver needs to be installed. If you do not see any error, you do not need to do anything in this chapter.



Figure 4-23 RMW Launch Error

When installing the VCP driver, disconnect the USB cable that connects the PC and the evaluation board.

Download the FTDI VCP driver from the following website. Figure 4-24 to Figure 4-25 show the installation procedure of the downloaded VCP driver.

<u>https://www.ftdichip.com/Drivers/VCP.htm</u>

CDM212364_Setup.zip	Open Open in new window Extract All 7-Zip CRC SHA	>		
Extract Compressed (Zipped) For         Select a Destination and Ex         Files will be extracted to this folder:         C:\\Desktop         Show extracted files when comp	tract Files	Brov	× wse	

Figure 4-24 Extracting of VCP driver




Figure 4-25 Installation of VCP driver



### 4.2.3.2 Start Tuning

Click "Start" to start the motor. When tuning is complete, the motor will stop and the tuning result will be displayed.



Figure 4-26 Tuning operation



### 4.2.3.3 Waveform Confirmation

Click "Scope" to check the waveform during motor operation. Click "RUN" to start the motor, and click "STOP" to stop the motor. To finish checking the waveform, click the "x" at the top right of the window.



Figure 4-27 Waveform confirmation



### 4.2.3.4 Output Header File

Click "Output Header File" as shown below to output the tuning result C source header file. The file output in this chapter are stored in the src¥application¥main folder.

For the files output by QE for Motor, refer to Chapter 5.

When tuning is complete, click "x" in the upper right corner of the window to exit Renesas Motor Workbench. After checking the motor operation by Tuner, cut off the power supply from J1 or CN1 of the Inverter Board.



Figure 4-28 Output Header file



### 4.3 Analyze

#### 4.3.1 Build Application Program

Click "Build Project" to build the project.



Figure 4-29 Build Project

If build errors have been occurred in RA family project, the code generation may not have been executed because of using different FSP version than the sample project.

Refer to Chapter 4.1.3, execute the code generation, and then execute the build again.



### **RA/RX** Family

#### 4.3.2 Download Application Program

Download the project to MCU on the CPU Board. The PC and evaluation board connection is required to download the sample project. Refer to the picture displayed on the workflow view and chapter 2.3.1 for the connection method when downloading the project.

Follow the steps below to download the project.

- Connect the PC and the evaluation board.
- Click "Download program" to download the project.

When downloading finishes, the debugger is disconnected.



Figure 4-30 Download Application Program



#### 4.3.3 Start Analyzer

To start Analyzer, it is necessary to connect the PC and the evaluation board via the communication board. Refer to the picture displayed on the workflow view and chapter 2.3.2 for the connection method when checking the motor operation with Analyzer.

Click "Launch Renesas Motor Workbench analyzer" as shown below to launch Analyzer of Renesas Motor Workbench. The settings required for analysis in Renesas Motor Workbench are automatically loaded from Analyze configuration file. If Analyzer does not start and an error is displayed, see Section 4.2.3.1.

The sample projects used in this guide includes analyzer configuration file.



#### Figure 4-31 Start Analyzer

For details on the Analyzer function of Renesas Motor Workbench, refer to "R21UZ0004 Motor Control Development Support Tool Renesas Motor Workbench 3.1.2 User's Manual".

The sample project provides two modes of operation, Board UI and RMW UI. This document describes an operation example of the RMW UI that controls the motor operation from the Analyzer of Renesas Motor Workbench.



-(1)

- (2)

### 4.3.3.1 Start to Analyze

Follow the steps below to analyze the motor operation.

- Click "RUN" in the Scope Window to start analysis
  Click "RMW UI" in the User Button Control Window
- Select RMW UI mode to control the motor from Renesas Motor Workbench.
  Click "RUN" in the User Button Control Window to start the motor (3)
- Change the Ref speed value in the User Button Control Window and click "Set Speed" to change the motor rotation speed

   (4)
- Click "STOP" in the User Button Control Window to stop the motor (5)

The User Button Control Window may be hidden at the bottom of the screen. If you cannot see it after launching Analyzer, try expanding the window.



Figure 4-32 Analyze the motor operation



By clicking "Easy" at the top of the window, you can easily change the motor speed etc. using the GUI.



Figure 4-33 Viewing of Easy mode



### 5. Output Files

The files output by QE for Motor and Renesas Motor Workbench (RMW) are as follows.

#### Table 5-1 List of output files

Folder name	File name	Generated item
QE_Motor¥Tuner¥	[RMW bundled file name *1].hex	Tuning program
[Motor control system name]	[RMW bundled file name *1].sbd <sup>%2</sup>	
	[RMW bundled file name *1].rmt	Tuner configuration file
QE_Motor	[Project name].qmc	RMW launch configuration file
src¥application¥main <sup>%2</sup>	r_mtr_control_parameter.h	Tuning result
motor_module¥cfg¥ <sup>%3</sup>	r_mtr_motor_parameter.h	7

\*1: This is the file name included with Renesas Motor Workbench. Renesas Motor Workbench includes files for various evaluation boards. The file corresponding to the motor control system selected in the tuning program preparation is used.

\*2: For the sample program for RA6T2 : RA6T2\_MCILV1\_SPM\_LESS\_FOC\_E2S\_Vxxx

\*3: For the sample program for RX26T : RX26T\_MCBA\_MCILV1\_SPM\_LESS\_FOC\_E2S\_Vxxx



## 6. Help and Guide Function

You can check the details of the functions of "QE for Motor" from the help of e<sup>2</sup> studio.

Image: Source - Reflector Navigate Search Projection         File       Edit         Source Reflector Navigate Search Projection         Image: Source Reflector Navigate Search Projection         Image	ct Renesss Views Run Window 672_MCILV1_SPM_LESS_FOC_E2 V		P :	•	: 0 <sub>0</sub> • ₩ <sub>0</sub> □►	
Htep -+* susio     Search:      Search:	Renease OE for Motor >           Motor Workflow (QE) View           Summary           This is the main view of this plug-in, which guides you through installation and evaluation of the motor control offiting you can on this view are as follows.           • Asim the expension and the introduction of the information regarding the Renews motor solutions, motor or and related tool.           • Displays More Software Configuration View for configuring motor correl offware           • Displays More Software Configuration View for configuring motor correl software			of the motor control software. The means motor solution, motor sample prog e	are. The main	
Reflecting User Guide	Analyze     Analyze	Select Large project RMT2_MOLV1_SPM_LEBS_FOC_F2 Select Large Guide : Project Prog Project Programming Longer Guide : Project Prog Project Programming Longer Guide : Project Prog	Port Number Motor Control System : Sens oftware Configuration atr Control Stativer Onliguestan paratilian	evaluate the motor	, ``	

Figure 6-1 Help function

Also, usage guide information is displayed at the bottom of each workflow page.



Figure 6-2 Guide function



# **Revision History**

		Description		
Rev.	Date	Page	Summary	
1.00	Jun.06.22		First edition	
1.10	May.22.23	_	Changed the version of QE for Motor to V1.2.	
1.20	Jan.30.24	_	Changed the version of QE for Motor to V1.2.	
			Changed the version of Renesas Motor Workbench 3.1.1.	
1.30	Feb.26.24	—	Added contents for RX family.	
			Changed the version of Renesas Motor Workbench 3.1.2.	
1.40	Apr.08.24		Added 4.1.3.2 (3) and (4) for how to modify driver configurations (RX family)	



### 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 is supplied until the 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.).

7. Prohibition of access to reserved addresses

Access to reserved addresses is prohibited. The reserved addresses are provided for possible future expansion of functions. Do not access these addresses as the correct operation of the LSI is not guaranteed.

8. Differences between products

Before changing from one product to another, for example to a product with a different part number, confirm that the change will not lead to problems. The characteristics of a microprocessing unit or microcontroller unit products in the same group but having a different part number might differ in terms of internal memory capacity, layout pattern, and other factors, which can affect the ranges of electrical characteristics, such as characteristic values, operating margins, immunity to noise, and amount of radiated noise. When changing to a product with a different part number, implement a system-evaluation test for the given product.

### Notice

- Descriptions of circuits, software and other related information in this document are provided only to illustrate the operation of semiconductor products and application examples. You are fully responsible for the incorporation or any other use of the circuits, software, and information in the design of your product or system. Renesas Electronics disclaims any and all liability for any losses and damages incurred by you or third parties arising from the use of these circuits, software, or information.
- Renesas Electronics hereby expressly disclaims any warranties against and liability for infringement or any other claims involving patents, copyrights, or other intellectual property rights of third parties, by or arising from the use of Renesas Electronics products or technical information described in this document, including but not limited to, the product data, drawings, charts, programs, algorithms, and application examples.
- 3. No license, express, implied or otherwise, is granted hereby under any patents, copyrights or other intellectual property rights of Renesas Electronics or others.
- 4. You shall be responsible for determining what licenses are required from any third parties, and obtaining such licenses for the lawful import, export, manufacture, sales, utilization, distribution or other disposal of any products incorporating Renesas Electronics products, if required.
- 5. You shall not alter, modify, copy, or reverse engineer any Renesas Electronics product, whether in whole or in part. Renesas Electronics disclaims any and all liability for any losses or damages incurred by you or third parties arising from such alteration, modification, copying or reverse engineering.
- Renesas Electronics products are classified according to the following two quality grades: "Standard" and "High Quality". The intended applications for each Renesas Electronics product depends on the product's quality grade, as indicated below.
   "Standard". Computers: office and viewal any impact to any impact t
  - "Standard": Computers; office equipment; communications equipment; test and measurement equipment; audio and visual equipment; home electronic appliances; machine tools; personal electronic equipment; industrial robots; etc.

"High Quality": Transportation equipment (automobiles, trains, ships, etc.); traffic control (traffic lights); large-scale communication equipment; key financial terminal systems; safety control equipment; etc.

Unless expressly designated as a high reliability product or a product for harsh environments in a Renesas Electronics data sheet or other Renesas Electronics document, Renesas Electronics products are not intended or authorized for use in products or systems that may pose a direct threat to human life or bodily injury (artificial life support devices or systems; surgical implantations; etc.), or may cause serious property damage (space system; undersea repeaters; nuclear power control systems; aircraft control systems; key plant systems; military equipment; etc.). Renesas Electronics disclaims any and all liability for any damages or losses incurred by you or any third parties arising from the use of any Renesas Electronics product that is inconsistent with any Renesas Electronics data sheet, user's manual or other Renesas Electronics document.

- 7. No semiconductor product is absolutely secure. Notwithstanding any security measures or features that may be implemented in Renesas Electronics hardware or software products, Renesas Electronics shall have absolutely no liability arising out of any vulnerability or security breach, including but not limited to any unauthorized access to or use of a Renesas Electronics product or a system that uses a Renesas Electronics product. RENESAS ELECTRONICS DOES NOT WARRANT OR GUARANTEE THAT RENESAS ELECTRONICS PRODUCTS, OR ANY SYSTEMS CREATED USING RENESAS ELECTRONICS PRODUCTS WILL BE INVULNERABLE OR FREE FROM CORRUPTION, ATTACK, VIRUSES, INTERFERENCE, HACKING, DATA LOSS OR THEFT, OR OTHER SECURITY INTRUSION ("Vulnerability Issues"). RENESAS ELECTRONICS DISCLAIMS ANY AND ALL RESPONSIBILITY OR LIABILITY ARISING FROM OR RELATED TO ANY VULNERABILITY ISSUES. FURTHERMORE, TO THE EXTENT PERMITTED BY APPLICABLE LAW, RENESAS ELECTRONICS DISCLAIMS ANY AND ALL WARRANTIES, EXPRESS OR IMPLIED, WITH RESPECT TO THIS DOCUMENT AND ANY RELATED OR ACCOMPANYING SOFTWARE OR HARDWARE, INCLUDING BUT NOT LIMITED TO THE IMPLIED WARRANTIES OF MERCHANTABILITY, OR FITNESS FOR A PARTICULAR PURPOSE.
- 8. When using Renesas Electronics products, refer to the latest product information (data sheets, user's manuals, application notes, "General Notes for Handling and Using Semiconductor Devices" in the reliability handbook, etc.), and ensure that usage conditions are within the ranges specified by Renesas Electronics with respect to maximum ratings, operating power supply voltage range, heat dissipation characteristics, installation, etc. Renesas Electronics disclaims any and all liability for any malfunctions, failure or accident arising out of the use of Renesas Electronics products outside of such specified ranges.
- 9. Although Renesas Electronics endeavors to improve the quality and reliability of Renesas Electronics products, semiconductor products have specific characteristics, such as the occurrence of failure at a certain rate and malfunctions under certain use conditions. Unless designated as a high reliability product or a product for harsh environments in a Renesas Electronics data sheet or other Renesas Electronics document, Renesas Electronics products are not subject to radiation resistance design. You are responsible for implementing safety measures to guard against the possibility of bodily injury, injury or damage caused by fire, and/or danger to the public in the event of a failure or malfunction of Renesas Electronics, such as safety design for hardware and software, including but not limited to redundancy, fire control and malfunction prevention, appropriate treatment for aging degradation or any other appropriate measures. Because the evaluation of microcomputer software alone is very difficult and impractical, you are responsible for evaluating the safety of the final products or systems manufactured by you.
- 10. Please contact a Renesas Electronics sales office for details as to environmental matters such as the environmental compatibility of each Renesas Electronics product. You are responsible for carefully and sufficiently investigating applicable laws and regulations that regulate the inclusion or use of controlled substances, including without limitation, the EU RoHS Directive, and using Renesas Electronics products in compliance with all these applicable laws and regulations. Renesas Electronics disclaims any and all liability for damages or losses occurring as a result of your noncompliance with applicable laws and regulations.
- 11. Renease Electronics products and technologies shall not be used for or incorporated into any products or systems whose manufacture, use, or sale is prohibited under any applicable domestic or foreign laws or regulations. You shall comply with any applicable export control laws and regulations promulgated and administered by the governments of any countries asserting jurisdiction over the parties or transactions.
- 12. It is the responsibility of the buyer or distributor of Renesas Electronics products, or any other party who distributes, disposes of, or otherwise sells or transfers the product to a third party, to notify such third party in advance of the contents and conditions set forth in this document.
- This document shall not be reprinted, reproduced or duplicated in any form, in whole or in part, without prior written consent of Renesas Electronics.
   Please contact a Renesas Electronics sales office if you have any questions regarding the information contained in this document or Renesas
- Electronics products.
- (Note1) "Renesas Electronics" as used in this document means Renesas Electronics Corporation and also includes its directly or indirectly controlled subsidiaries.
- (Note2) "Renesas Electronics product(s)" means any product developed or manufactured by or for Renesas Electronics.

(Rev.5.0-1 October 2020)

## **Corporate Headquarters**

TOYOSU FORESIA, 3-2-24 Toyosu, Koto-ku, Tokyo 135-0061, Japan

#### www.renesas.com

### Trademarks

Renesas and the Renesas logo are trademarks of Renesas Electronics Corporation. All trademarks and registered trademarks are the property of their respective owners.

## **Contact information**

For further information on a product, technology, the most up-to-date version of a document, or your nearest sales office, please visit: <a href="http://www.renesas.com/contact/">www.renesas.com/contact/</a>.