RA2A1 Group

Board Control Program for QE for AFE

Introduction

The control program operates on RA2A1 on the EK-RA2A1 evaluation board, communicates commands with the AFE development support tool ‘QE for AFE’, and can set registers for analog IP and obtain the A/D conversion values and the comparison values as shown below.

— 24-Bit Sigma-Delta A/D Converter (SDADC24)
— 16-Bit A/D Converter (ADC16)
— High-Speed Analog Comparator (ACMPHS)
— Low-Power Analog Comparator (ACMPLP)
— 12-Bit D/A Converter (DAC12)
— 8-Bit D/A Converter (DAC8)
— Operational Amplifier (OPAMP)

Target Device

RA2A1 (R7FA2A1AB3CFM)

Board to Be Operated

EK-RA2A1 Evaluation Kit for RA2A1 Microcontroller Group

Available Communication I/F:

— USB PCDC Communication
— SCI UART Communication: A separate USB-UART conversion adapter is required.
— Emulator I/F Communication

Contents

1. Overview

This control program is intended to be used in combination with 'QE for AFE'.

Therefore, refer to the 'QE for AFE' document and use this control program.

1.1 System Overview

This control program (hereinafter abbreviated as 'FW') operates on RA2A1 on the EK-RA2A1 board.

You can communicate using 'QE for AFE' via USB PCDC or SCI UART and control the following according to the command request from 'QE for AFE':

- Register Settings for 24-Bit Sigma-Delta A/D Converter (SDADC24)
- Register Settings for 16-Bit A/D Converter (ADC16)
- Register Settings for High-Speed Analog Comparator (ACMPHS) and Output Pin Setting
- Register Settings for Low-Power Analog Comparator (ACMPHS) and Output Pin Setting
- Register Settings for 12-Bit D/A Converter (DAC12) and Output Pin Setting
- Register Settings for 8-Bit D/A Converter (DAC8) and Output Pin Setting
- Operation Amplifier (OPAMP) Register Settings
- Start/Stop the A/D Conversion of SDADC24 or ADC16 and Send their A/D Value
- Start/Stop the Comparison Processing of ACMPHS or A/D Conversion and Send their Comparison Value

The differences in specifications/functions due to differences in connection methods are shown below. Select the connection method according to your purpose.

For the specific connection method, refer to '2.2.1 Connecting to PC'.

Table 1-1 Connection Method and Differences in Specifications/Functions

<table>
<tr><th colspan="2">Items</th><th>SCI UART
Emulator I/F</th><th>USB PCDC</th></tr>
<tr><td colspan="2">System Clock</td><td>HOCO 64MHz
XTAL 12MHz</td><td>HOCOC 48MHz</td></tr>
<tr><td colspan="2">ICLK Frequency (max.)</td><td>32MHz: divided HOCO</td><td>48MHz: divided HOCO</td></tr>
<tr><td colspan="2">PCLKB Frequency (max.)</td><td>32MHz: divided HOCO</td><td>24MHz: divided HOCO</td></tr>
<tr><td colspan="2">PCLKD(=ADCLK) Frequency (max.)</td><td>32MHz: divided HOCO</td><td>24MHz: divided HOCO</td></tr>
<tr><td rowspan="3">ADC16</td><td>ADCLK Frequency (max.)</td><td>32MHz</td><td>24MHz</td></tr>
<tr><td>Continuous Measurement of A/D conversion [Note 1]</td><td colspan="2">Support under specific conditions</td></tr>
<tr><td>One-shot Measurement of A/D conversion [Note 1]</td><td colspan="2">Supported</td></tr>
<tr><td rowspan="2">SDADC24</td><td>SDADC24 Reference Clock Frequency)</td><td colspan="2">4MHz</td></tr>
<tr><td>Continuous Measurement of A/D Conversion [Note 1]</td><td colspan="2">Supported</td></tr>
<tr><td rowspan="2">ACMPHS</td><td>Comparison Processing Sampling Period [ms]</td><td colspan="2">Integer value ,1ms (min.), 1024ms (max.)</td></tr>
<tr><td>Continuous Measurement of Comparison Processing [Note 1]</td><td colspan="2">Supported</td></tr>
<tr><td rowspan="2">ACMPLP</td><td>Comparison Processing Sampling Period [ms]</td><td colspan="2">Integer value ,1ms (min.), 1024ms (max.)</td></tr>
<tr><td>Continuous Measurement of Comparison Processing [Note 1]</td><td colspan="2">Supported</td></tr>
</table>

Note 1: For details, refer to '1.1.2 Measured Value Transmission Operation during A/D Conversion and Comparison'

1.1.1 About the Included HEX Files and e2 studio Projects

The overview of the included HEX files and the e2 studio projects are shown below.

(1) HEX Files

Evaluation is possible by writing the HEX file to the EK-RA2A1 board.

For the FW writing method, refer to '2.1.1 Writing using Renesas Flash Programmer'.

Also, refer to '1.4 Operation Confirmation Environment' for the settings when creating a HEX file.

Table 1-2 HEX Files

HEX Files	File Name
HEX File for SCI UART Communication (PCLKB = PCLKD frequency: 32MHz)	ek_ra2a1-uart-32MHz-rev200.hex
HEX File for SCI UART Communication (PCLKB = PCLKD frequency: 8MHz)	ek_ra2a1-uart-8MHz-rev200.hex [Note 1]
HEX File for USB PCDC Communication (PCLKB = PCLKD frequency: 24MHz)	ek_ra2a1-usb-24MHz-rev200.hex
HEX File for USB PCDC Communication (PCLKB = PCLKD frequency: 12MHz)	ek_ra2a1-usb-12MHz-rev200.hex [Note 1]

Note 1: This file is a HEX file for ADC16 Continuous measurement. For details, refer to '1.1.2 Measured Value Transmission Operation during A/D Conversion and Comparison'.

(2) e2 studio Projects

Evaluation is possible by importing the e2 studio project and writing it to the EK-RA2A1 board.

It is provided with the setting to be automatically executed when the **'Build'** is executed,  is pressed, and the **'Debug'** mode is launched.

For the FW writing method, refer to '3.4 Write and Build Using e2 studio Integrated Development Environment (IDE)'.

Also, refer to '1.4 Operation Confirmation Environment' for the settings when creating a HEX file.

Table 1-3 e2 studio Projects

Project Name	Folder Name
SCI UART Communication Project (PCLKB=PCLKD frequency: 32MHz) [Note 1]	_uart
USB PCDC Communication Project (PCLKB=PCLKD frequency: 24MHz) [Note 2]	_usb
Emulator I/F Communication Project (PCLKB=PCLKD frequency: 32MHz)	_emulator

Note 1: It is the setting of ek_ra2a1-uart-32MHz-rev200.hex shown in 'Table 1-2 HEX Files'.
Note 2: It is the setting of ek_ra2a1-usb-24MHz-rev200.hex shown in 'Table 1-2 HEX Files'.

1.1.2 Measured Value Transmission Operation during A/D Conversion and Comparison

During A/D conversion and Comparison, the measured values are sent to the PC for Continuous measurement. This measurement is defined as **'Continuous measurement'**.

When using ADC16, which is capable of high output data rate, the transmission process may not be in time. In that case, after acquiring the specified number of A/D values, A/D conversion is stopped and the acquired A/D values are sent together. This measurement is defined as **'One-shot measurement'**.

(1) When Using SCI UART or USB PCDC

Table 1-4 shows the measurement operation for each measurement target.

Table 1-4 Measurement Operation of SDADC24, ADC16, ACMPHS, ACMPLP

Measurement Target	Measurement Operation
SDADC24, ACMPHS, ACMPLP	**Continuous measurement**
ADC16	Switched to **Continuous measurement** or **One-shot measurement** depending on operating conditions

(a) Continuous Measurement

Table 1-5 shows the continuous measurement operating conditions of ADC16 when using SCI UART and USB PCDC. The FW switches to the Continuous measurement or One-shot measurement depending on both PCLKB frequency and the output data rate setting of ADC16.

Table 1-5 Continuous Measurement Operating Conditions of ADC16 when Using SCI UART and USB PCDC

PCLKB Frequency [Note1]	ADSSTRn (n=00 – 08, L) [Note1]
12MHz	All ADSSTR values of ch to use : 0x8A (138) or more
Under 12MHz	All ADSSTR values of ch to use : 0x78 (120) or more

Note 1: Operating condition settings assuming PCLKD frequency = PCLKB frequency.
If PCLKD frequency > PCLKB frequency, the continuous measurement setting will be set, but the number of measurement data will be too large, and the transmission process will not be in time.

Table 1-6 shows an example of settings for which continuous measurement operation has been confirmed.
These settings do not guarantee the continuous measurement operation.

Table 1-6 ADC16 Continuous Measurement Operation Confirmed Setting Example

System Clock	Communication I/F	ICLK Frequency	PCLKB = PCLKD Frequency	ADSSTRn (n=00 – 08, L) of Ch to Use	UART Bitrate Setting [Note 7]	Remarks
HOCO 48MHz	USB	24MHz	12MHz	All 0x8A(138) or more [Note 4]	(Not required for USB)	[Note 2]
	UART			All 0xB4(180) or more [Note 5]	2,000,000 bps [Note1]	
HOCO 64MHz		32MHz	8MHz	All 0x78(120) or more [Note 6]	1,333,333 bps [Note1]	[Note 3]
HOCO 48MHz		24MHz	6MHz		1,000,000 bps [Note 1]	
	USB				(Not required for USB)	

Note 1: If the value other than the specified value is set, FW will not be able to measure because the transmission will not be in time.
Note 2: It is the setting of the HEX file 'ek_ra2a1-usb-12MHz-rev200.hex' shown in 'Table 1-2 HEX Files'.
Note 3: It is the setting of the HEX file 'ek_ra2a1-uart-8MHz-rev200.hex' shown in 'Table 1-2 HEX Files'.
Note 4: In the QE for AFE setting, input "11.5 [us]" or more.
Note 5: In the QE for AFE setting, it is possible to input from "11.5 [us]", but "15 [us]" or more is recommended. If the value is less than "15 [us]", drawing may stop in less than 1 minute.

Note 6: In the QE for AFE setting, input the following.
If PCLKB = PCLKD = 8MHz, input “15 [us]” or more.
If PCLKB = PCLKD = 6MHz, input “20 [us]” or more.

Note 7: QE for AFE switches to the Bitrate shown in the table during SCI UART connection processing. For details, refer to ‘3.3.3 QE for AFE: Automatic Bitrate Switching when UART Is Connected’.

In addition, QE for AFE may miss data depending on PC environment during the Continuous measurement operation. In that case, the following error will be displayed on QE for AFE.

```
[Error]Some data missed in communication. Please check missing data in [Raw Data] view.
```

Figure 1-1 Error Message when Data Is Missed

Therefore, please evaluate it when other applications are stopped or network offline. If data is still missing, increase the ADSSTR value and lower the output data rate.

(b) One-Shot Measurement

The number of measured values and the time of measurement that can be acquired in the case of One-shot measurement settings are shown below.

Table 1-7 Number of Storable Measured and Measurement Time for ADC16 One-shot Measurement

Items	Contents
Number of measured values for One-shot measurement	8,192 (Max.) **Number of Measured Values of Each Channel** = 8,192/(Number of measurement channels); (Rounded down)
Measurement Time of One-shot measurement	Sum of [(**Number of Measured Values of Each Channel)** x (sampling time of each channel)]

When combined with QE for AFE, intermittent measurement that repeats One-shot measurement is possible.

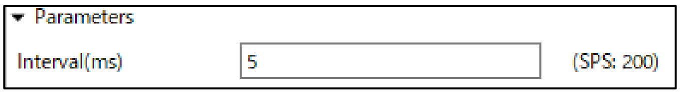
(2) When Using Emulator I/F

Only Continuous measurement is supported.

However, the Emulator I/F has a slow communication speed, therefore it is not possible to acquire all the data at high output data rate. It is necessary to reduce the output data rate in order to acquire the continuous data.

Table 1-8 shows the settings that enable continuous data acquisition when using the Emulator I/F.

Table 1-8 Settings that enable continuous data acquisition when using Emulator I/F

Items	Descriptions
SDADC24	It is possible by setting the output data rate as follows. — 1000 sps or less: OSR = 1024 (976.5625 sps) with 1ch setting [Note 1]
ADC16	There is no setting for the Continuous measurement. Measurement data is acquired intermittently.
ADC16 Temperature Sensor	Since it operates in single scan mode, the data can be acquired.
ADC16 Internal Reference Voltage	
ACMPHS	It t is possible by setting the output data rate as follows. — Set the ‘Interval’ on the GUI to “5ms” or more. [Note 1]
ACMPLP	

Note 1: These settings do not guarantee the continuous measurement operation. Depending on the PC environment, QE for AFE may miss data. In that case, lower the output data rate further.

1.2 File Configurations

The following is a list of file configurations. The description of some folders and files is omitted.

```
r01an5795xx0200-ra2a1-serial
├──ek_ra2a1
│   ├──_uart                              e2 studio project for SCI UART Communication
│   │   ├──.settings
│   │   ├──ra
│   │   ├──ra_cfg
│   │   ├──ra_gen
│   │   ├──script
│   │   └──src
│   │       ├──hal_entry.c
│   │       ├──hal_entry.h
│   │       ├──r_common_config.h
│   │       ├──r_common_func.c
│   │       ├──r_common_func_if.h
│   │       ├──r_communication_control_api.c
│   │       ├──r_communication_control_api_if.h
│   │       ├──r_interrupt_callback.c
│   │       ├──r_interrupt_callback_if.h
│   │       ├──r_reg_write.c
│   │       ├──r_reg_write_if.h
│   │       └──r_usb_pcdc_descriptor.c
│   ├──_usb                               e2 studio project for USB PCDC Communication
│   │     The folder structure and file structure are the same as the UART, so they are omitted.
│   │
│   └──_emulator                          e2 studio project for Emulator I/F Communication
│         The folder structure and file structure are the same as the UART, so they are omitted.
│
├──Hex
│   ├──ek_ra2a1-uart-32MHz-rev200.hex           Hex file for UART PCLKB=PCLKD=32MHz
│   ├──ek_ra2a1-uart-8MHz-rev200.hex            Hex file for UART PCLKB=PCLKD=8MHz
│   ├──ek_ra2a1-usb-24MHz-rev200.hex            Hex file for USB PCLKB=PCLKD=24MHz
│   └──ek_ra2a1-usb-12MHz-rev200.hex            Hex file for USB PCLKB=PCLKD=12MHz
├──r01an5795ej0200-ra2a1-serial.pdf
└──r01an5795jj0200-ra2a1-serial.pdf
```

Figure 1-2 File Configurations

1.3 List of Changes

The changes are shown below.

Table 1-9 Changes

Items	Before Changes (Rev.1.60)	After Changes (Rev.2.00)
Emulator I/F Communication	Not supported	Supported
ADC16 Continuous Measurement Condition for SCI UART	PCLKB=PCLKD=8MHz and ADSSTR = 0xFF	Expansion of frequency condition of CLKB = PCLKD and expansion of ADSSTR value range
ADC16 Continuous Measurement for USB PCDC	Not supported	Supported
FSP Version	v2.3.0	v3.6.0

1.4 Operation Confirmation Environment

This FW is confirmed under the operating conditions shown in Table 1-10 and Table 1-11.

The settings of the included HEX file are shown below.

Table 1-10 Operating Confirmation Conditions

Items	Descriptions
MCU	R7FA2A1AB3CFM (Renesas RA2A1 MCU Group) Supply voltage: 3.3V
IDE	Renesas e2 studio V2022-01 (22.1.0)
FSP	v3.6.0
Tool Chain	GNU ARM Embedded 10.3.1.20210824
Emulator	SEGGER J-Link®
FW Writing Tool	Renesas Flash Programmer V3.08.01
FTDI Driver for PC	Virtual COM port (VCP) drivers V2.12.36.4 URL: VCP Drivers - FTDI (ftdichip.com)

Table 1-11 Clock Settings and Tools to Use (SCI UART)

Items	SCI UART						
System Clock	HOCO 64MHz			HOCO 48MHz			XTAL 12MHz
ICLK	32MHz			48MHz			12MHz
PCLKB	32MHz	16MHz	8MHz	24MHz	12MHz	6MHz	12MHz
PCLKD	32MHz	16MHz	8MHz	24MHz	12MHz	6MHz	12MHz
FCLK	32MHz			24MHz			12MHz
SDADCCLK Clock Source	HOCO 64MHz			HOCO 48MHz			XTAL 12MHz
UCLK							
USB-UART Conversion Adapter	Pmod™ USBUART						
HEX File	Included [Note 1]		Included [Note 2]				
e2 Project/ Folder name	Included /_uart						

Note 1: It is the setting of the HEX file 'ek_ra2a1-uart-32MHz-rev200.hex' shown in 'Table 1-2 HEX Files'.
Note 2: It is the setting of the HEX file 'ek_ra2a1-uart-8MHz-rev200.hex' shown in 'Table 1-2 HEX Files'.

Table 1-12 Clock Settings (USB PCDC)

Items	USB PCDC		
System Clock	HOCO 48MHz		
ICLK	48MHz		
PCLKB	24MHz	12MHz	6MHz
PCLKD	24MHz	12MHz	6MHz
FCLK	24MHz		
SDADCCLK Clock Source	HOCO 48MHz		
UCLK	HOCO 48MHz		
HEX File	Included [Note 1]	Included [Note 2]	
e2 Project/ Folder name	Included /_usb		

Note 1: It is the setting of the HEX file 'ek_ra2a1-usb-24MHz-rev200.hex' shown in 'Table 1-2 HEX Files'.
Note 2: It is the setting of the HEX file 'ek_ra2a1-usb-12MHz-rev200.hex' shown in 'Table 1-2 HEX Files'.

Table 1-13 Clock Settings (Emulator I/F)

Items	Emulator I/F	
System Clock	HOCO 64MHz	HOCO 48MHz
ICLK	32MHz	48MHz
PCLKB	32MHz	24MHz
PCLKD	32MHz	24MHz
FCLK	32MHz	24MHz
SDADCCLK Clock Source	HOCO 64MHz	HOCO 48MHz
UCLK		
e2 Project/ Folder name	Included/ _emulator	

1.5 Related Documentation

- Renesas RA2A1 Group User's Manual: Hardware (R01UH0888EJ0100)
- Renesas RA2A1 Group Evaluation Kit for RA2A1 Microcontroller Group EK-RA2A1 Quick Start Guide (R20QS0010EU0102)
- Renesas RA2A1 Group Evaluation Kit for RA2A1 Microcontroller Group EK-RA2A1 v1 User's Manual (R20UT4580EU0101)
- Renesas RA2A1 Group QE for AFE[RA] Analog Front End Tuning Guide (R01AN5973JJ0100)

2. How to Use

2.1 How to Write FW

There are two ways to write the FW to the EK-RA2A1 board.

— Write Using e2 studio Integrated Development Environment (IDE)
— Writing using Renesas Flash Programmer
: Refer to '3.4Write and Build Using e2 studio Integrated Development Environment (IDE)'.

2.1.1 Writing using Renesas Flash Programmer

You can write HEX files to the RA2A1 on the EK-RA2A1 board using Renesas Flash Programmer. For the included HEX files, refer to 'Table 1-2 HEX Files'.

Get the Renesas Flash Programmer V3.08.01 or later that supports RA Family from the following.

https://www.renesas.com/software-tool/renesas-flash-programmer-programming-gui

The operation procedure when using Renesas Flash Programmer V3.08.01 is shown below.

(1) EK-RA2A1 board writing preparation

1. Switch J8 Jumper on EK-RA2A1 Board

Switch the J8 jumper to 'SCI/USB BOOT'.

Figure 2-1 Setting J8 Jumper to 'SCI/USB BOOT' (Set When Writing FW)

2. Connect PC to EK-RA2A1 Board

Connect both DEBUG USB and DEVICE USB to your PC.
At this point, the PC device manager recognizes the EK-RA2A1 board as USB Serial Device.

3. Press RESET Button

Press the RESET button. The PC device manager recognizes the EK-RA2A1 board as 'RA USB Boot(CDC)'.

Figure 2-2 RESET Button

(2) Launch the Renesas Flash Programmer and Communication Settings

(a) If No Renesas Flash Programmer Project for RA Family Has Been Created

1. Create a new project.

Click ‘New Project ...’ in ‘File’.

Set the ‘Microcontroller’ in ‘Project Information’ to “RA”.

Set the ‘Tool’ of ‘Communication’ to "COM port".

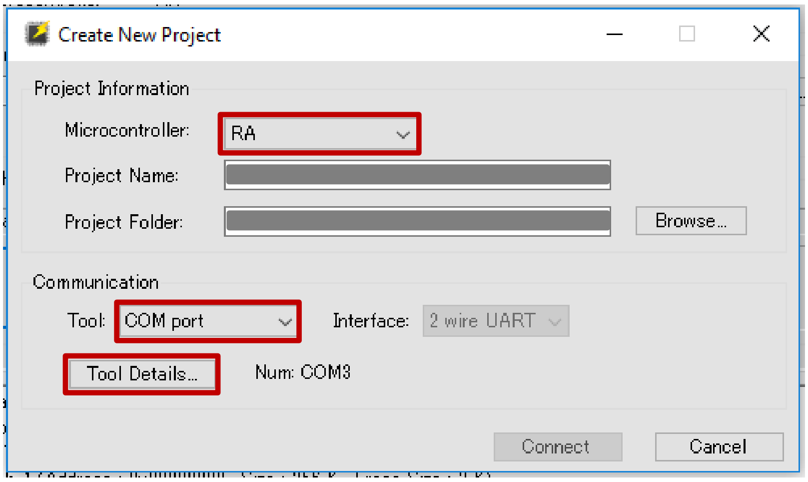


Figure 2-3 Setting of ‘Microcontroller’ and ‘Tool’

2. Select Tool

Click ‘Tool Details…’ in ‘Communication’ and select "RA USB Boot(CDC)" on the ‘Select Tool’ tab. After confirming, click "OK".

If you see USB Serial Device, try ‘2.1.1(1) EK-RA2A1 board writing preparation’ again.

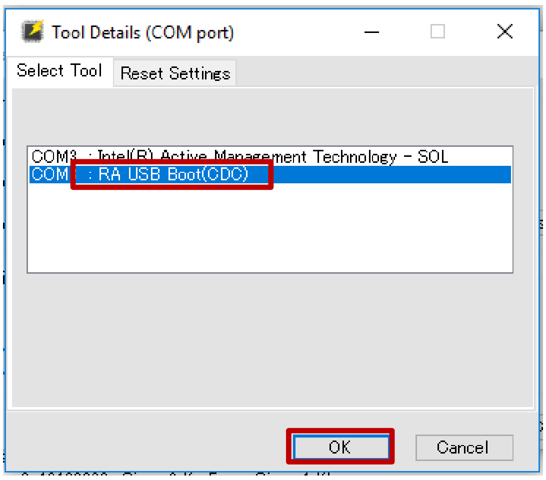


Figure 2-4 "RA USB Boot(CDC)" Selected

3. Connection process

Return to the ‘Create New Project Window’ and click “Connect”. Renesas Flash Programmer starts the connection process.

(b) If Renesas Flash Programmer Project for RA Family Has Been Created

1. Open the project.

Click 'Open Project ...' in 'File' and select the project file.

Click the 'Connect Settings' tab.

Set the 'Tool' of 'Communication' to "COM port". Refer to also 'Figure 2-3 Setting of 'Microcontroller' and 'Tool' '.

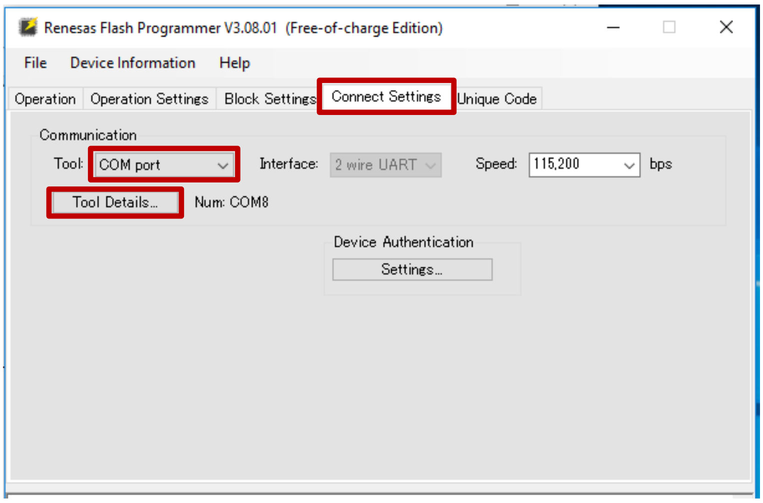


Figure 2-5 Setting of 'Connect Setting' Tab

2. Select Tool

Click 'Tool Details' in 'Communication' and select "RA USB Boot(CDC)" on the 'Select Tool' tab. Refer to also 'Figure 2-4 "RA USB Boot(CDC)" Selected'. After confirming, click "OK".

If you see USB Serial Device, try '2.1.1(1) EK-RA2A1 board writing preparation' again.

(3) Writing to RA2A1

Write the FW according to the operating procedure of Renesas Flash Programmer.

Note: After the write is complete, be sure to return the J8 jumper to its original state and press the RESET button.

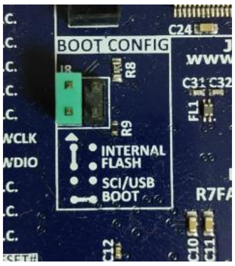


Figure 2-6 Set J8 Jumper to 'INTERNAL FLASH' (Return to Original Setting after Writing)

2.2 Run Project

2.2.1 Connecting to PC

Debug USB I/F provides a power supply voltage for the EK-RA2A1 board. Refer to the 'EK-RA2A1 v1 User's Manual (R20UT4580EU0101)'.

Connection examples are shown below.

2.2.1.1 USB PCDC Communication

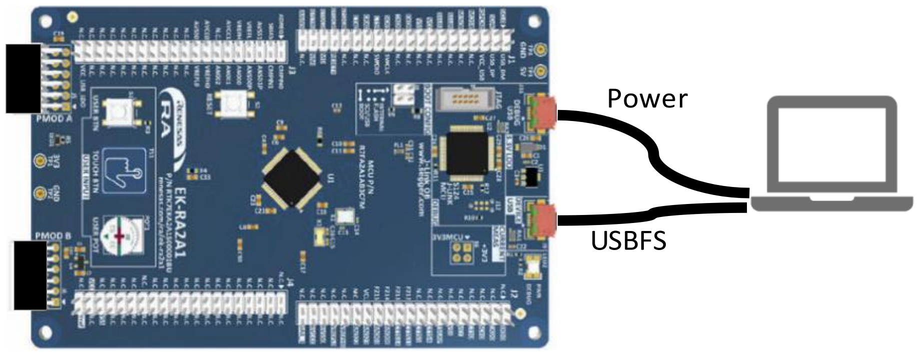


Figure 2-7 Connection Example for USB PCDC Communication

2.2.1.2 USB PCDC Communication

Turn on the power with the connection described in the EK-RA2A1 board manual.

Some USB-UART conversion adapters can supply 3.3V voltage from the adapter. Do not use the function. Do not supply power from the USB-UART conversion adapter.

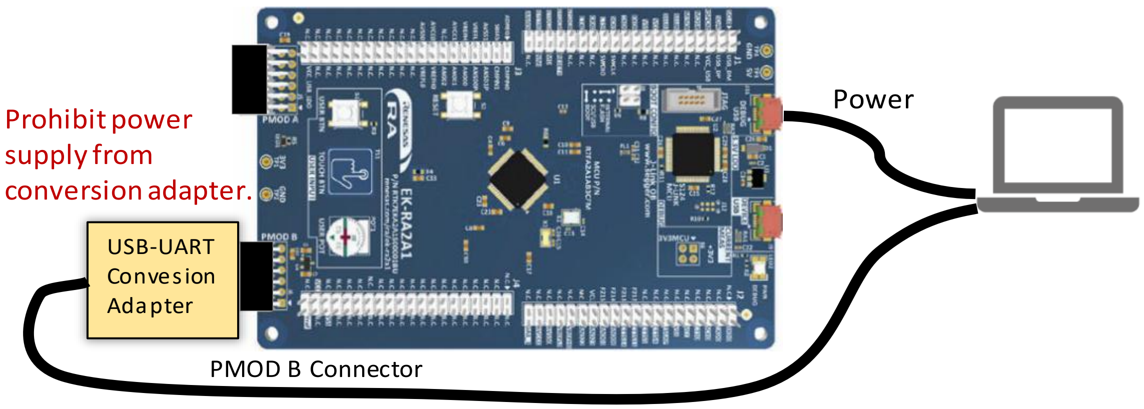


Figure 2-8 Connection Example for SCI UART Communication

2.2.1.3 Emulator I/F Communication

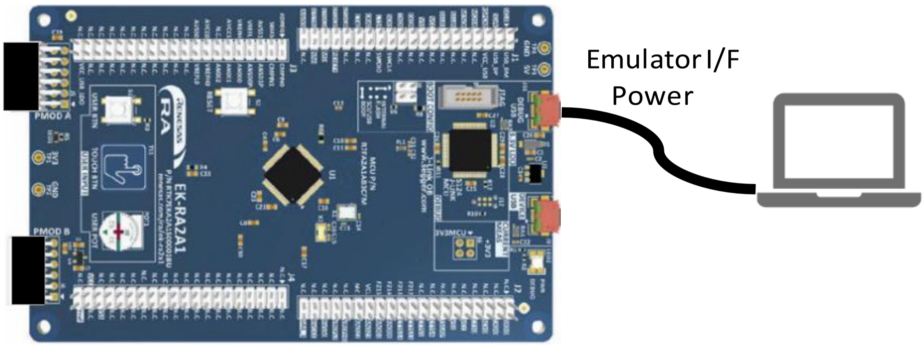


Figure 2-9 Connection Example for Emulator I/F Communication

2.2.2 ADC16 Precautions When Using

The reference voltage pins for ADC16 are as follows.

— Positive reference voltage: Reference voltage pin (VREFH0) or Internal reference voltage (VREFADC)
— Negative reference voltage: Reference ground pin (VREFL0)

On the EK-RA2A1 board, VREFH0 and VREFL0 are open. Therefore, when using ADC16, it is necessary to supply reference voltage to these pins.

Pin 34 (VREFL0) and pin 36 (AVSS0) of “J2” on EK-RA2A1 board are adjacent pins and can be easily connected using jumper as shown below.

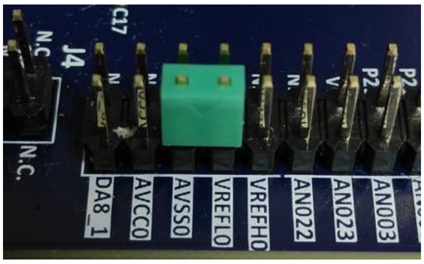


Figure 2-10 Connecting J2 34-pin (VREFL0) and J2 36-pin (AVSS0) on Board Using ADC16

2.2.3 Launch QE for AFE

'QE for AFE' has a **plugin version** that works in the e2 studio environment and a **standalone version**.

Here, the procedure for measuring using the **standalone version** is shown.

For details on the operation of 'QE for AFE', refer to the 'QE for AFE' Help.

2.2.3.1 Preparation

Prepare the following in advance.

(1) Connection J2 34 Pin (VREFL0) and J2 36 Pin (AVSS0) on EK-RA2A1 Board

Refer to '2.2.2 ADC16 Precautions When Using'.、

(2) Writing FW

Refer to '2.1 How to Write FW'.
Also, when writing using Renesas Flash Programmer, make sure that the J8 jumper is set to 'INTERNAL FLASH'.

(3) Connection between PC and EK-RA2A1 Board

Refer to '2.2.1 Connecting to PC'.

2.2.3.2 Launching QE for AFE and Connecting to Target Board

Follow the steps below to connect the target board.

(1) Launching QE for AFE

(2) Importing Configuration [Note] File if Configuration file Has Been Prepared

If there is already a set file, the imported set value during the connection process with the target boat will be written.

(3) Connection with Target Board

Check the COM number of USB Serial Device in the PC device manager and select the COM number from 'COM Port:'.

Figure 2-11 Selecting COM Number

Also, check the following display on the console.

[Info]Connect succeeds.

Figure 2-12 Message on Console when Connection is Successful

If it has been imported, the setting value will be written subsequently. The following is displayed on the console.

[Info]Write $$$ register value to the target board successfully.

Figure 2-13 Message on Console when Connection is Successful ($$$: IP Name)

2.2.3.3 Message at Time of Completion of QE for AFE Continuous Measurement and Time to Output

QE for AFE has an upper limit on the number of acquired data.

When the output data rate is 15.625ksps (SDADC24 1ch OSR = 64), **one hours** of data can be acquired.

The message when the upper limit is reached is shown below.

```
[Error]The reserved buffer is full. Tuning is forced to stop. If longer tuning time is required, please increase the average number or the over sampling ratio.
```

Figure 2-14 Message for SDADC24

```
[Error]The reserved buffer is full. Tuning is forced to stop. If longer tuning time is required, please increase the average number or the over sampling ratio.
```

Figure 2-15 Message for ADC16

The approximate time until the above message for ADC16 is output during continuous measurement of ADC16 is shown below.

Table 2-1 Approximate Time until Message Output for ADC16 Continuous Measurement

<table>
<tr><th>System Clock</th><th>Communication I/F</th><th>ICLK Frequency</th><th>PCLKB = PCLKD Frequency</th><th>ADSSTRn (n=00 – 08, L) of Ch to Use</th><th>UART Bitrate Setting</th><th>Approximate Time until Message Output</th></tr>
<tr><td rowspan="2">HOCO 48MHz</td><td>USB</td><td rowspan="2">24MHz</td><td rowspan="2">12MHz</td><td>All 0x8A(138)</td><td></td><td>About 13 minutes</td></tr>
<tr><td rowspan="3">UART</td><td>All 0xB4(180)</td><td>2,000,000 bps</td><td rowspan="2">About 16 minutes</td></tr>
<tr><td>HOCO 64MHz</td><td>32MHz</td><td>8MHz</td><td rowspan="3">All 0x78(120)</td><td>1,333,333 bps</td></tr>
<tr><td rowspan="2">HOCO 48MHz</td><td rowspan="2">24MHz</td><td rowspan="2">6MHz</td><td>1,000,000 bps</td><td rowspan="2">About 22 minutes</td></tr>
<tr><td>USB</td><td></td></tr>
</table>

3. Program Description

3.1 Overview

This FW supports the Command/Response method communication.

The UART communication with 'QE for AFE' via USB PCDC or SCI UART of EK-RA2A1. Then A/D measurement and Comparison measurement are executed according to the Command Request from 'QE for AFE'.

3.2 Peripherals to Use and Pin Settings

3.2.1 Peripherals to Use

The following shows the list of peripherals used in this FW, and the settings for each peripheral function are shown below.

Table 3-1 Peripheral Features List

Project	Intended Use
SDADC24	A/D measurement
ADC16	A/D measurement
ACMPHS	Comparison measurement
ACMPLP	Comparison measurement
DAC12	D/A output
DAC8	D/A output
OPAMP	Amplification of analog input voltage
USBFS	Communication: Used of USB PCDC communication
SCI0	Communication: Used of UART SCI communication: When using, connect USB-UART conversion adapter to the PMOD B connector. Refer to 'Figure 3-1 Wiring Diagram of EK-RA2A1 Board and USB-UART Conversion Adapter'.
DTC	Used for SCI0 UART communication and data acquisition from the following registers • ADC16 A/D data registers y(ADDRy) • ADC16 A/D Temperature Sensor Data Register (ADTSDR) • ADC16 A/D Internal Reference Voltage Data Register (ADOCDR) • SDADC24 Sigma-Delta A/D Converter Conversion Result Register (ADCR) • SDADC24 Sigma-Delta A/D Converter Average Value Register (ADAR)
AGT0	Used for comparison measurement of ACMPHS/ACMPLP

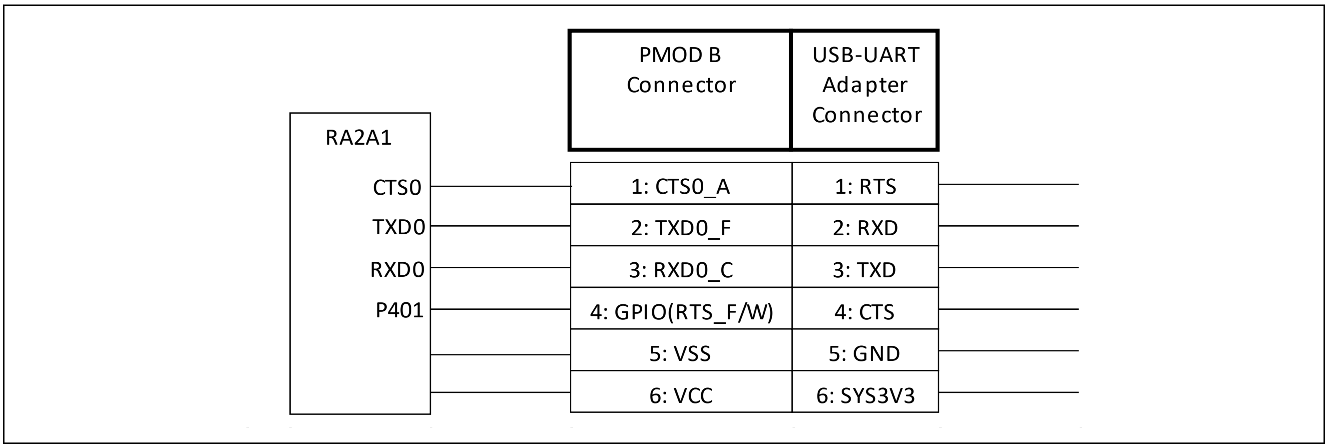


Figure 3-1 Wiring Diagram of EK-RA2A1 Board and USB-UART Conversion Adapter

3.2.2 Pin Settings

3.2.2.1 Pin List

The following is a list of pins used in this FW.

Table 3-2 Pins used List

No	Pin	Configuration Function	Content
1	P400	CMPIN0	Used as an analog pin [Note 2]
2	P401	P401	RTS Pin Assignment for SCI0 UART
3	P402	P402	-
4	P403	P403	-
5	VCL	VCL	-
6	P215	XCIN	-
7	P214	XCOUT	-
8	VSS	VSS	-
9	P213	XTAL	-
10	P212	EXTAL	-
11	VCC	XCOUT	-
12	P411	P411	TXD0 pin for SCI0 UART
13	P410	P410	CTS0 pin for SCI0 UART
14	P409	P409	-
15	P408	CMPIN1	Used as an analog pin [Note 2]
16	P407	USB_VBUS	USB FS VBUS
17	VSS_USB	VSS_USB	-
18	P915	USB_DM	D- I/O pin for on-chip USB transceiver
19	P914	USB_DP	D+ I/O pin for on-chip USB transceiver
20	VCC_USB	VCC_USB	-
21	VCC_USB_LDO	VCC_USB_LDO	-
22	P206	P206	-
23	P205	P205	For LED1 control
24	P204	P204	RXD0 pin for SCI0 UART
25	Nothing	Nothing	-
26	P201	MD	-
27	P200	P200	-
28	P304	P304	-
29	P303	P303	-
30	P302	P302	-
31	P301	P301	-
32	P300	SWCLK	-
33	P108	SWDIO	-
34	P110	CMPREF1	Reference voltage input pin [Note 2]
35	P111	P111	-
36	P112	P112	-
37	ADREG	ADREG	-
38	SBIAS/VREFI	SBIAS/VREF1	-
39	AVCC1	AVCC1	-
40	AVSS1	AVSS1	-
41	P107	ANSD3N/AN023	Used as an analog pin
42	P106	ANDS3P/AN022	Used as an analog pin
43	P105	ANSD2N/AN021	Used as an analog pin
44	P104	ANDS2P/AN020	Used as an analog pin
45	P103	ANSD1N/AN019	Used as an analog pin

46	P102	ANDS1P/AN018	Used as an analog pin
47	P101	ANSD0N/AN017/IVREF2	Used as an analog pin
48	P100	ANDS0P/AN016/IVCMP2	Used as an analog pin
49	P500	AN000/IVCMP0/AMP0+/DA12_0	Used as an analog pin [Note 1]
50	P501	AN001/IVREF0/AMP0-	Used as an analog pin
51	P502	AN002/AMP0O	Used as an analog pin
52	P015	AN003/AMP1O	Used as an analog pin
53	P014	AN004/IVREF1/AMP1-	Used as an analog pin
54	P013	AN005/IVCMP1/AMP1+/DA8_0	Used as an analog pin [Note 1]
55	P012	AN008/AMP2O	Used as an analog pin
56	AVCC0	AVCC0	-
57	AVSS0	AVSS0	
58	VREFL0	VREFL0	**ADC16 reference power supply (Low potential reference voltage)**
59	VREFH0	VREFH0	**ADC16 reference power supply (High potential reference voltage)**
60	P003	AN006/AMP2-	Used as an analog pin
61	P002	AN007/AMP2+/DA8_1	Used as an analog pin [Note 1]
62	P001	P001	-
63	P000	P000	-
64	P109	CMPREF0	Reference voltage input pin [Note 2]

Note 1: It cannot be used as a D/A output pin.
Note 2: It is for ACMPHS/ACMPLP and cannot be used.

3.2.3 How LED1 Work

LED1 on the EK-RA2A1 board lights up during the following operations.

- During A/D conversion operation of SDADC24 or ADC16
- During comparison processing of ACMPHS or ACMPLP

By opening the copper jumper E3 on the EK-RA2A1 board, LED lighting can be suppressed. For more information, refer to ‘5.4.4 LEDs’ in the ‘EK-RA2A1 v1 User Manual (R20UT4580EU0101)’

.

3.3 Communication Specifications

The communication specifications for 'QE for AFE' and FW are as follows.

3.3.1 Communication I/F and VCC Operating Voltage

Table 3-3 shows the relationship between the supported communication I/F and the lower limit voltage condition of VCC. The lower limit voltage condition of VCC differs depending on the communication I/F.

For UART SCI communication, connect the USB-UART conversion adapter to the PMOD B connector on the EK-RA2A1 board. For the USB-UART conversion adapter used for operation confirmation, refer to '1.4 Operation Confirmation Environment'.

For the VCC operating voltage conditions of RA2A1, refer to User's Manual: Hardware (R01UH0888).

Table 3-3 Communication I/F and Lower Limit Voltage Condition of VCC

Communication I/F	Lower Limit Voltage Condition of VCC [Note 1]
USB PCDC (Used the DEVICE USB side connector on the EK-RA2A1 board)	3.0 V <= VCC [Note 2]
UART SCI (used the PMOD B connector on EK-RA2A1 board)	2.5 V <= VCC [Note 3]
Emulator (Used the DEBUG USB side connector on the EK-RA2A1 board)	RA2A1 VCC operating lower limit voltage

Note 1: It shows the operating conditions of the communication IP regardless of the circuit configuration of the EK-RA2A1 board. In addition, there are operating voltage conditions for each IP used.

Note 2: It depends on the operating conditions of USB IP.

Note 3: When using the USB-UART conversion adapter described in '1.4 Operation Confirmation Environment'

3.3.2 UART Serial Communication Settings

The serial communication settings for UART SCI communication are as follows.

Table 3-4 Serial Communication Settings

Items	Settings
Transfer Speed (Bitrate)	Default: 1M bps Maximum: 3M bps [Note 1] The bitrate can be changed after the initial communication. The bitrate that has been confirmed to work are shown below. If you set the bitrate other than the following, normal communication may not be possible. Also, if the bitrate is set to less than 1M bps, the measurement may stop due to the low transmission speed of the measurement data. may stop. — 3M bps — 2M bps — 1.5M bps — 1.333333M bps [Note 3] — 1M bps
Data Length	8-bit
Parity	No parity
Stop Bit	1-bit
Hardware Flow Control [Note 2]	CTS pin: Set to CTS function disabled (RTS function enabled) RTS pin: Assigned the RTS pin to the P401

Note 1: Depends on the specifications of the USB-UART conversion adapter. Therefore, 3M bps may not be supported.

Note 2: Refer to 'Figure 3-1 Wiring Diagram of EK-RA2A1 Board and USB-UART Conversion Adapter'.

Note 3: It is the maximum value when PCLKB frequency = 8MHz, and communication has been confirmed only when PCLKB frequency = 8MHz.

3.3.3 QE for AFE: Automatic Bitrate Switching when UART Is Connected

QE for AFE executes automatic bitrate switching processing from the response information of the EK-RA2A1 board when UART is connected. Table 3-5 shows the bitrate after UART connection.

Therefore, the bitrate switching process is not required during the Continuous measurement of ADC16. Also Refer to '1.1.2(1)(a) Continuous Measurement'.

Table 3-5 Bitrate after UART Connection

PCLKB Frequency	Bit rate after Switching processing
32MHz	1M bps
24MHz	
16MHz	
12MHz	2M bps (Bitrate for Continuous measurement of ADC16)
8MHz	1.333333M bps (Bitrate for Continuous measurement of ADC16)
6MHz	1M bps

However, in the following cases, change the bitrate setting of QE for AFE back to 1M bps.

— When the EK-RA2A1 board is reset

3.4 Write and Build Using e2 studio Integrated Development Environment (IDE)

Import the project, build the project, and write to RA2A1 on the EK-RA2A1 board. For the included projects, refer to 'Table 1-3 e2 studio Project'.

3.4.1 Import Procedure

The import procedure is shown in the figure below.

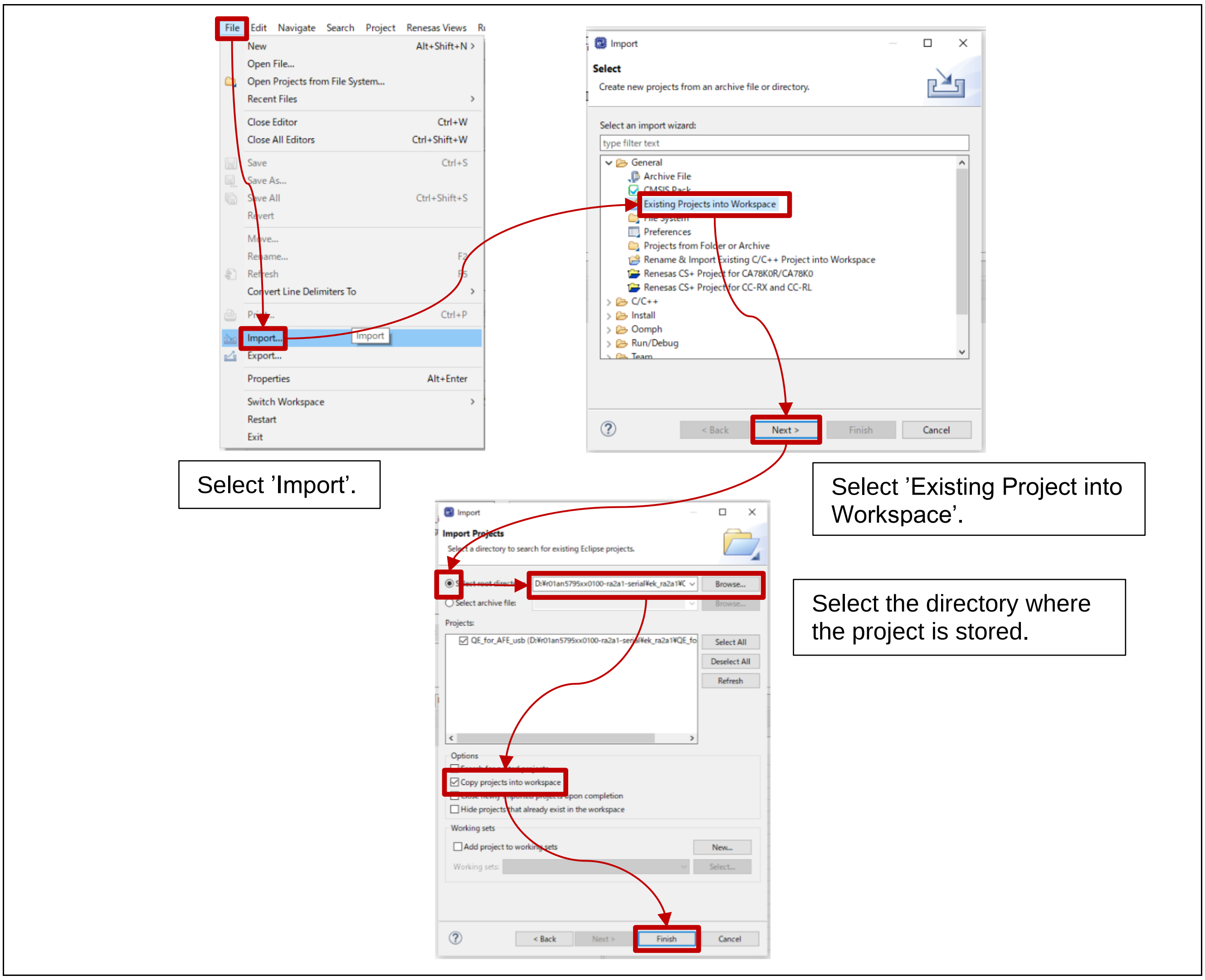


Figure 3-2 Steps to Import a Project into e2 studio

3.4.2 Launch Debug Mode

Execute the **'Build'** and press . Then the **'Debug'** mode will be executed automatically.

3.4.3 Notes on Building Project for SCI UART Communication Using HOCO 64MHz

This applies to the SCI UART communication project and the Emulator I/F communication project that use HOCO 64MHz.

After import, the warning occurs as follows for UCLK setting. This indicates an error for USB clock configuration. The SCI UART communication project does not use USB I/F. Therefore, ignore it.

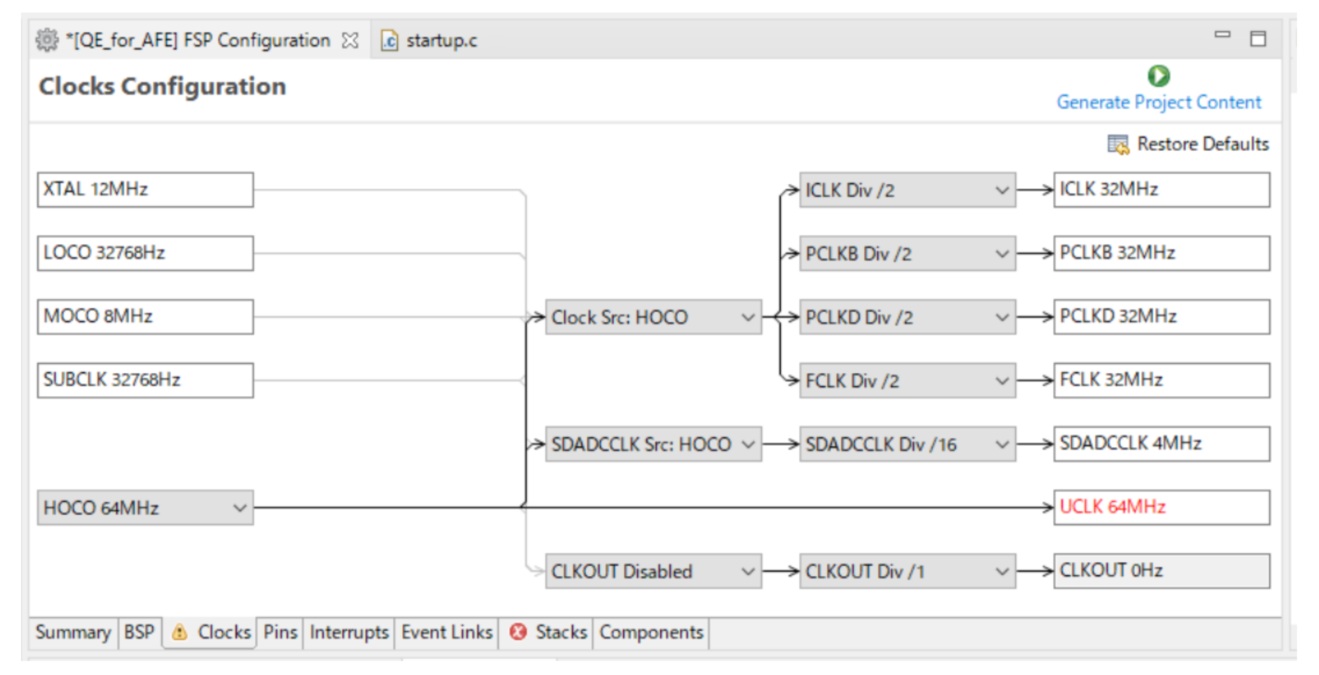


Figure 3-3 Warning in FSP Configuration for SCI UART Communication and Emulator I/F Communication Project

3.4.4 Stack Size

The stack size is set as follows.

Table 3-6 Stack Size Setting

Project	Stack Size
SCI UART communication	0x600
USB PC DC communication	0x600 (If it is set to less than 0x600, it may not work.)
Emulator I/F communication	0x600

3.4.5 About e2 studio Project Source Changes

(1) When Using SCI UART or USB PCDC

Using FSP Configuration, only the clock setting change is allowed.

Figure 3-4 shows where the clock settings were changed.

Use the FSP version shown in 'Table 1-10 Operating Confirmation Conditions'.

If the FSP version is old, please update it.

For the clock setting, refer to User's Manual: Hardware (R01UH0888).

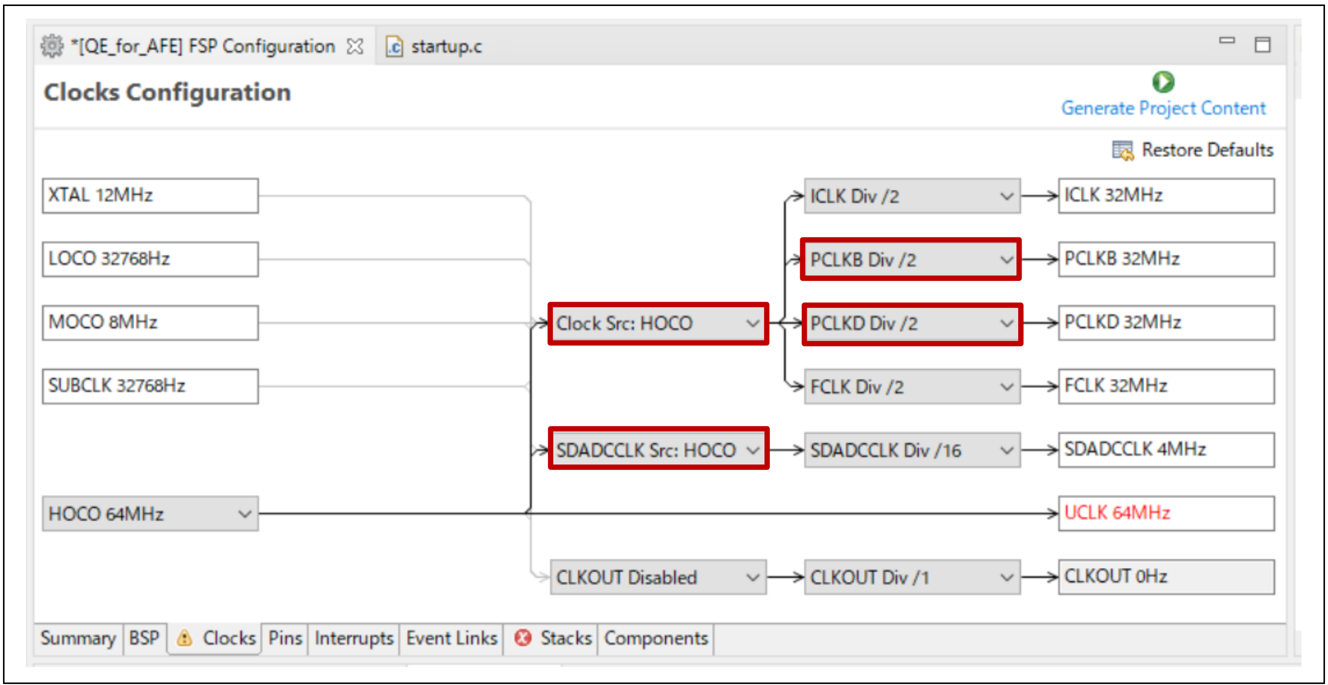


Figure 3-4 FSP Configuration Clock Setting Screen when Using SCI UART or USB PCDC

For the clocks that are allowed to change and their frequencies, Renesas recommend setting of the clocks and their frequencies shown in 'Table 1-11 Clock Settings and Tools to Use (SCI UART)' and 'Table 1-12 Clock Settings (USB PCDC)'.

During continuous measurement operation, if the clock frequency is lowered, it may not be possible to measure normally. Therefore, please evaluate it sufficiently.

For clock settings during continuous measurement operation, refer to 'Table 1-6 ADC16 Continuous Measurement Operation Confirmed Setting Example'.

(2) When Using Emulator I/F

Using FSP Configuration, only the clock setting change is allowed.

For the clocks that are allowed to change and their frequencies, refer to 'Table 1-13 Clock Settings (Emulator I/F)'.

Figure 3-5 shows where the clock settings were changed.

Use the FSP version shown in 'Table 1-10 Operating Confirmation Conditions'.

If the FSP version is old, please update it.

For the clock setting, refer to User's Manual: Hardware (R01UH0888).

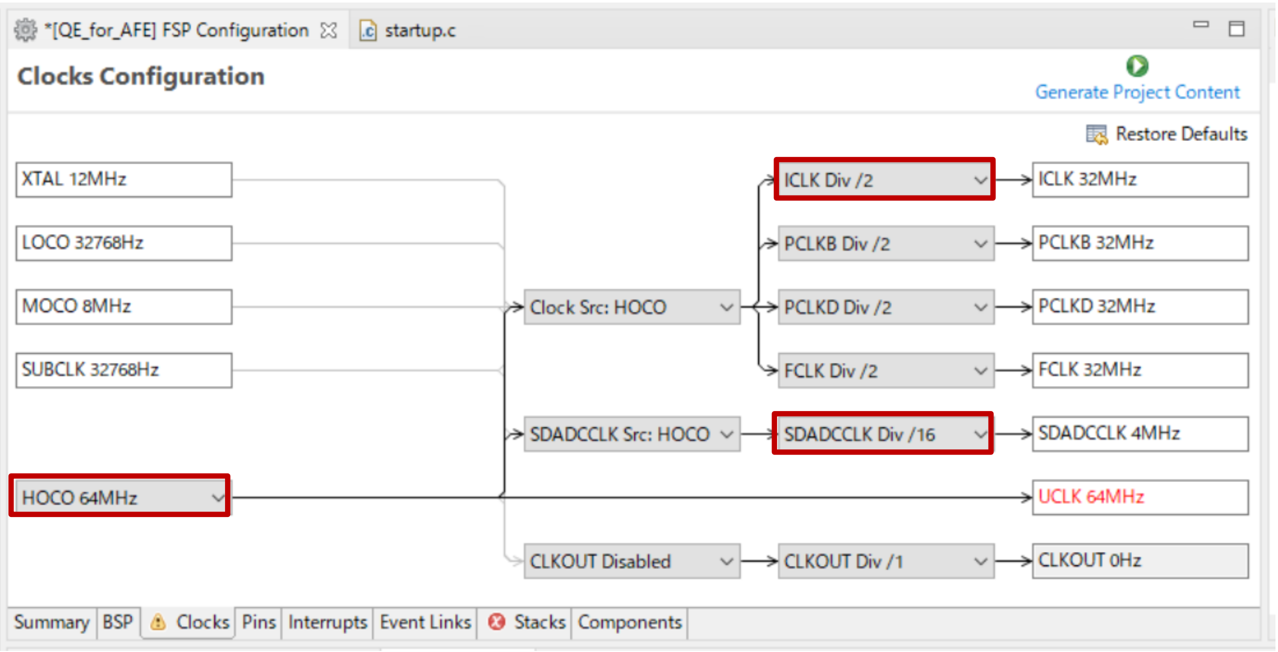


Figure 3-5 FSP Configuration Clock Setting Screen when Using Emulator I/F

4. Trouble-solving Method

The trouble cases are shown below. Please refer to it when evaluating.

<table>
<tr><td>1</td><td>

• Unable to connect to board after writing with Renesas Flash Programmer.

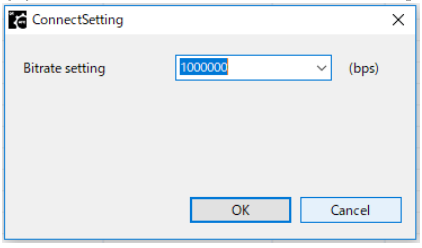
The J8 jumper setting may be incorrect.
Set the J8 jumper to "INTERNAL FLASH".

</td></tr>
<tr><td>2</td><td>

• When using UART I/F: Cannot connect to the board.

There may be a bit rate mismatch. Follow the steps below.

(1) Reset the board.
(2) Set the Bitrate of ‘QE for AFE’ [ConnectSetting] to 1M bps.

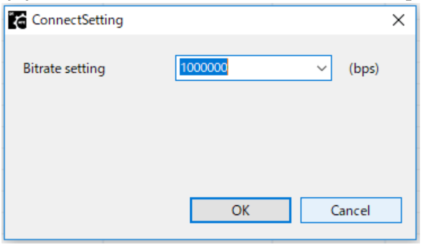


(3) Connect to the board using ‘QE for AFE’.

Note: Since it is necessary to change the bit rate during continuous measurement of ADC16, it is necessary to set the bitrate of ‘QE for AFE’ to 1M bps if the board reset is executed.

You may set the bitrate that does not work and performed board connection processing. Follow the steps below.

(1) Reset the board.
(2) Set the Bitrate of ‘QE for AFE’ [ConnectSetting] to 1M bps.



(3) Connect to the board using ‘QE for AFE’.
(4) Set the bitrate to the different value and try changing the bitrate.

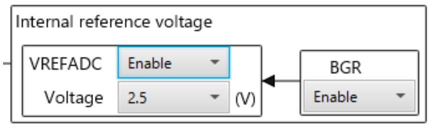
Note: If the bit rate is set to a large value, communication may not be possible.

</td></tr>
<tr><td>3</td><td>

• ADC16 A/D value is significantly different from the expected value.

The reference voltage may be incorrect. Check the following.

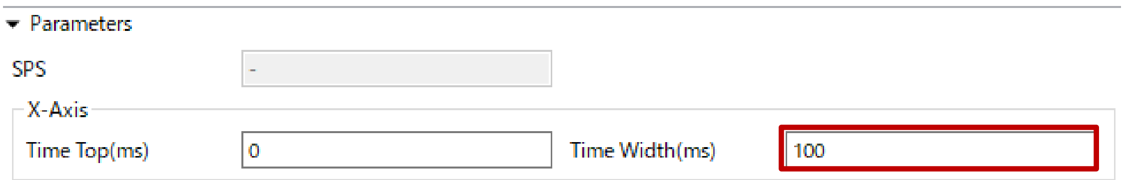
● At the ‘QE for AFE’ -> ‘AFE Connection’ -> ‘ADC16’ tab, check the internal reference voltage (VREFH0 or VREFADC).



The left is a setting example when using VREFADC.

● Check the connection of VREFH0 (J2 # 32, J3 # 16) on the board.
Make sure VREFH0 is open when setting the VREFADC output.
Note: Pay attention to the connection to avoid applying different voltages.

</td></tr>
</table>

4	• **QE for AFE drawing stops during Continuous measurement.**
	The following are the causes of drawing stoppage. ● The measurement was automatically stopped because the upper limit of the number of data acquired by QE for AFE was exceeded. For measurable time, refer to ‘2.2.3.3 Message at Time of Completion of QE for AFE Continuous Measurement and Time to Output’. ●Since the FTDI driver is old, data was missed on the PC and drawing stopped. Please install the version shown in ‘1.4 Operation Confirmation Environment’ or later on your PC. ●During continuous measurement, FW became unable to transmit data or QE for AFE stopped drawing due to variations in data acquisition timing on the PC USB side. As a result of signal analysis with PC USB, it has been confirmed that data communication may rarely be performed for a period longer than the data transmission interval. In order to avoid the period when the PC is not communicating, we recommend that you do not run other PC applications as much as possible and evaluate in the offline state. Still, the data missing may occur. Refer to ‘1.1.2(1)(a) Continuous Measurement’. Also, if drawing is stopped due to this cause, the LED on the EK-RA2A1 board may be lit. In that case, stop tuning QE for AFE and check that the LED is off. If the LED is lit, reset the board and try connecting again.
5	• **QE for AFE drawing stops during One-shot measurement.**
	The following are the causes of drawing stoppage. ● The measurement was automatically stopped because the upper limit of the number of data acquired by QE for AFE was exceeded. For measurable time, refer to ‘1.1.2(1)(b) One-Shot Measurement’.
6	• **Graph of QE for AFE is not drawn when measuring ADC16 or SDADC24.**
	It is possible that the **Time Width** setting is not appropriate. Check the following. (1) If the **Time Width(ms)** is larger than the initial value of 100ms, set it to "**100m**s". 

Revision History

Rev.	Date	Description	
		Page	Summary
1.00	Mar.31.21	-	First Release
1.20	May.31.21	5	Added 1.2 List of Changes
		6	Updated 1.4 File Configurations
		7	Updated Table 1-3 Peripheral Features List in 1.4 File Configurations
		10	Added “The clock setting can be changed in FSP v1.20 environment.” in 1.8 About Project Source Changes.
		11	Added the following in 2. How to Write FW “- Write Using e2 studio Integrated Development Environment (IDE) - Writing using Renesas Flash Programmer”
		12	Added the warning messages in Figure 2-2 Project Build Results for USB PCDC Communication Project in 2.1.2 Notes on Building Project for USB PCDC Communication.
		12	Added the warning messages in Figure 2-4 Project Build Results for SCI UART Communication Project in 2.1.3 Notes on Building Project for SCI UART Communication.
		13	Updated the filename in 2 2 HEX Files in 2.2 Writing using Renesas Flash Programmer.
		17	Added (2) Importing Configuration File in 3.2.2 Launching QE for AFE and Connecting to Target Board.
		17	Added “If it has been imported,…” and Figure 3-5 in 3.2.2 Launching QE for AFE and Connecting to Target Board.
		18	Updated the filename in 3-1 Sample Configuration Files for Operation Confirmation in 3.3 Sample Configuration File.
		20	Updated (2) Setting of ADC16 A/D Sampling State Register n (ADSSTRn) in 3.3.2.1 Project for USB PCDC Communication.
		21	Updated (2) Setting of ADC16 A/D Sampling State Register n (ADSSTRn) in 3.3.2.2 Project for SCI UART Communication.
		24	Added 3.5 How to Check Output Data Rate.
1.40	Aug.20.21	-	Reviewed the overall chapter structure
		1	Updated Introduction.
		3	Updated 1. Overview. Updated 1.1 System Overview.
		4	Added 1.1.1 About the Included HEX Files and e2 studio Projects.
		5	Added 1.1.2 Measured Value Transmission Operation during A/D Conversion and Comparison
		6	Updated 1.2 File Configurations.
		7	Updated 1.3 List of Changes. Updated 1.4 Operation Confirmation Environment. Updated Table 1 7 Operating Confirmation Conditions. Added Table 1 8 Clock Settings and Tools to Use.
		8	Updated 1.6 Related Documentation.
		9 - 11	Changed Chapter 2 to ‘How to Use’.

		12	Changed Chapter 2.2 to ‘Run Project’. Updated Figure 2 7 Connection Example for USB PCDC Communication in 2.1.1 Write Using e2 studio Integrated Development Environment (IDE). Updated Figure 2 8 Connection Example for SCI UART Communication in 2.2.1.2 USB PCDC Communication. Updated 2.1.2 Writing using Renesas Flash Programmer.
		13	Updated 2.2.2 ADC16 Precautions When Using.
		14	Updated 2.2.3.2 Launching QE for AFE and Connecting to Target Board.
		15	Changed Chapter 3. to ‘Program Description’. Added 3.1 Overview. Updated 3.2.1 Peripherals to Use. Added Figure 3 1 Wiring Diagram of EK-RA2A1 Board and USB-UART Conversion Adapter.
		17	Updated 3.2.3 How LED1 Work
		18	Added 3.3.1 Communication I/F and VCC Operating Voltage. Updated 3.3.2 UART Serial Communication Settings.
		19	Updated 3.4 Write and Build Using e2 studio Integrated Development Environment (IDE).
		20	Updated 3.4.2 Notes on Building Project for SCI UART Communication. Added 3.4.3 Stack Size. Updated 3.4.4 About e2 studio Project Source Changes.
		22	Added 4. Trouble-solving Method.
1.60	Dec.20.21	-	Updated filenames.
		5	1.1.2 Measured Value Transmission Operation during A/D Conversion and Comparison, Table 1-5 ADC16: Number of Storable Measured when One-shot Measurement Is Set, Changed Number of measured values for One-shot measurement to 8,192.
		6	1.2 File Configurations, Updated Figure 1-1.
		7	Updated 1.3 List of Changed.
		20	Updated 3.4.3 Stack Size.
		22	4 Trouble-solving Method, Added “3 QE for AFE drawing stops during continuous measurement.”
2.00	Mar.31.22	1	Available Communication I/F Added Emulator I/F Communication.
		4	1.1 System Overview Updated Table 1 1 Connection Method and Differences in Specifications/Functions.
		5	1.1.1 About the Included HEX Files and e2 studio Projects Updated Table 4-1 HEX Files and Table 1 3 e2 studio Projects. Updated (2) e2 studio Projects.
		6 - 7	1.1.2 Measured Value Transmission Operation during A/D Conversion and Comparison Updated.
		8	1.2 File Configurations Updated.
		9	1.3 List of Changes Updated.

		9 - 10	1.4 Operation Confirmation Environment Updated.
		16	2.2.1.3 Emulator I/F Communication Added.
		17	2.2.3 Launch QE for AFE Updated.
		18	2.2.3.3 Message at Time of Completion of QE for AFE Continuous Measurement and Time to Output Added.
		20	3.2.2.1 Pin List No2 P401: Updated. No13 P410: Updated.
		22	3.3 Communication Specifications Table 3 3 Communication I/F and Lower Limit Voltage Condition of VCC: Updated.
		22	3.3.2 UART Serial Communication Settings Table 4-2 Serial Communication Settings: Updated Hardware Flow Control.
		23	3.3.3 QE for AFE: Automatic Bitrate Switching when UART Is Connected Added.
		24	3.4.2 Launch Debug Mode Added.
		25	3.4.3 Notes on Building Project for SCI UART Communication Using HOCO 64MHz Updated.
		25	3.4.4 Stack Size Updated.
		26 - 27	3.4.5 About e2 studio Project Source Changes Updated.
		28 - 29	4. Trouble-solving Method Updated.

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.).
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.

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