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)
  Hi-Speed USB-UART conversion adapter enables continuous measurement with the following high-speed sampling settings.
  - 1 channel setting and sampling time setting of 7us or more
  - 2 or more channels setting and sampling time setting of 5us or more
- 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:

- SCI UART Communication: A separate USB-UART conversion adapter is required.
  Hi-Speed 12Mbps:
  USB 2.0 Hi-Speed to UART Cable C232HD- EDHSP-0 manufactured by Future Technology Devices International (FTDI)
  (Hereafter abbreviated as Hi-Speed 12Mbps USB-UART conversion adapter)
  3Mbps:
  Pmod™ I/F: FTD, PmodUSBUART™ manufactured by FTDI
  (Hereinafter, both are abbreviated as 3Mbps USB-UART conversion adapter)

  The ADC16 is capable of high-data rate output, so when using "ADC16 Continuous Measurement", set the connection Bitrate to 3 Mbps or higher.
  For details, refer to "Table 1-5 ADC16 Continuous Measurement Operation Conditions when Using SCI UART".

- USB PCDC Communication
- Emulator I/F Communication

Contents

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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.

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 of the provided projects and HEX files settings 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

Items		**SCI UART Emulator I/F**	**USB PCDC**	**SCI UART**
Main Clock		HOCO 64MHz	HOCOC 48MHz	XTAL 12MHz
ICLK Frequency (max.)		32MHz	48MHz	12MHz
PCLKB Frequency (max.)		32MHz	24MHz	12MHz
PCLKD(=ADCLK) Frequency (max.)		32MHz	24MHz	12MHz
ADC16	ADCLK Frequency (max.)	32MHz	24MHz	12MHz
	Continuous Measurement of A/D conversion [Note 1]	Support under specific conditions		Not Supported
	One-shot Measurement of A/D conversion [Note 1]	Supported		
SDADC24	SDADC24 Reference Clock Frequency	4MHz		
	Continuous Measurement of A/D Conversion [Note 1]	Supported		
ACMPHS	Comparison Processing Sampling Period [ms]	Integer value ,1ms (min.), 1024ms (max.)		
	Continuous Measurement of Comparison Processing [Note 1]	Supported		
ACMPLP	Comparison Processing Sampling Period [ms]	Integer value ,1ms (min.), 1024ms (max.)		
	Continuous Measurement of Comparison Processing [Note 1]	Supported		

Note 1: For details, refer to ‘1.2 Measured Value Transmission Operation during A/D Conversion and Comparison’.
If the ICLK frequency is 12MHz, continuous measurement may stop.

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 EK-RA2A1.

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

Also, refer to ‘1.6 Operation Confirmation Environment’ for the settings when creating a HEX file.

Table 1-2 HEX Files

I/F	HEX Files	Destination
UART0	RTS/CTS flow control [Note 1] • PCLKB frequency: 32MHz • PCLKD frequency: 32MHz	Hex └─ek_ra2a1 └─ek_ra2a1-uart0-32MHz-rev230.hex
	RTS/CTS flow control [Note 2, 5] • PCLKB frequency: 16MHz • PCLKD frequency: 16MHz	Hex └─ek_ra2a1 └─ek_ra2a1-uart0-16MHz-rev230.hex
USB	RTS/CTS flow control [Note 3] • PCLKB frequency: 24MHz • PCLKD frequency: 24MHz	Hex └─ek_ra2a1 └─ek_ra2a1-usb-24MHz-rev230.hex
	RTS/CTS flow control [Note 4, 5] • PCLKB frequency: 12MHz • PCLKD frequency: 12MHz	Hex └─ek_ra2a1 └─ek_ra2a1-usb-12MHz-rev230.hex

Note 1: This is the same setting as "ek_ra2a1_uart0_32MHz" in ‘Table 1-3 e2 studio Projects’.
Note 2: This is a setting in which the clock frequency is changed based on the above " ek_ra2a1_uart0_32MHz".
Note 3: This is the same setting as "ek_ra2a1_usb_24MHz" in ‘Table 1-3 e2 studio Projects’.
Note 4: This is a setting in which the clock frequency is changed based on the above " ek_ra2a1_uart0_24MHz".
Note 5: This is the Hex file for ADC16 continuous measurement. For details, see "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.

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 ‘1.6 Operation Confirmation Environment’ for the settings when creating a HEX file.

For pin, refer to ‘Table 3-2 Pins Used List’.

Table 1-3 e2 studio Projects

I/F	e2 studio Project	Destination
UART0	RTS/CTS flow control • PCLKB frequency: 32MHz • PCLKD frequency: 32MHz	ek_ra2a1 └─ek_ra2a1_uart0_32MHz
USB	• PCLKB frequency: 32MHz • PCLKD frequency: 32MHz	ek_ra2a1 └─ek_ra2a1_usb_24MHz
Emulator	• PCLKB frequency: 24MHz • PCLKD frequency: 24MHz	ek_ra2a1 └─ek_ra2a1_emulator_32MHz

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 (Analog Input Pins), 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'**.

1.2.1 When Using SCI UART

The following shows the measurement operation for each measurement target.

Table 1-4 Measurement Operation of SDADC24, ADC16, ACMPHS, ACMPLP when Using SCI UART

Measurement Target	Measurement Operation
SDADC24	**Supports Continuous measurement only.**
ADC16 (Analog Input Pins)	Switched to **Continuous measurement** or **One-shot measurement** depending on operating conditions. [Note 1]
ADC16 (Temperature Sensor Output)	Supports Single measurement with single scan.
ADC16 (Internal Reference Voltage)	
ADC16 (Internal Reference Voltage)	

Note 1: Refer to 'Table 1-5 ADC16 Continuous Measurement Operation Conditions when Using SCI UART'.

(1) ADC16

Switching between **Continuous measurement** and **One-shot measurement** operating conditions and precautions are indicated.

(a) ADC16 Continuous Measurement

The following shows the continuous measurement operating conditions of ADC16 when using SCI UART.

Depending on the settings of PCLKB frequency = PCLKD frequency, sampling time and number of channels, the FW switches between continuous measurement or one-shot measurement.

These settings do not guarantee the continuous measurement operation.

Table 1-5 ADC16 Continuous Measurement Operation Conditions when Using SCI UART

System Clock	Communication I/F	ICLK Freq.	PCLKB Freq. = PCLKD Freq.	Sampling Time -Upper: Single channel -Lower: Multiple channels -Value in (): ADSSTR value [Note 1]	UART Bitrate Setting [bps]	QE for AFE Measurement Time (Sampling Time Dependence)	Remarks
HOCO 48MHz	UART	48MHz	24MHz	7us (168) or more 5us (120) or more	4,000,000	Shown for each average value of sampling time. -5us: About 5 min. -7us: About 7 min. -7.5us: About 7.5 min. -10us: About 10 min.	
				7.5us (180) or more 7us (168) or more	3,000,000		
			12MHz	10us (120) or more 10us (120) or more	2,000,000		[Note 3]
HOCO 64MHz		32MHz	32MHz	7us (224) or more 5us (160) or more	5,333,333		
				7.5us (240) or more 7us (224) or more	3,000,000		
			16MHz	7.5us (120) or more 7.5us (120) or more	2,666,666		[Note 4]

Note 1: The time is an estimate. It is judged by the ADSSTR value.
The total ADSSTR value of the set channels is compared with the number of channels x ADSSTR value.
Note 2: If a value less than the specified value is set, the transmission will not be in time and measurement will not be possible.
Note 3: It is the setting of the HEX file 'ek_ra2a1-uart0-12MHz-rev230.hex' shown in "Table 1-2 HEX Files".
Note 4: It is the setting of the HEX file 'ek_ra2a1-uart0-16MHz-rev230.hex' shown in "Table 1-2 HEX Files".

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) ADC16 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 1-6 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 [Auto] that repeats One-shot measurement is possible.

Note that in the case of this measurement, the start and end of measurement are repeated, so the start of the measurement after the end of the measurement and the start of the next measuremen is not continuous data because there is a gap in the measurement time.

1.2.2 When Using USB PCDC

The following shows the measurement operation for each measurement target.

Table 1-7 Measurement Operation of SDADC24, ADC16, ACMPHS, ACMPLP when Using USB PCDC

Measurement Target	Measurement Operation
SDADC24	**Supports Continuous measurement only.**
ADC16 (Analog Input Pins)	Switches to **Continuous measurement** or **One-shot measurement** depending on operating conditions. [Note 1, 2]
ADC16 (Temperature Sensor Output)	Supports Single measurement with single scan [Note 3]
ADC16 (Internal Reference Voltage)	

Note 1: Refer to 'Table 1-8 ADC16 Continuous Measurement Operation Conditions when Using USB PCDCTable 1-5 ADC16 Continuous Measurement Operation Conditions when Using SCI UART'.

Note 2: There is a restriction on use. Refer to '1.3 Precautions and Restrictions on Use'.

Note 3: There is a precaution on use. Refer to '1.3 Precautions and Restrictions on Use'.

(1) ADC16

Switching between **Continuous measurement** and **One-shot measurement** operating conditions and precautions are indicated.

(a) ADC16 Continuous Measurement

The following shows the continuous measurement operating conditions of ADC16 when using SCI UART.

Depending on the settings of PCLKB frequency = PCLKD frequency, sampling time and number of channels, the FW switches between continuous measurement or one-shot measurement.

These settings do not guarantee the continuous measurement operation.

Table 1-8 ADC16 Continuous Measurement Operation Conditions when Using USB PCDC

System Clock	Communication I/F	ICLK Freq.	PCLKB Freq. = PCLKD Freq.	Sampling Time -Value in (): ADSSTR value [Note 1]	QE for AFE Measurement Time (Sampling Time Dependence)	Remarks
HOCO 48MHz	UART	48MHz	12MHz	11.5us (138) or more [Note 2]	About 13min.	Note 4
			6MHz	20us (120) or more [Note 3]	About 22min.	

Note 1: The time is an estimate. It is judged by the ADSSTR value.

Note 2: In the QE for AFE setting, input "11.5 [us]" or more. If QE for AFE drawing stops, set a larger value.

Note 3: If QE for AFE drawing stops, set a larger value.

Note 4: It is the setting of the HEX file 'ek_ra2a1-usb-12MHz-rev230.hex' shown in "Table 1-2 HEX Files".

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 1-2 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) ADC16 One-Shot Measurement

Same as when using SCI UART. See "1.2.1(1)(b)ADC16 One-Shot Measurement"

.

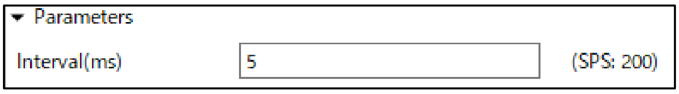
1.2.3 When Using Emulator I/F

The following shows the measurement operation for each measurement target.

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 1-9 Measurement Operation of SDADC24, ADC16, ACMPHS, ACMPLP 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 (Analog Input Pins)	There is no setting for Continuous measurement. Measurement data is acquired intermittently. [Note 2]
ADC16 (Temperature Sensor Output)	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 number of channels and the PC environment, QE for AFE may miss data. In that case, lower the output data rate further.

Note 2: There is a restriction on use. It is also not possible to obtain data (including average value acquisition) during Continuous measurement. Refer to ‘1.3 Precautions and Restrictions on Use’.

1.3 Precautions and Restrictions on Use

- Precaution on ADC16 (Temperature Sensor Output) (Internal Reference Voltage) when USB PCDC Connection
  After monitoring the ADC16 (Analog Input Pins), if you monitor the ADC16 (Temperature Sensor Output) (Internal Reference Voltage), the measurement results may not be displayed on the QE for AFE. In this case, reset the board.
- Restriction on ADC16 (Internal Reference Voltage) when USB PCDC Connection
  "Continuous measurement" monitoring of ADC16 (Analog Input Pins) may not work properly. Select UART connection.
- Restrictions on ADC16 when Emulator Connection
  When Emulator connection is selected in plug-in version of QE for AFE, ADC16 (Analog Input Pins) cannot be monitored. Select UART connection or USB PCDC connection.

1.4 Feature Updates History

The feature updates are as follows.

Table 1-10 Feature Updates History

Items	**Before Change (Rev.2.00)**	**After Change (Rev.2.30)**
UART I/F: • Hi-Speed 12Mbps USB-UART Conversion adapter	Not Supported	Supported
UART I/F: • ADC16 Continuous Measurement Conditions	Frequency of PCLKB = PCLKD is 12MHz or 8MHz	Frequency of PCLKB = PCLKD of 32MHz or 24MHz
Emulator I/F: • ADC16 (Analog Input Pins) Continuous Measurement	Intermittent acquisition of measurement data is supported.	Acquisition of measurement data is **not** supported.
FSP Version	v3.6.0	v5.6.0

1.5 File Configurations

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

```
r01an5795xx0230-ra2a1-serial
├─ek_ra2a1
│  ├─ek_ra2a1_uart0_32MHz                e2 studio project for SCI UART0 PCLKB_32MHz
│  │  ├─.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
│  ├─ek_ra2a1_usb_24MHz                  e2 studio project for USB PCDC PCLKB_24MHz
│  │    The folder structure and file structure are the same as the UART, so they are omitted.
│  │
│  └─ek_ra2a1_emulator_32MHz             e2 studio project for Emulator I/F PCLKB_32MHz
│       The folder structure and file structure are the same as the UART, so they are omitted.
│
├─Hex
│  ├─ek_ra2a1-uart0-32MHz-rev230.hex           Hex file for UART0 PCLKB=PCLKD=32MHz
│  ├─ek_ra2a1-uart0-16MHz-rev230.hex           Hex file for UART0 PCLKB=PCLKD=16MHz
│  ├─ek_ra2a1-usb-24MHz-rev230.hex             Hex file for USB PCLKB=PCLKD=24MHz
│  └─ek_ra2a1-usb-12MHz-rev230.hex             Hex file for USB PCLKB=PCLKD=12MHz
├─r01an5795ej0230-ra2a1-serial.pdf
└─r01an5795jj0230-ra2a1-serial.pdf
```

Figure 1-3 File Configurations

1.6 Operation Confirmation Environment

This FW is confirmed under the operating conditions shown in Table 1-11 and Table 1-12.

The settings of the included HEX file are shown below.

Table 1-11 Operating Confirmation Conditions

Items	Descriptions
MCU	R7FA2A1AB3CFM (Renesas RA2A1 MCU Group) Supply voltage: 3.3V
IDE	Renesas e2 studio V2024-10 (24.10.0)
FSP	v5.6.0
Tool Chain	GNU ARM Embedded 13.1.1.arm-13-7 Optimization Level: -O2
QE for AFE	V2.3.0
Emulator	SEGGER J-Link®
FW Writing Tool	Renesas Flash Programmer V3.11.01
USB-UART Conversion Adapter	Hi-Speed 12Mbps USB-UART conversion adapter: • USB 2.0 Hi-Speed to UART Cable C232HD-EDHSP-0 3Mbps USB-UART conversion adapter: • PMOD I/F: PmodUSBUART
FTDI Driver for PC	Virtual COM port (VCP) drivers V2.12.36.4 URL: VCP Drivers - FTDI (ftdichip.com)

Table 1-12 Clock Settings and Tools to Use (SCI UART)

<table>
<tr><th>Items</th><th colspan="5">SCI UART</th></tr>
<tr><td>Main Clock</td><td colspan="2">HOCO 64MHz</td><td colspan="2">HOCO 48MHz</td><td>XTAL 12MHz</td></tr>
<tr><td>ICLK</td><td colspan="2">32MHz</td><td colspan="2">48MHz</td><td>12MHz</td></tr>
<tr><td>PCLKB</td><td>32MHz</td><td>16MHz</td><td>24MHz</td><td>12MHz</td><td>12MHz</td></tr>
<tr><td>PCLKD</td><td>32MHz</td><td>16MHz</td><td>24MHz</td><td>12MHz</td><td>12MHz</td></tr>
<tr><td>FCLK</td><td colspan="2">32MHz</td><td colspan="2">24MHz</td><td>12MHz</td></tr>
<tr><td>SDADCCLK Clock Source</td><td colspan="2">HOCO 64MHz</td><td colspan="2">HOCO 48MHz</td><td>XTAL 12MHz</td></tr>
<tr><td>UCLK</td><td colspan="2"></td><td colspan="2"></td><td></td></tr>
<tr><td>USB-UART Conversion Adapter</td><td colspan="5">• Hi-Speed 12Mbps USB-UART conversion adapter:
Available at 5.333333Mbps or less
• 3Mbps USB-UART conversion adapter:
Available at 3Mbps or less
The maximum bitrate for both depends on the PCLKB frequency [Note 3].</td></tr>
<tr><td>HEX File</td><td colspan="2">Included [Note 1]</td><td></td><td></td><td></td></tr>
<tr><td>e2 Project</td><td>Included [Note 2]</td><td></td><td></td><td></td><td></td></tr>
</table>

Note When using "ADC16 Continuous measurement", use a system clock of HOCO 64MHz or 48MHz.
Note 1: Refer to 'Table 1-2 HEX Files'.
Note 2: Refer to 'Table 1-3 e2 studio Projects'.
Note 3: Use at maximum bitrate.

Table 1-13 Clock Settings (USB PCDC)

Items	USB PCDC	
System Clock	HOCO 48MHz	
ICLK	48MHz	
PCLKB	24MHz	12MHz
PCLKD	24MHz	12MHz
FCLK	24MHz	
SDADCCLK Clock Source	HOCO 48MHz	
UCLK	HOCO 48MHz	
HEX File	Included [Note 1]]	
e2 Project	Included [Note2]	

Note When using "ADC16 Continuous measurement", use PCLKB frequency = PCLKD frequency = 12 MHz.
Note 1: Refer to 'Table 1-2 HEX Files'.
Note 2: Refer to 'Table 1-3 e2 studio Projects'.

Table 1-14 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	Included [Note 1]	

Note 1: Refer to 'Table 1-3 e2 studio Projects'.

1.7 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.

- Writing HEX files using Renesas Flash Programmer
  — References to Connecting to PC: ‘2.1.1(1) EK-RA2A1 Writing Preparation’
  — References to Writing using Renesas Flash Programmer: ‘2.1.1(2) Launch the Renesas Flash Programmer and Communication Settings’

- Writing a project using the e2 studio integrated development environment (IDE)
  — References to Connecting to PC：‘2.2.1 Connecting to PC’
  — References to Debugging operation: 3.4 Write and Build Using e2 studio Integrated Development Environment (IDE)‘’

2.1.1 Writing using Renesas Flash Programmer

You can write HEX files to RA2A1 on the EK-RA2A1 using Renesas Flash Programmer.

The operation procedure when using Renesas Flash Programmer V3.11.01 is shown below.

Get the Renesas Flash Programmer V3.11.01 or later that supports RA Family from the following.

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

(1) EK-RA2A1 Writing Preparation

1. Connecting to a PC

   Use the on-board debug mode of the EK-RA2A1's USB debugging I/F.
   By default, the jumper is enabled with the onboard debugger.
   Regarding the connection method, since only the USB debugging I/F is connected, connect in the same way as "Figure 2 4 Example of connection when communicating with the Emulator I/F".

(2) Launch the Renesas Flash Programmer and Communication Settings

The following two cases are explained.

- If No Renesas Flash Programmer Project for RA Family has been created
- If Renesas Flash Programmer Project for RA Family has been created

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

1. Create a new project and connect.

   Click ‘New Project ...’ in ‘File’.
   Set the ‘Microcontroller’ in ‘Project Information’ to “RA”.
   Set the ‘Tool’ of ‘Communication’ to "COM port".
   Under ‘Communication’, set ‘Tool’ to "J-Link" and ‘Interface’ to "SWD".
   Click "Connect".
   Renesas Flash Programmer will start the connection process. Verify that the connection was successful.

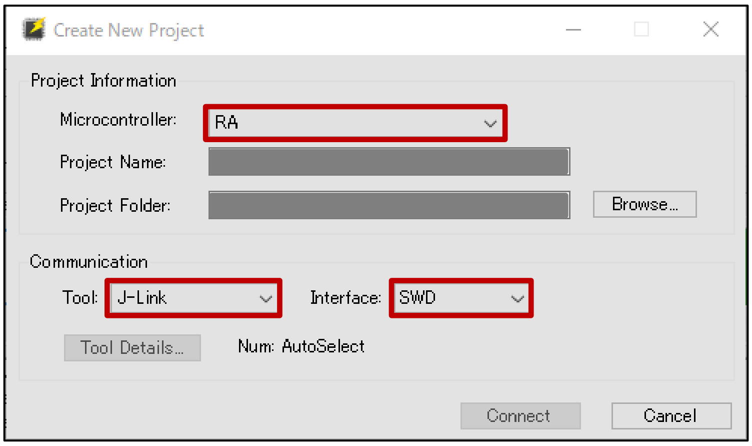


Figure 2-1 Setting of ‘Microcontroller’, ‘Tool’ and ‘Interface’

(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.

(3) Writing to RA2A1

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

2.2 Run Project

2.2.1 Connecting to PC

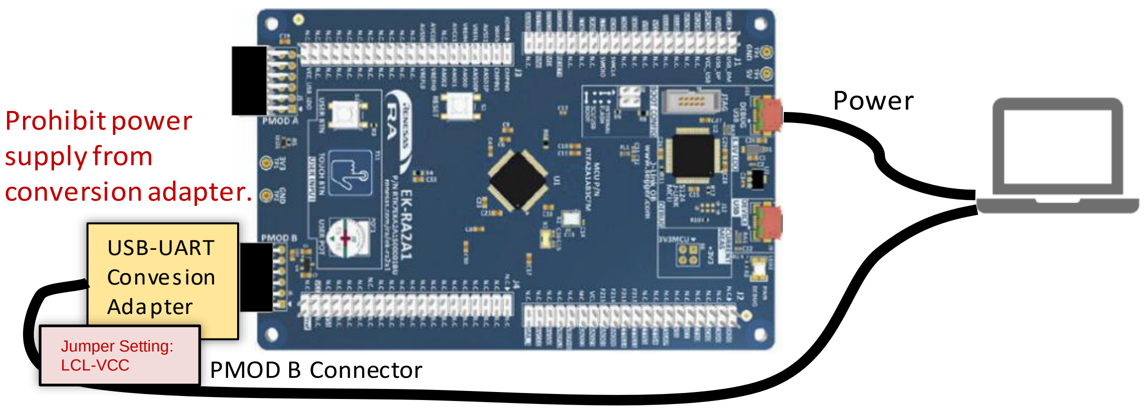
Debug USB I/F provides a power supply voltage for the EK-RA2A1. Refer to the 'EK-RA2A1 v1 User's Manual (R20UT4580)'.

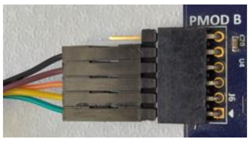
Connection examples are shown below.

2.2.1.1 SCI UART Communication

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





Connection with USB 2.0 Hi-Speed to UART Cable C232HD-EDHSP-0

Figure 2-2 Connection Example for SCI UART Communication

Table 2-1 How to Connect PMOD B Connector and USB-UART Conversion Adapter

EK-RA2A1 PMOD B Connector		USB-UART Conversion Adapter	
PMOD B Connector	**Pin Assign**	**C232HD-EDHSP-0**	**PmodUSBUART**
#1: CTS	+3.3V	RTS# / GREEN	#1: RTS#
#2: TXD	GND	RXD0 / YELLOW	#2: RXD
#3: RXD	P102/SCK0	TXD / ORANGE	#3: TXD
#4: RTS	P101/RXD0	CTS# / BROWN	#4: CTS#
#5: GNDI	P100/TXD0	GND / BLACK	#5: GND
#6: +3.3V	P103/CTS0 [Note3]	-- [Note 1]	#6: VCC [Note 2]

Note 1: Do not connect the VCC of the USB-UART conversion adapter because there is a voltage difference between the board VDD and the USB-UART conversion adapter VCC. The same applies even if the VCC of the USB-UART conversion adapter is 3.3V.

Note 2: Set the jumper on PmodUSBUART to "LCL-VCC".

2.2.1.2 USB PCDC Communication

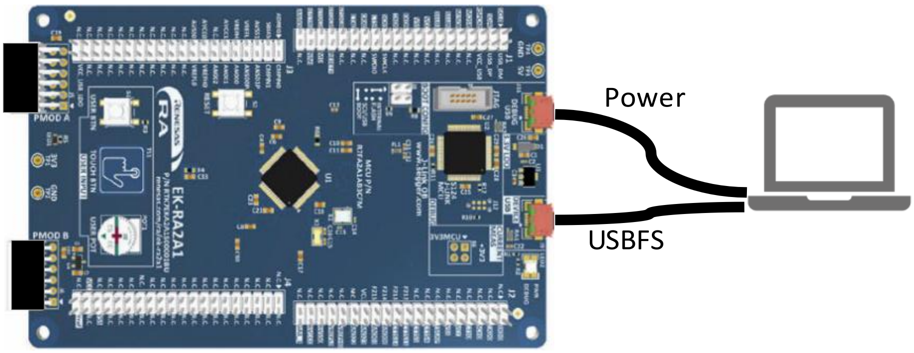


Figure 2-3 Connection Example for USB PCDC Communication

2.2.1.3 Emulator I/F Communication

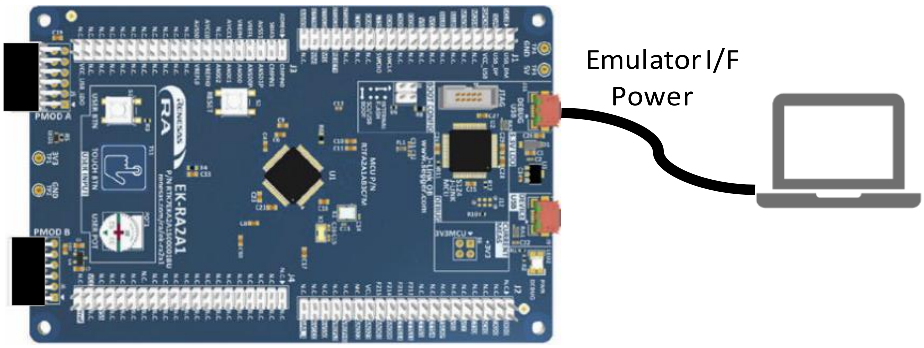


Figure 2-4 Connection Example for Emulator I/F Communication

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, 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 are adjacent pins and can be easily connected using jumper as shown below.

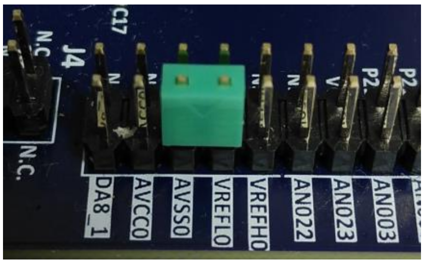


Figure 2-5 Connecting J2 34-pin (VREFL0) and J2 36-pin (AVSS0) on Board using ADC16

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 "S**tandalone 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

   Refer to '2.2.2 ADC16 Precautions When Using'.

2. Writing FW

   Refer to '2.1 How to Write FW'.

3. Connection between PC and EK-RA2A1

   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 to 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-UART Conversion Adapter in the PC device manager and select the COM number from 'COM Port:'.

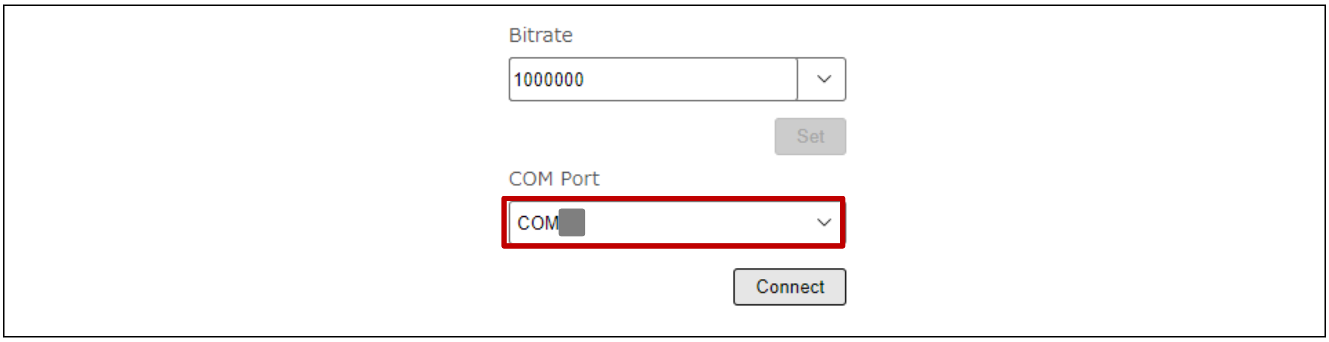


Figure 2-6 Selecting COM Number

Also, check the following display on the console.

```
[Info]Connect succeeds.
```

Figure 2-7 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 2-8 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 Measurement Time

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

Depending on the IP used, the message when the upper limit is reached will differ.

(1) SDADC24

When the output data rate is 15.625ksps (SDADC24 1ch OSR = 64), **one hour** 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 2-9 Message when Maximum Number of Acquired Data is Reached in Case of SDADC24

(2) ADC16

The continuous measurement time depends on the setting of ADSSTRn.

For the approximate time to output the message during ADC16 continuous measurements, refer to 'Table 1-5 ADC16 Continuous Measurement Operation Conditions when Using SCI UART

The message when the limit is reached is as follows:

```
[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 2-10 Message when Maximum Number of Acquired Data is Reached in Case of ADC16

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 'Table 1-11 Operating Confirmation Conditions'.
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

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 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, LED lighting can be suppressed. For more information, refer to '5.4.4 LEDs' in the 'EK-RA2A1 v1 User Manual (R20UT4580)'

.

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 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	3.0 V <= VCC [Note 2]
UART SCI	2.5 V <= VCC [Note 3]
Emulator	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. 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 '1.6 Operation Confirmation Environment'

3.3.2 UART Serial Communication Settings

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

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

— When the EK-RA2A1 is reset

Table 3-4 Serial Communication Settings

Items	Settings
Transfer Speed (Bitrate)	Default: 1M bps (Lower Limit) Maximum: 3M bps [Note 1] / 4M bps [Note 4] / 5.333333M bps [Note 5] The bitrate (over 1Mbps) 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. — 5.333333M bps [Note 5] — 4M bps [Note 4] — 3M bps — 2.666666M bps [Note 3] — 2M bps — 1.5M bps — 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: This value is when using a 3Mbps USB-UART conversion adapter.

Note 2: Refer to 'Table 3-2 Pins Used List'.

Note 3: PCLKB frequency = 16MHz, Hi-Speed 12Mbps USB-UART conversion adapter can be used.

Note 4: PCLKB frequency = 24MHz, Hi-Speed 12Mbps USB-UART conversion adapter can be used.

Note 5: PCLKB frequency = 32MHz, Hi-Speed 12Mbps USB-UART conversion adapter can be used.

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. 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.

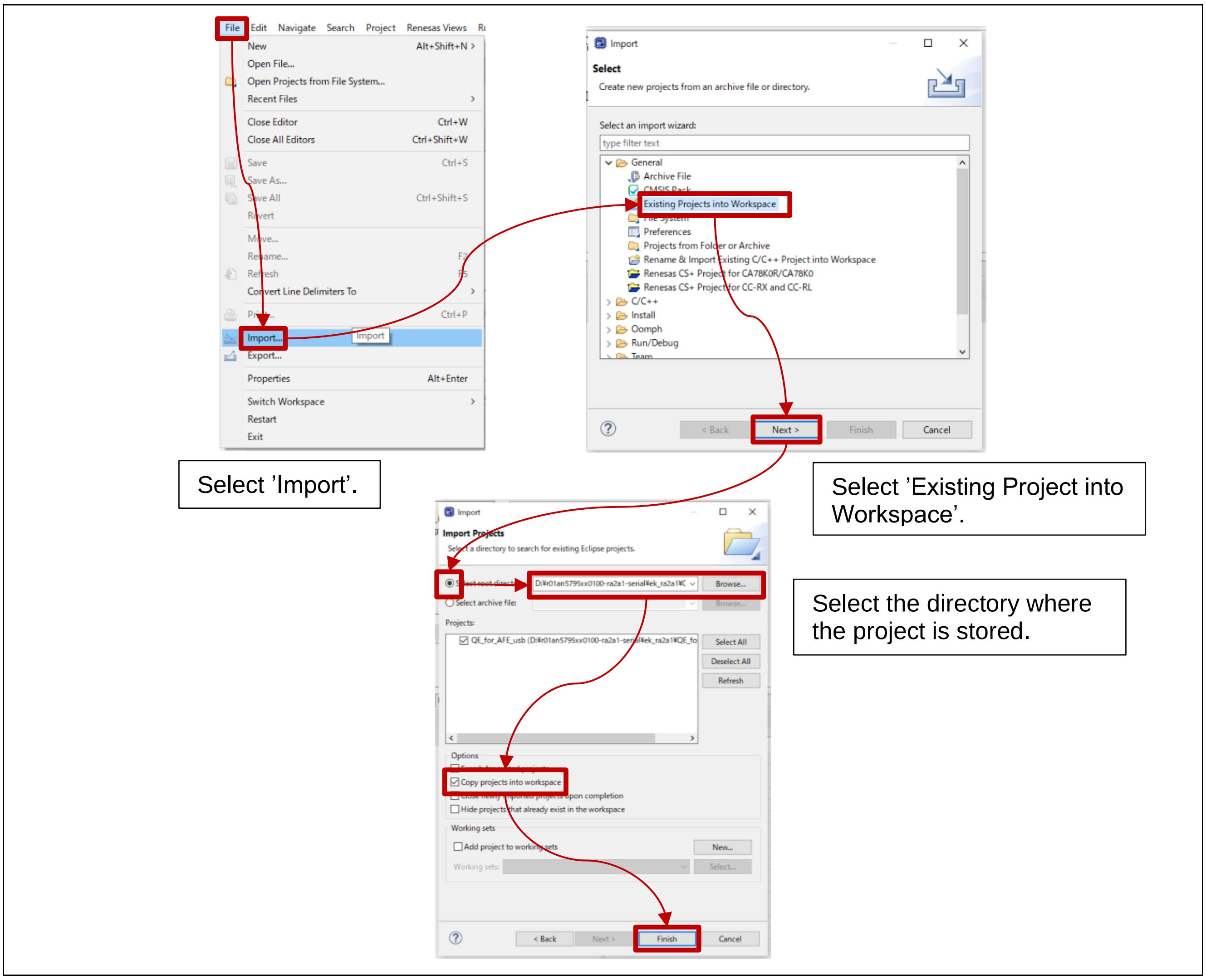


Figure 3-1 Steps to Import a Project into e2 studio

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.

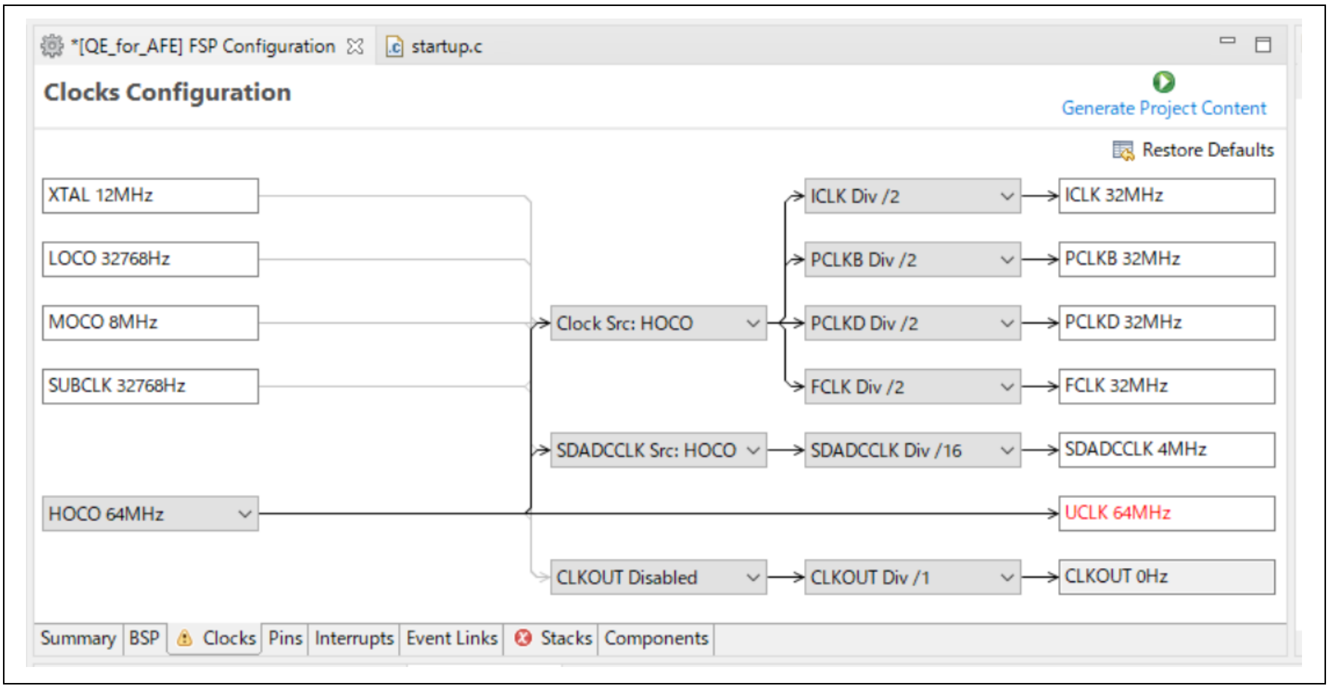


Figure 3-2 Warning in FSP Configuration for SCI UART Communication and Emulator I/F Communication Project

3.4.4 Stack Size

The stack size is set as follows.

Table 3-5 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

In FSP Configuration, only the clock setting is allowed to be changed.

Therefore, select the project on which you want to base your changes. For details on setting up a project, '1.1.1(2) e2 studio Projects'.

Follow the steps below to display the 'Clocks Configuration'.

[Project Explorer] -> [configuration.xml] file -> Click [Clocks] tab]

Figure 3-3 shows Clock setting changes.

It is possible to change the clock setting in the FSP environment shown in 'Table 1-11 Operating Confirmation Conditions'.

For details on clock settings, refer to User's Manual: Hardware.

For the clocks that are allowed to change and their frequencies, Renesas recommend setting of the clocks and their frequencies shown in 'Table 1-12 Clock Settings and Tools to Use (SCI UART)' and 'Table 1-13 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 1-5 ADC16 Continuous Measurement Operation Conditions when Using SCI UART'.

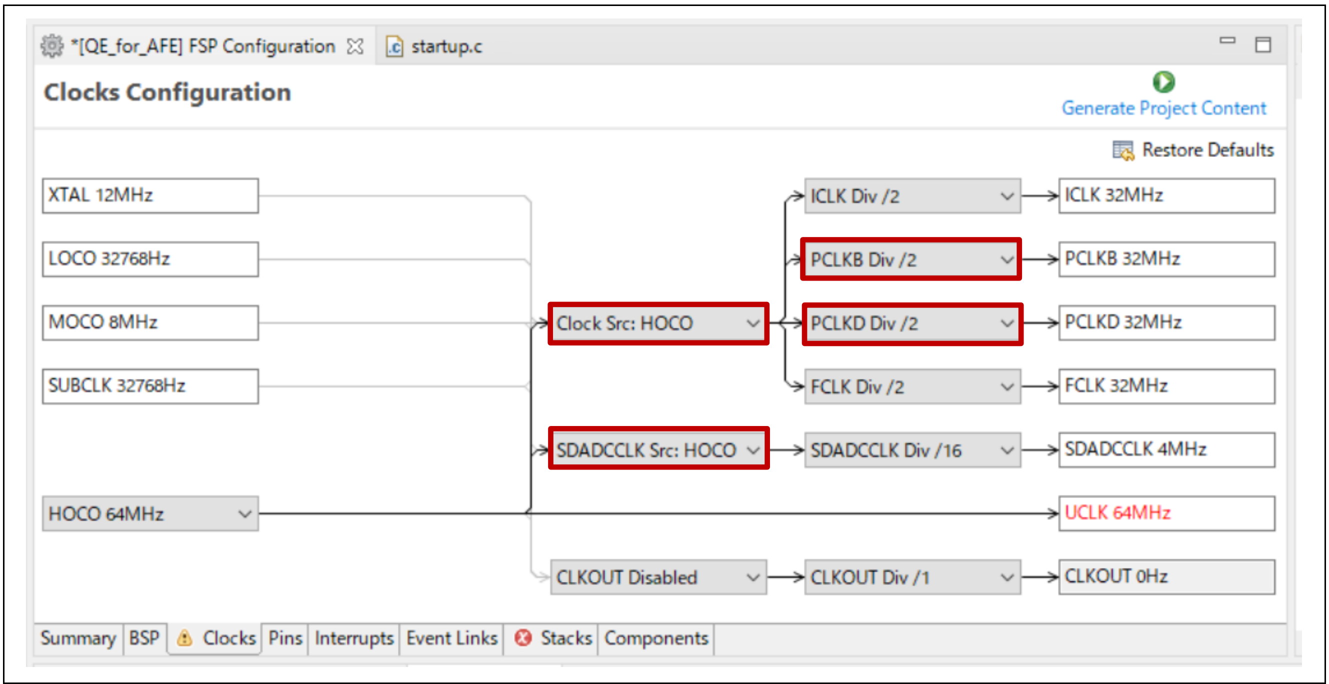


Figure 3-3 FSP Configuration Clock Setting Screen when Using SCI UART or USB PCDC

(2) When Using Emulator I/F

In FSP Configuration, only the clock setting is allowed to be changed.

Therefore, select the project on which you want to base your changes. For details on setting up a project, ‘1.1.1(2) e2 studio Projects’.

Follow the steps below to display the ‘Clocks Configuration’.

[Project Explorer] -> [configuration.xml] file -> Click [Clocks] tab]

Figure 3-4 shows Clock setting changes.

It is possible to change the clock setting in the FSP environment shown in ‘Table 1-11 Operating Confirmation Conditions’.

For details on clock settings, refer to User's Manual: Hardware.

For the clocks that are allowed to change and their frequencies, refer to ‘Table 1-14 Clock Settings (Emulator I/F)’.

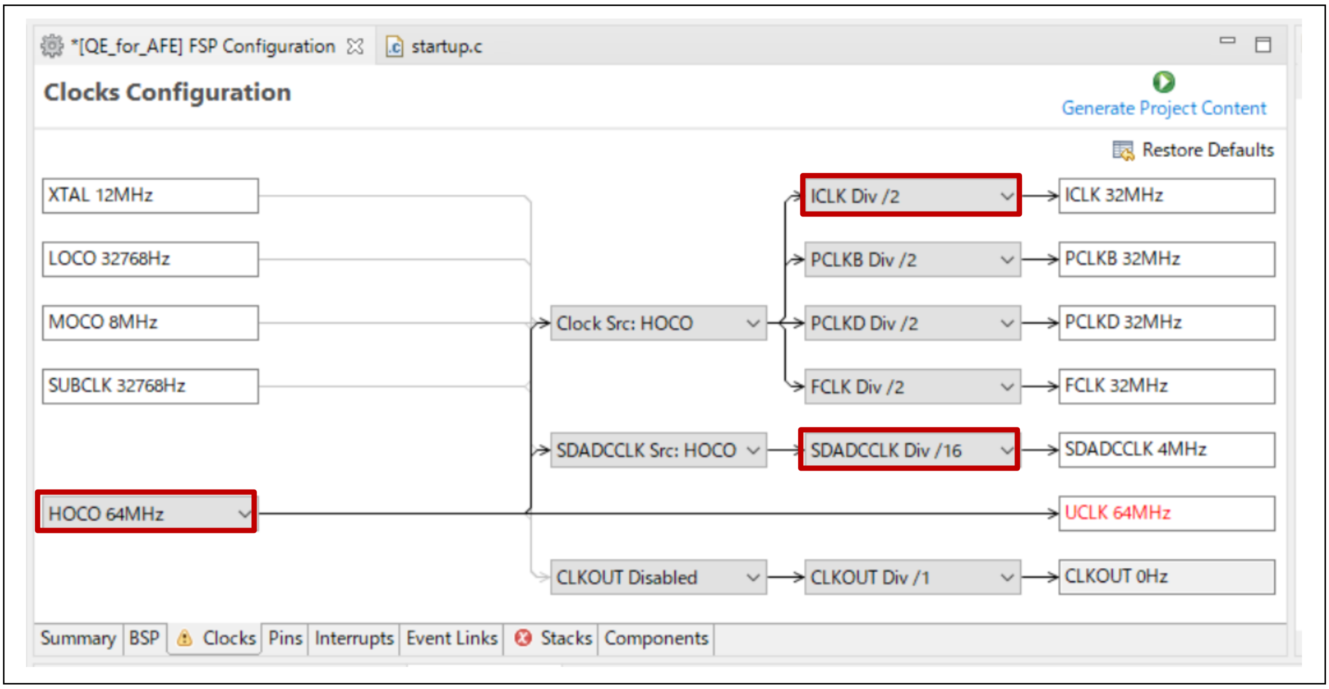
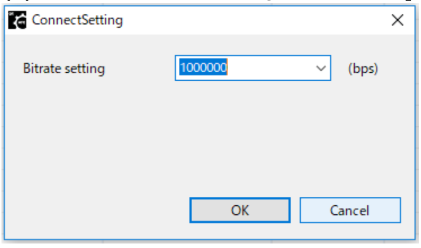


Figure 3-4 FSP Configuration Clock Setting Screen when Using Emulator I/F

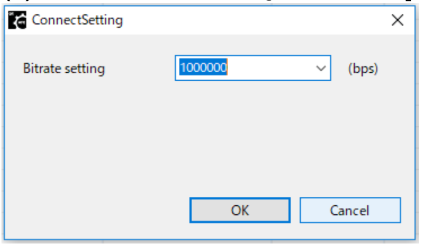
4. Trouble-solving Method

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

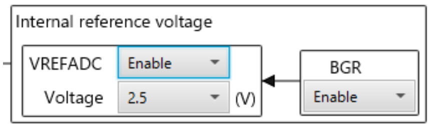
<table>
<tr><td>1</td><td>• Unable to connect to board after writing with Renesas Flash Programmer.</td></tr>
<tr><td></td><td>The J8 jumper setting may be incorrect.
Set the J8 jumper to "INTERNAL FLASH".</td></tr>
<tr><td>2</td><td>• When using UART I/F: Cannot connect to the board.</td></tr>
<tr><td></td><td>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.

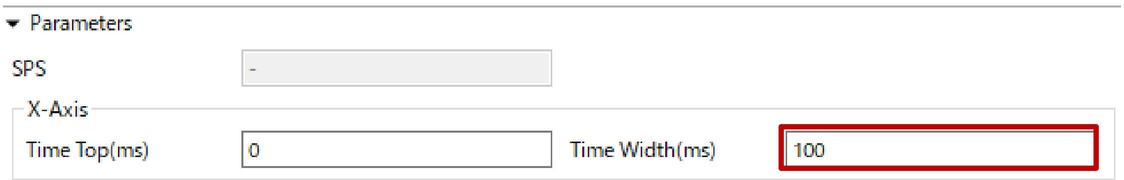
You may set the bitrate that does not work and performed board connection processing. Follow the steps below.
(1) Reset the board.
(2) Set the Bitrate of ‘QE for AFE’ [ConnectSetting] to 1M bps.


(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.</td></tr>
<tr><td></td><td>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 Measurement Time'. ●Since the FTDI driver is old, data was missed on the PC and drawing stopped. Please install the version shown in '1.6 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 '1.2.1(1)(a) ADC16 Continuous Measurement'. Also, if drawing is stopped due to this cause, the LED on the EK-RA2A1 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 '1.2.1(1)(b) ADC16 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.
2.30	Jan.20.25	-	FW updated. Added ADC16 Continuous measurement features at sampling time 5us.

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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