

RA0E1 Group FPB-RA0E1 Tutorial

Introduction

This application note explains how to create a new project and debug a program using the e² studio integrated development environment for the FPB-RA0E1 board with Renesas' RA0E1 group MCU.

Target Device

RA0E1 group

Related Documents

[1] Renesas RA Family FPB-RA0E1 v1 User's Manual (R20UT5378)

[2] Integrated development environment e ² studio 2022-07 or higher User's manual Quick start guide Renesas microcontroller RA family (R20UT5210)



RA0E1 Group

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1. Development environment

This application note explains using the following development environment.

1.1 Hardware environment

Use the following hardware:

Board: FPB-RA0E1 (RTK7FPA0E1S00001BJ)
 Connect the board and PC using the USB Type A to Type C cable included with the product.

1.2 Software environment

This document uses the following software. Please install the software in advance.

- Integrated development environment
 e² studio 2024- 01.1 or later
- compiler
 - GNU ARM Embedded: 13.2.1.arm-13.7 or later
- Flexible Software Package

 Version: 5.2.0 or later Download: <u>https://github.com/renesas/fsp/releases</u>



2. Software overview

This section explains the specifications of the program created using this application note.

2.1 Program to create

A program which alternately toggles two on-board LEDs using a 500ms periodic timer interrupt.

Indicates the board used and the location of the LEDs.

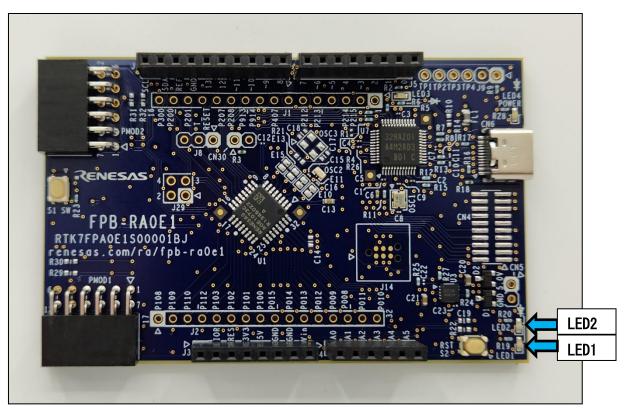


Figure 2-1 On-board LED position

2.2 Resources

This section describes the resources consumed by the program described in this application note.

2.2.1 Clock

HOCO clock frequency: 32MHz HOCO clock division: 1 division ICLK selection source: HOCO ICLK frequency: 32MHz TAU CK00 supply clock : 62.5kHz

2.2.2 Timer

Timer functions used:	TAU channel 0
TAU clock supplied to channel 0:	CK00
Channel 0 operating mode:	interval timer mode
Interval timer period:	500ms
FSP software stack used:	ritual

2.2.3 Port

Ports used:	P008 (LED1) / P009(LED2)
FSP software stack used:	r_ioport



3. How to create a program

This chapter explains how to create a project, set up peripheral functions using FSP, write application code, and build.

3.1 Create new project

- 3.1.1 Project launch
 - From the e² studio menu bar Select "New" → "Renesas C/C++ Project " → " Renesas RA ".

ile	Edit	Source	Refactor	Navigate	Search	Project	Rene	esas <u>V</u> iews	<u>R</u> un	Renesas Al	Window	<u>H</u> elp		
	New				Alt+Sh	ift+N >		Renesas C	/C++ P	roject			>	Renesas Debug
	Open	File					C *	Makefile	roject	with Existing	Code		- F	Renesas RA
	Open	Projects	from File Sy	ystem			C	C/C++ Pr	oject					
	Recen	nt Files				>		Project						

2. "Renesas RA C/C++ Project " and click "Next".

🗿 New C/C++ Pr	oject	-		×
Templates for	Renesas RA Project			
All C/C++	Renesas RA C/C++ Project Create an executable or static library C for Renesas RA.	'C++ pro	ject	
?	< Back Next > Finish		Cance	1

Figure 3-2 Project launch



- 3. Project name Write any name and click "Next".
 - " Use default location ", the project will be created in the path shown below. If you want to create it in another location, uncheck it and set the path.

Renesas RA C/C++ Project	— 🗆
Renesas RA C/C++ Project	
Project Name and Location	
Project name	
FPB_RA0E1_Tutorial Use default location	

You can download more Renesas packs here





3.1.2 Device/Tool Configuration

The following steps outline the configuration of the projects target device and tooling.

1. FSP Version : Select the latest version (minimum 5.2.0) Language : Select C.

Renesas Ra	A C/C++ Project ols Selection		
Device Selecti	on		
FSP Version:	5.2.0	~	Board
Board:	Custom User Board (Any Device)	×	
Device:	R7FA0E1073CFJ		
Core:	CM23	~	
Language:	OC ○C++		Devic
			Trus

Figure 3-4 Device/Tool Configuration

2. Board: Select **FPB-RA0E1** from the list. (**Device** and **core** is set automatically)

FSP Version:	5.2.0	
Board:	Custom User Board (Any Device)	~
-	EK-RA4W1	
Device:	EK-RA6E2	
Core:	EK-RA6M1	
	EK-RA6M2	
	EK-RA6M3	
Language:	EK-RA6M3G	
	EK-RA6M4	
	EK-RA6M5	
	EK-RA8D1	
	EK-RA8M1	
	FPB-RA0E1	
	FPB-RA2E1	
	FPB-RA2E2	
	EDD DADED	

Figure 3-5 Device/Tool Configuration



3. Toolchains settings : Select " GNU ARM Embedded" . Select the latest version from the list of versions.

LLVM Embedded Toolchain fo	or Arm
13.2.1.arm-13-7	~

Figure 3-6 Device/Tool Configuration

4. Debugger settings: Select J -Link ARM .

Debugger	
J-Link ARM	~

Figure 3-7 Device/Tool Configuration

The settings are complete.

5. Confirm the settings in the red framed areas and click "Next.

🛐 Renesas R/	A C/C++ Project					×
Renesas R	A C/C++ Project					\$
Device Selecti FSP Version: Board: Device: Core: Language:		~ 	··· Visit https://www.	Board for RA0E1 MCU Group renesas.com/ra/fpb-ra0e1 to get kit u rt guide, errata, design package, exam No 32 Cortex-M23		
Toolchains GNU ARM E LLVM Ember 13.2.1.arm-12	dded Toolchain for Arm		Debugger J-Link ARM			
			< Back	Next > Finish	Cance	

Figure 3-8 Device/Tool Configuration



3.1.3 Build artifact settings

In this application note, we will generate an executable file from the program, so select Executable.

Since we do not use RTOS, select No RTOS.

Click Next.

🚳 Renesas RA C/C++ Project		_	×
Renesas RA C/C++ Project			\diamond
Build Artifact and RTOS Selection			
Build Artifact Selection	RTOS Selection		
 Executable Project builds to an executable file 	No RTOS		~
 Static Library Project builds to a static library file 			
 Executable Using an RA Static Library Project builds to an executable file Project uses an existing RA static library project 			

Figure 3-9 Build artifact settings



3.1.4 Template type settings

1. In this application note, we will explain how to use FSP, so this time we will select Bare Metal - Minimal. Then click "Finish".

Brief overview of the options:

Bare Metal - Blinky will generate an application which toggles all on board LEDs determined from the BSP using a simple software delay.

Bare Metal - Minimal will generate an empty application with basic C-runtime setup but no executable code.

Renesas RA C/C++ Project			
Project Template Selection			Ź
Project Template Selection			
Bare Metal - Blinky Bare metal FSP project that includes BSP and will blink LEDs if available. This project will initialize close the C runtime environment. [Renesas.RA.5.2.0.pack]	ocks, pins, :	stacks, an	d
• Bare Metal - Minimal Bare metal FSP project that includes BSP. This project will initialize clocks, pins, stacks, and the C runt [Renesas.RA.5.2.0.pack]	time enviro	onment.	
Code Generation Settings			
(?) < Back	sh	Cance	el

Figure 3-10 Template type settings



2. Explain this option opens the "FSP Configuration" Perspective which optimizes the FSP Configuration workflow.

If you click no, it can be accessed again by selecting "Open New Perspective" ... then provide images/instructions of this process.

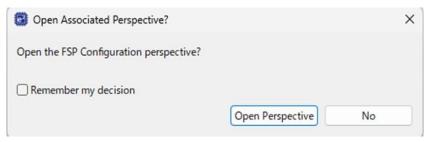


Figure 3-11 Template type settings

3. Project creation is complete.

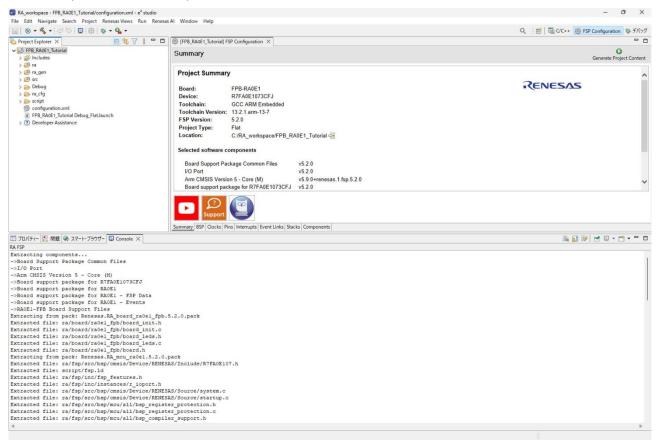


Figure 3-12 Template type settings



3.2 FSP Configurator settings

Use FSP Configurator to configure the system clock and initial settings for peripheral functions.

3.2.1 How to call the FSP Configurator

The FSP Configuration page should be open by default. If it is not open, double-click the configuration.xml file in the Project Explorer to display the configuration screen.

RA_workspace - FPB_RA0E1_Tutorial/configuration.xml - e ² studio			- 0 X
File Edit Navigate Search Project Renesas Views Run Renesas	Al Window Help		
📓 🖲 • 🐔 • 🖉 🏷 🔛 🕲 🏘 • 💁 •			Q、 I 館 国 C/C++ 徳 FSP Configuration 参 デバッグ
Project Explorer X	[FPB_RA0E1_Tutorial] FSP Configuration ×		- 8
V S FPB_RAOE1_Tutorial			9
> 🔊 Includes	Summary		Generate Project Content
> 😂 ra			
> 😂 ra_gen	Project Summary		
> 😂 src	,		
> 🗁 Debug	Board: FPB-RA0E1		RENESAS
> 🗁 ra_cfg	Device: R7FA0E1073CFJ		
2 Cript	Toolchain: GCC ARM Embedded		
鬰 configuration.xml	Toolchain Version: 13.2.1.arm-13-7		
EPB_PAGEt_Taterial Debug_Flat.launch	ESP Version: 52.0		
> ⑦ Developer Assistance	Project Type: Flat		
	Location: C:/RA_workspace/FPB_R	A0E1 Tutorial	
	C.Noworkspace/ PD_N		
	Selected software components		
	Board Support Package Common Files	v5.2.0	
	I/O Port	v5.2.0	
	Arm CMSIS Version 5 - Core (M)	v5.9.0+renesas.1.fsp.5.2.0	~
	Board support package for R7FA0E1073CFJ	v5.2.0	
	Support		
	Summary BSP Clocks Pins Interrupts Event Links Sta	cks Components	
□ ブロバティー શ 問題 🧠 スマート・ブラウザー 📮 Console ×			🔍 🚮 😥 🚽 🔂 🗸 🗖 🗖
RA FSP			
Extracting components			
->Board Support Package Common Files			
->I/O Port ->Arm CMSIS Version 5 - Core (M)			
->Board support package for R7FA0E1073CFJ			
->Board support package for RAOE1			
->Board support package for RAOE1 - FSP Data			
->Board support package for RAOE1 - Events			1
->RAOE1-FPB Board Support Files			
Extracting from pack: Renesas.RA_board_ra0e1_fpb.	5.2.0.pack		
Extracted file: ra/board/ra0el_fpb/board_init.h Extracted file: ra/board/ra0el_fpb/board_init.c			
Extracted file: ra/board/ra0el fpb/board leds.h			
Extracted file: ra/board/ra0el fpb/board leds.c			
Extracted file: ra/board/ra0el_fpb/board.h			
Extracting from pack: Renesas.RA_mcu_ra0e1.5.2.0.			
Extracted file: ra/fsp/src/bsp/cmsis/Device/RENES	AS/Include/R7FA0E107.h		
Extracted file: script/fsp.ld			
Extracted file: ra/fsp/inc/fsp_features.h Extracted file: ra/fsp/inc/instances/r ioport.h			
Extracted file: ra/fsp/src/bsp/cmsis/Device/RENES	AS/Source/system.c		
Extracted file: ra/fsp/src/bsp/cmsis/Device/RENES			
Extracted file: ra/fsp/src/bsp/mcu/all/bsp_regist			
Extracted file: ra/fsp/src/bsp/mcu/all/bsp_regist	er_protection.c		
Extracted file: ra/fsp/src/bsp/mcu/all/bsp_compile	er_support.h		
4			3

Figure 3-13 How to call the FSP Configurator screen



3.2.2 Clock setting

1. Select the "Clocks" tab to open the clock settings screen . Make sure the default screen looks like the one below.

The path of each clock is indicated by a thick arrow.

[FPB_RAGE1_Tutorial] FSF Clocks Configuration				
HOCO 32MHz V	HOCO Div /1	✓ → ICLK Src: HOCO	1	→ ICLK 32MHz
MOCO 4MHz	HOCO Div /1	~~	>> TAU CK00 Div /1	✓ → TAU CK00 32MHz
X1 20MHz	X1 Div /1	~~	→ TAU CK01 Div /1	✓ → TAU CK01 32MHz
SUBCLK 32768Hz			→ TAU CK02 Div /2	✓ → TAU CK02 16MHz
LOCO 32768Hz			> TAU CK03 Div /256	✓ → TAU CK03 125kHz
		CLKOUT Disabled V		✓ → CLKOUT 0Hz
	\	UARTA Src: Disabled V		> UARTA UTA0 0Hz
		TML32 FITL0 Disabled V		> TML32 FITL0 0Hz
		TML32 FITL1 Disabled 🗸		TML32 FITL1 0Hz
		$ ightarrow$ TML32 FITL2 Disabled $\!$		→ TML32 FITL2 0Hz
	> FSXP Src: SUBCLK	~		FSXP 32.768kHz

Figure 3-14 Clock setting

2. In the program being described we require a timer with period 500ms. As this cannot be created with a supply clock (CK00) of 32MHz we must reduce it down to a more sensible value of 62.5kHz. Click TAU CK00 Div /1 and select **TAU CK00 Div /512 from the list.**

[FPB_RA0E1_Tutorial]	FSP Configuration \times			
Clocks Configura	ation			
HOCO 32MHz	HOCO Div /1	V VICLK Src: HOCO	~	> ICLK 32MHz
MOCO 4MHz		~~	TAU CK00 Div /1	→ TAU CK00 32MHz
X1 20MHz	X1 Div /1	~~	TAU CK00 Div /1 TAU CK00 Div /2 TAU CK00 Div /4	→ TAU CK01 32MHz
SUBCLK 32768Hz]		TAU CK00 Div /8 → TAU CK00 Div /16 TAU CK00 Div /32	→ TAU CK02 16MHz
LOCO 32768Hz]		TAU CK00 Div /64 TAU CK00 Div /128 TAU CK00 Div /256	→ TAU CK03 125kHz
		CLKOUT Disabled	TALLCK00 Div /512	→ CLKOUT 0Hz
	¢	> UARTA Src: Disab	Died V TAU CK00 Div /4096 TAU CK00 Div /8192	→ UARTA UTAO OHz
	¢	TML32 FITL0 Disa	TAU CK00 Div /16384 abled ~ TAU CK00 Div /32768	→ TML32 FITL0 0Hz
	·	>> TML32 FITL1 Disa	abled ~	→ TML32 FITL1 0Hz
		→ TML32 FITL2 Disa	abled ~	TML32 FITL2 OHz
	FSXP Src: SUBCLK			FSXP 32.768kHz

Figure 3-15 Clock setting



Check that the TAU CK00 supply clock is 62.5kHz.

Clocks Configu	ration						
HOCO 32MHz	 → HOCO Div /1 	~ ~	> ICLK Src: HOCO	~	1	;	→ ICLK 32MHz
MOCO 4MHz	MOCO Div /1	~~			→ TAU CK00 Div /512	~->	► TAU CK00 62.500kHz
K1 20MHz	X1 Div /1	~~			→ TAU CK01 Div /1	~->	TAU CK01 32MHz
SUBCLK 32768Hz					→ TAU CK02 Div /2	~	TAU CK02 16MHz
LOCO 32768Hz					→ TAU CK03 Div /256	\rightarrow	TAU CK03 125kHz
		ļ	CLKOUT Disabled	~	→ CLKOUT Div /1	\rightarrow	CLKOUT OHz
	·		UARTA Src: Disabled	~			→ UARTA UTA0 0Hz
			>> TML32 FITL0 Disabled	~			TML32 FITL0 0Hz
	·		TML32 FITL1 Disabled	~			TML32 FITL1 0Hz
		1	TML32 FITL2 Disabled	~		;	TML32 FITL2 OHz
	FSXP Src: SUBCLK	~					FSXP 32.768kHz

Figure 3-16 Clock setting

3.2.3 Pin settings

- 1. Select the "Pins" tab and then the "Pin Function" tab.
 - Then select P008.

You will see the Symbolic Name is given to LED1. This is because in <u>section 3.1.2</u> the board FPB-RA0E1 was selected and the BSP has this assignment saved. This is the same for other peripherals and this Symbolic Name can be used when writing the code for the program.

elect Pin Configuration		Expe	ort to CSV file 🔚 Configure Pin Driv	ver Warnings
FPB-RA0E1	Manage configuratio	<u>ns</u>	Generate data: g_bsp_pin_cfg	
Pin Selection	${\mathbb E} \ \boxdot \ {\mathbb E} \ {\downarrow^{a}_{z}}$	Pin Configuration		
Type filter text		Name	Value	Link
✓ ✓ Ports		Symbolic Name	LED1	
V V PO	1	Comment	GREEN_ARDUINO_A4	
¥ P008		Mode	Output mode (Initial Low)	
✓ P009		Output Type	CMOS	
✓ P010		Drive Capacity	L	
✓ P011		✓ Input/Output		
V P012		P008	✓ GPIO	
¥ P013				
Y P014				
Y P015				
> 🗸 P1				
> 🗸 P2				
> 🗸 b3				
> 🗸 P4				
> 🗸 ba		Module name: P008		
> 🗸 Other Pins			1000	
V V Peripherals		Port Capabilities: ADCO: AN	1002	
🔉 🗹 Analog:ADC				

Figure 3-17 Pin settings



2. Since we want P008 to be initially lit (High output), set the "Mode" to "Output mode (Initial High)".

# *[FPB_RA0E1_Tutorial] FSP Configuration ×			
Pin Configuration			
Select Pin Configuration		📑 Export to CSV file 🛛 🗄 Configure Pin I	Driver Warnings
FPB-RA0E1 Manage configu	rations	Generate data: g_bsp_pin_cfg	
Pin Selection $\blacksquare \blacksquare \blacksquare \downarrow_2^a$	Pin Configuration		
Type filter text ✓ ✓ Ports ✓ ✓ P0 ✓ P009 ✓ P010 ✓ P012 ✓ P013	Name Symbolic Name Comment Mode Output Type Drive Capacity V Input/Output P008	Value LED1 GREEN_ARDUINO_A4 Output mode (Initial Hig Disabled Input mode Output mode (Initial Low) Output mode (Initial High)	

Figure 3-18 Pin settings

3. Since we want P009 to be initially off (Low output), set the "Mode" to "Output mode (Initial Low)".

💮 *[FPB_RA0E1_Tutorial] FSP Configu	ration ×			
Pin Configuration				
Select Pin Configuration			📑 Export to CSV file 🛛 🖺 Configure Pin I	Driver Warnings
FPB-RA0E1	Manage configura	ations	Generate data: g_bsp_pin_cfg	
Pin Selection	E ⊞ ⊡ ↓ª₂	Pin Configuration		
Type filter text		Name	Value	Link
✓ ✓ Ports		Symbolic Name	LED2	
v v Po	1	Comment	GREEN_PMOD1_CS3_GPI	
✓ P008		Mode	Output mode (Initial Low)	
✓ P009		Output Type	CMOS	
✓ P010		Drive Capacity	L	
✓ P011		✓ Input/Output		
✓ P012		P009	 GPIO 	
A Dota				

Figure 3-19 Pin settings



3.2.4 Adding the Timer

1. Select the "Stack" tab - it is from here we can add all drivers and middleware components.

Project Explorer ×	😫 🍞 🖇 📟 🗖 👹 *[FPB_RAGE1_Tutorial] FSP G	onfiguration ×		
> 😸 FPB_RA0E1_Tutorial	Stacks Configuration	1		Generate Project Conter
	Threads	🐔 New Thread 🔬 Remove 📄	HAL/Common Stacks	🛐 New Stack > 🏥 Extend Stack > 🙀 Remove
	v 🔮 HAU/Common 🔮 g_ioport VO Port (r	Jopoti		
	Objects	Kin Object > Kin Remove		
] Properties × 😰 問題 🧠 スマート・ブラウザー		terrupts Event Link Stacks Components		c :

Figure 3-20 Setting the timer function

 Select "New Stack ", a list of functions will be displayed. Select "Timers" > "Timer, Independent Channel, 16-bit and 8-bit Timer Operation (r_tau)".

		Generate	Project Conte
HAL/Common Stacks	🗿 New Stac'	₽ F	- E Remov
		Analog	>
		Audio	>
		Bootloader	>
<u>(</u>)		Connectivity	>
		DSP	>
		Input	>
		Monitoring	>
		Motor	>
		Networking	>
		Power	>
		Security	>
		Sensor	>
		Storage	>
		System	>
Realtime Clock (r. rtc. c)		Timers	>
Timer, Independent Channel, 16-bit and 8-bit Timer Operation	n (r_tau)	Transfer	>
Timer, Simultaneous Channel Operation (r_tau_pwm)	A	Search	

Figure 3-21 Setting the timer function

3. Verify that a stack named g_timer0 has been added.

The properties tab is where the configuration of drivers and middlewares is performed. This is shown in the red frame for g timer0 below.

RA_workspace - FPB_RA0E1_Tutorial/configuration.xml - e ² studio	-		
<u>File Edit Navigate Search Project Renesas Views Run</u> Renesa			
🍋 Project Explorer X	*[FPB_RA0E1_Tutorial] FSP C	onfiguration ×	
> 📂 FPB_RA0E1_Tutorial	Stacks Configuration	1	
	Threads	new Thread 🔊 Remove 📄	HAL/Common Stacks
	 ✓ AHL/Common g_ioport I/O Port (r) ⊕ g_timer0 Timer, Inde Objects 	joport) ependent Channel, 16-bit and 8-bit Timer Operation (r_ta 	 <i>g</i>.joport I/O Port (r_ioport) Independent Channel, Independent Channel, 16-bit and 8-bit Timer ①
	Summary BSP Clocks Pins In	terrupts Event Links Stacks Components	
🔲 Properties 🗙 🔝 問題 🧠 スマート・ブラウザー 🛷 検索 🖳 Console			
g_timer0 Timer, Independent Channel, 16-bit and 8-bit Tir	mer Operation (r_tau)		
Settings Property		Value	
API Info Parameter Checking		Default (BSP)	
Pin Output Support		Disabled	
Pin Input Support		Disabled	
 Module g_timer0 Timer, Independent Channel, 16-bit and 	8-bit Timer Operation (r_tau)		
> General			
> Input			
> Output			
> Interrupts			
✓ Pins			
Tioo		<unavailable></unavailable>	
TO00		<ur><unavailable></unavailable></ur>	

Figure 3-22 Setting the timer function

If you cannot find the "Properties" window, select "Window" \rightarrow "Show View" \rightarrow "Properties" from the e² studio menu bar to display it. ----

.

ile <u>E</u> dit <u>N</u> avigate Se <u>a</u> rch <u>P</u> roject Renesas <u>V</u> iews <u>R</u> un Renesas		Window Help		
	SAI Y	Indow Help		
📓 🛛 🗞 🕶 📣 🗠 🗐 🗐 🔯 🗄 🏘 🕶 💁 🕶		New Window		
Project Explorer X	1	Editor	>	figuration ×
FPB_RA0E1_Tutorial	c	Appearance	>	
> 🔊 Includes		Show View	>	- Drojost Suplorer
> 🔑 ra > 🔑 ra_gen		Perspective	>	Properties
> 😂 src		Navigation	>	🌸 Smart Browser
> 🔁 Debug	-			Other Alt+Shift+Q, Q
> 🧀 ra_cfg		Preferences		

Figure 3-23 Setting the timer function



4. Open the "General" properties list in preparation of the following steps as shown in the red frame below.

Properties ×	🔝 問題	👒 スマート・ブラウザー 🛷 検索	🖳 Console 🏘 デバッグ
--------------	------	-------------------	------------------

ttings	Property	Value
PI Info	✓ Common	
	Parameter Checking	Default (BSP)
	Pin Output Support	Disabled
	Pin Input Support	Disabled
	 Module g timer0 Timer, Independent Channel, 16-bit and 8-bit Timer Operation (r tau) 	
	✓ General	
	Name	g_timer0
	Channel	0
	Function	Interval Timer
	Bit Timer Mode	16-bit timer
	Operation Clock	CK00
	Period	0x10000
	Period Unit	Raw Counts
	Period (Higher 8-bit timer)	0x100
	Period Unit (Higher 8-bit timer)	Raw Counts
	> Input	
	> Output	
	> Interrupts	
	✓ Pins	
	TIOO	<unavailable></unavailable>
	TO00	<unavailable></unavailable>

Figure 3-24 Setting the timer function

First, set the name of the timer module.
 Name : Set the name of the timer module. This time, we will create it with the name " MyTimer ".

 Module g_timer0 Timer, Independent Channel, 16-bit and 8-bit Timer Operation (r_tau) 	
✓ General	
Name	MyTimer
Channel	0

Figure 3-25 Setting the timer function

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6. Next, set the following items.
Channel: 0

This is the TAU peripherals channel we will be using.
Function: Interval Timer
This is the function of the timer, here we will use it as an interval (periodic) timer.
Bit Timer Mode: 16-bit timer
This is the width of the count register.
Operation Clock : CK00
This is the clock supplied to the TAU channel used for counting.
Period: 500
This is the period in "units" of the timers counter.

These are the units for the "period" being counted.

 Module MyTimer Timer, Independent Channel, 16-bit and 8-bit Timer Operation (r_tau) 	
✓ General	
Name	MyTimer
Channel	0
Function	Interval Timer
Bit Timer Mode	16-bit timer
Operation Clock	CK00
Period	500
Period Unit	Milliseconds
Period (Higher 8-bit timer)	Raw Counts
Period Unit (Higher 8-bit timer)	Nanoseconds
> Input	Microseconds
> Output	Milliseconds
> Interrupts	Seconds Hertz
✓ Pins	Kilohertz

Figure 3-26 Setting the timer function

7. Now open the "Interrupts" properties list to configure the interrupt settings.

✓ Interrupts	
Setting of starting count and interrupt	Timer interrupt is not generated when
Callback	NULL
Interrupt Priority	Disabled
Higher 8-bit Interrupt Priority	Disabled

Figure 3-27 Setting the timer function



 Set a user-implementable interrupt handling function to Call back. The default setting "NULL" means there is no function to implement. This time we will create a callback function named " MyISR ".

	•
✓ Interrupts	
Setting of starting count and interrupt	Timer interrupt is not generated when o
Callback	MyISR
Interrupt Priority	Disabled
Higher 8-bit Interrupt Priority	Disabled

Figure 3-28	Setting	the	timer	function

9. Set the interrupt priority in Interrupt Priority.

The default "Disabled" means interrupts are disabled.

Since we will be using interrupts this time, set the Priority to one of 0 to 3.

✓ Interrupts	
Setting of starting count and interrupt	Timer interrupt is not generated when countir
Callback	MyISR
Interrupt Priority	Priority 3
Higher 8-bit Interrupt Priority	Priority 0 (highest)
✓ Pins	Priority 1
TIOO	Priority 2
TO00	Priority 3 Disabled
	Disabled

Figure 3-29 Setting the timer function

This completes the Timer settings.

10. The settings necessary for creating this program have been completed, so press the "Generate Project Content" button to generate the code.

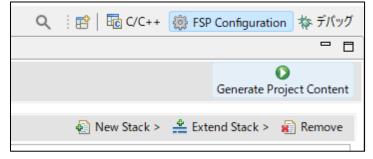


Figure 3-30 Setting the timer function



11. You will be asked if you want to save it to the Configuration.xml file, so click the "Proceed" button to save it.

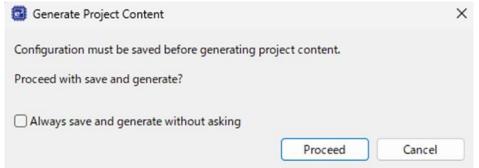


Figure 3-31 Setting the timer function



RA0E1 Group

3.3 Coding

In this section we will introduce writing the application code.

The contents to be implemented are as follows.

Main program

Starting the timer

Interrupt program

LED toggling

- 3.3.1 Implementation of the main program
 - 1. When developing using the FSP, the application entry point is in the src\hal_entry.c file. Double click this file to open it.

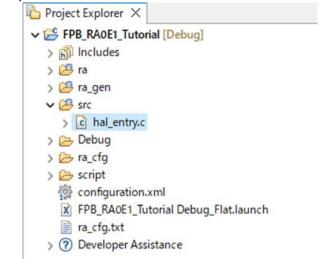


Figure 3-32 Implementation of the main program

 The void hal_entry(void) function is the application entry point. The initial I/O settings and C runtime setup is already performed when reaching this point. The gray area on the screen indicates source code not being compiled due to preprocesor exclusion thus it can be ignored.

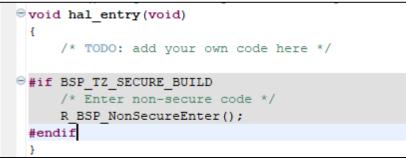


Figure 3-33 Implementation of the main program



3. First, define the return value variable defined by the function defined by the FSP. fsp err t err;

It is written as

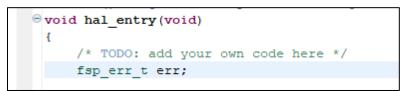


Figure 3-34 Implementation of the main program

4. Next, implement the timer open function.

Open the "Developer Assistance" list in the "Project Explorer" window and you will see the timer module MyTimer, which was configured in "3.2.4 Timer Function Settings".

Open the list further and you will see a list of functions.

The function to open the timer is R_TAU_Open(). Drag and drop this function into the source file with the mouse.

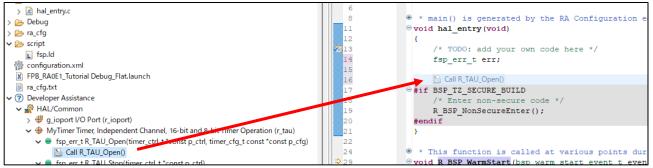


Figure 3-35 Implementation of the main program

5. Open API is implemented in the source code. By declaring a return value variable in advance, code containing assignment statements will be generated.

Open API is used for peripheral setup, that is turning the peripheral on and making any one-time settings.

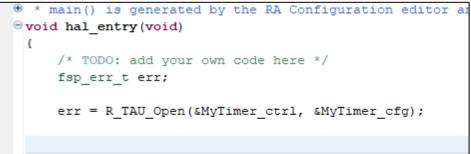


Figure 3-36 Implementation of the main program



6. Next, implement the timer start function. The start API is R_TAU_Start (). Drag and drop with your mouse below "R _TAU_ Open ()" in the source file.

Start API is used to start peripheral operation, in this case it will begin the timers counting operation.



Figure 3-37 Implementation of the main program

7. A start function is implemented in the source code.

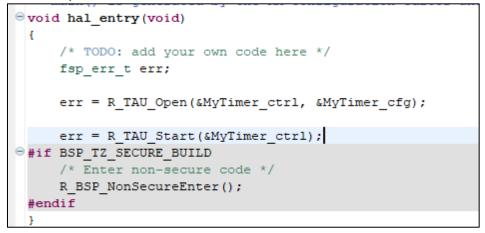


Figure 3-38 Implementation of the main program



8. To determine run time errors, checking for non-zero returns and hanging the application is used to alert the developer of settings errors.

```
while(err);
```

If the program terminates abnormally, the above statement will loop infinitely. Additionally upon successful execution, an infinite loop should be implemented. while (1)

```
{
___NOP();
}
```

The source code of the hal_entry() function is as follows.

```
* main() is generated by the RA Configuration editor a
void hal entry(void)
 Ł
     /* TODO: add your own code here */
     fsp err t err;
     err = R TAU Open(&MyTimer ctrl, &MyTimer cfg);
     while(err);
     err = R_TAU_Start(&MyTimer_ctrl);
     while(err);
Θ
     while(1)
      £
           NOP();
     1
⊖ #if BSP TZ SECURE BUILD
     /* Enter non-secure code */
     R BSP NonSecureEnter();
 #endif
 3
```

Figure 3-39 Implementation of the main program

9. The whole code is as follows. (Excluding invalid codes in gray)

```
void hal_entry(void)
{
   /* TODO: add your own code here */
fsp_err_t err;
err = R_TAU_Open(&MyTimer_ctrl, &MyTimer_cfg);
while(err);
err = R_TAU_Start(&MyTimer_ctrl);
while(err);
while(err);
while(1)
{
   ___NOP();
}
}
```



3.3.2 Implementation of interrupt program

1. Implement the interrupts callback function. The implementation should be placed in src\hal_entry.c as in previous steps.

Drag and drop the timer module's "Callback function definition " from the list of Developer Assistance onto the last line of the source file.

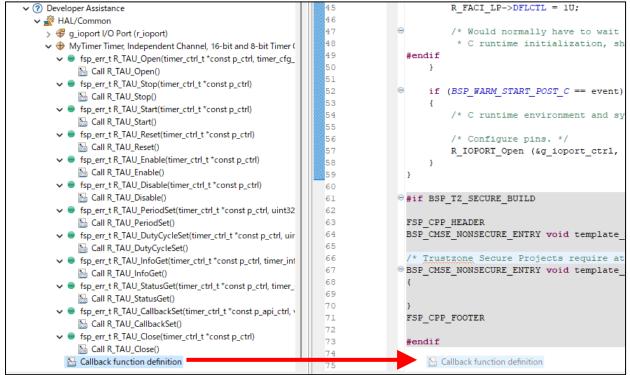


Figure 3-40 Implementation of interrupt program

 The callback function name set in FSP will appear. This function is described in "3.2.4 Adding the Timer" We will add LED inversion output processing to this function.

71	FSP_CPP_FOOTER
72	
73	#endif
74	
75	/* Callback function */
76	<pre> void MyISR(timer_callback_args_t *p_args) </pre>
77	{
78	<pre>/* TODO: add your own code here */</pre>
79	}
80	



3. Write the FSP return value type variable.

```
fsp_err_t status;
```

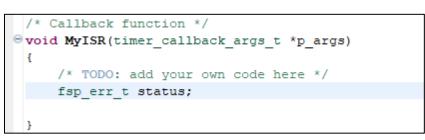


Figure 3-42 Implementation of interrupt program

 Read the current output state of the LED. The pin read function is R_IOPORT_PinRead (). Drag and drop the IO port module R_IOPORT_PinRead () from the Developer Assistance list into the interrupt function body.

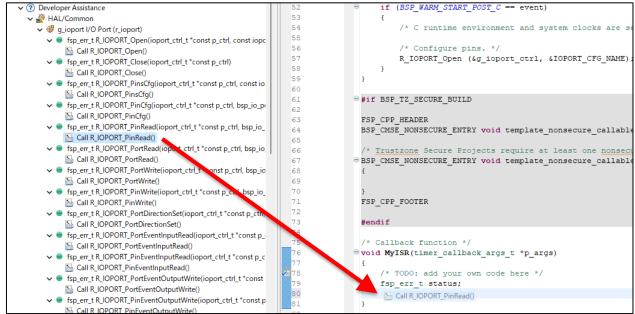


Figure 3-43 Implementation of interrupt program

5. The result should look as follows:

```
/* Callback function */
  void MyISR(timer_callback_args_t *p_args)
{
    /* TODO: add your own code here */
    fsp_err_t status;
    status = R_IOPORT_PinRead(&g_ioport_ctrl, pin, p_pin_value);
}
```

Figure 3-44 Implementation of interrupt program



- 6. Above the R_IOPORT_PinRead() line, provide a definition for the BSP IO level type, like so: bsp_io_level_t value;
- The 2nd argument of R_IOPORT_PinRead () is the pin number to read = "LED1", Set the address of the variable (bsp_io_level_t value) that stores the read result in the 3rd argument.

```
Write the following:
```

```
status = R IOPORT PinRead(&g ioport ctrl, LED1, &value);
```

63	}
64	FSP CPP FOOTER
65	
66	#endif
67	
67 68	/* Callback function */
69	<pre> woid MyISR(timer callback args t *p args) </pre>
70	{
71	/* TODO: add your own code here */
72	fsp err t status;
73	
74	bsp io level t value;
75	<pre>status = R_IOPORT_PinRead(&g_ioport_ctrl, LED1, &value);</pre>
76	

Figure 3-45 Implementation of interrupt program

8. The symbol "LED1" is declared in ra_cfg\fsp_cfg\bsp\bsp_pin_cfg.h in the project tree and can be referenced from hal_entry.c.

9	#define LED1 (BSP_IO_PORT_00_PIN_08) /* GREEN_ARDUINO_A4 */
10	<pre>#define LED2 (BSP_IO_PORT_00_PIN_09) /* GREEN_PMOD1_CS3_GPI010_ARDUIN0_A3 */</pre>

Figure 3-46 Implementation of interrupt program

9. Stores the value for inverting the read value and outputting it in the variable next_led1. Write the following.

bsp_io_level_t next_led1 ;

Write the process to invert and output the read value.

```
while(status);
if(BSP_IO_LEVEL_HIGH == value)
{
    next_led1 = BSP_IO_LEVEL_LOW;
}
else
{
    next_led1 = BSP_IO_LEVEL_HIGH;
}
```

```
void MyISR(timer_callback_args_t *p_args)
 ł
     /* TODO: add your own code here */
     fsp_err_t status;
     bsp io level t value;
     bsp io level t next ledl;
     status = R IOPORT PinRead(&g ioport ctrl, LED1, &value);
     while(status);
Θ
     if(BSP_IO_LEVEL_HIGH == value)
     {
         next led1 = BSP IO LEVEL LOW;
     }
     else
     ł
         next_led1 = BSP_IO_LEVEL_HIGH;
     }
 }
```

Figure 3-47 Implementation of interrupt program



 Add processing to write LED1 state The pin write function is R_IOPORT_PinWrite(). Drag and drop the IO port module R_IOPORT_PinWrite() into the interrupt function.

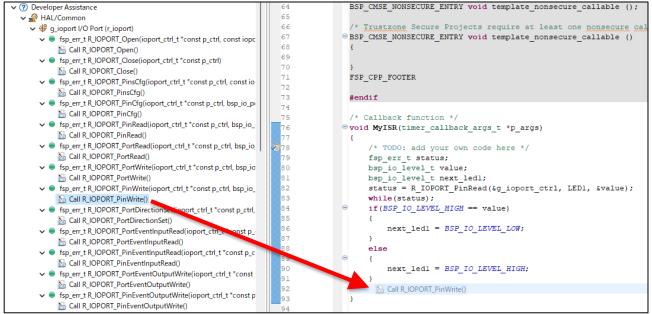


Figure 3-48 Implementation of interrupt program

11. The result is as follows:

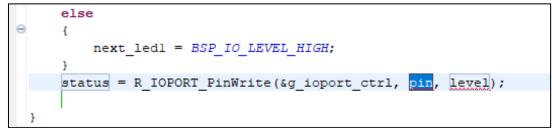


Figure 3-49 Implementation of interrupt program

12. Set " LED1 " to the 2nd argument of R_IOPORT_Pin Write() and the output value (=next_led1) to the 3rd argument .

```
Write the following.
    status = R_IOPORT_PinWrite(&g_ioport_ctrl, LED 1 , next_led1 );
    while(status);
```

```
status = R_IOPORT_PinWrite(&g_ioport_ctrl, LED1, next_led1);
while(status);
```

Figure 3-50 Implementation of interrupt program

```
13. Write the process to output the previous value of LED1 to LED2 as follows.
    status = R_IOPORT_PinWrite(&g_ioport_ctrl, LED2, value);
```



14. The implementation of the interrupt function is as follows.

```
void MyISR(timer_callback_args_t *p_args)
 £
     /* TODO: add your own code here */
     fsp_err_t status;
     bsp io level t value;
     bsp_io_level_t next_ledl;
     status = R IOPORT PinRead(&g ioport ctrl, LED1, &value);
     while(status);
     if (BSP_IO_LEVEL_HIGH == value)
e
      Ł
         next_led1 = BSP IO LEVEL LOW;
     }
     else
      Ł
         next_led1 = BSP_IO_LEVEL_HIGH;
     }
     status = R IOPORT PinWrite(&g ioport ctrl, LED1, next led1);
     while(status);
     status = R IOPORT PinWrite(&g ioport ctrl, LED2, value);
     while(status);
```

Figure 3-51 Implementation of interrupt program

15. The whole code is as follows.

```
/* Callback function */
void MyISR(timer callback args t *p args)
/* TODO: add your own code here */
fsp err t status;
bsp io level t value;
bsp_io_level_t next_led1;
status = R IOPORT PinRead(&g ioport ctrl, LED1, &value);
while (status);
if(BSP IO LEVEL HIGH == value)
{
next led1 = BSP IO LEVEL LOW;
}
else
{
next led1 = BSP IO LEVEL HIGH;
}
status = R IOPORT PinWrite(&g ioport ctrl, LED1, next led1);
while (status);
status = R IOPORT PinWrite(&g ioport ctrl, LED2, value);
while (status);
```



3.4 Build

The following steps describe building the application executable in preparation for debugging.

1. Right-click the project name in the project tree and select Build Project.

Project Explor	er X		
FPB_RAOF	1 Tutorial [Debug]		
> 🔊 Inc	New	>	
> 😕 ra	Go Into		
> 🔑 ra_ — > 🔑 src	Open in New Window		
> 🗁 Del	Show In	Alt+Shift+W >	e.
✓	Show in Local Terminal	>	
~ (Сору	Ctrl+C	
Ē	Paste	Ctrl+V	
24	Delete	Delete	
	Source	>	
	Move		
	Rename	F2	
	Import		
> 🗁 scr 📈	Export		
读 cor X FPE	Renesas FSP Export	>	
ra_	Build Project	Incremental Build of Selecte	ed Project
✓ ⑦ Det	Clean Project		
× 📽 🖉	Refresh	F5	

Figure 3-52 Build

Or you can build it by clicking the icon below.

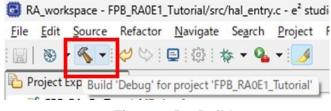


Figure 3-53 Build



2. The build log will be output to the " Console" window.

"Build Finished. 0 errors," is displayed at the end, it means that the build completed successfully. Yellow bands indicate warnings detected by the compiler. Check the contents of the warning and correct it if necessary.

	nsole (FPB RA		er 📮 Con	ISOIE A					
			/bsp/m	cu/all	1/bsp guard	L.C.			
-					l/bsp_io.c				
-		-	-		l/bsp_macl.	C			
-					1/bsp irq.c				
	al entry.c				_				
	_			-	ed paramete	r 'p args	' [-W	unused-r	arameterl
	void MyISR								
i.	-	_	_	_	~~~~~~				
Building	file:/	ra/fsp/sr	c/bsp/m	cu/all	l/bsp rom r	egisters.	C		
Building	file:/	ra/fsp/sr	/bsp/m	cu/all	l/bsp regis	ter prote	ction	.c	
Building	file:/	ra/fsp/sr	c/bsp/m	cu/all	l/bsp sbrk.	c			
Building	file:/	ra/fsp/sr	c/bsp/m	cu/all	l/bsp_secur	ity.c			
Building	file:/	ra/fsp/sr	/bsp/c	msis/I	Device/RENE	SAS/Sourc	e/sta:	rtup.c	
Building	file:/	ra/fsp/sr	/bsp/ci	msis/I	Device/RENE	SAS/Sourc	e/syst	tem.c	
Building	file:/	ra/board/	a0el_f	pb/boa	ard_init.c				
Building	file:/	ra/board/	a0el_f	pb/boa	ard_leds.c				
Building	target: F	PB_RAOE1_	Cutoria.	l.elf					
arm-none	-eabi-objc	opy -0 sr	C "FPB	RAOEL	L_Tutorial.	elf" "FP	B_RAO	El_Tutor	ial.srec"
arm-none	-eabi-size	format:	=berkel	ey "FE	PB_RAOE1_Tu	torial.el	f"		
	data	bss	dec	hex	filename				
text			000	1120	FPB RAOE1	Tutorial.	elf		

Figure 3-54 Build

If there is any coding mistake, a red band will appear. Please check the relevant line and revise the source code.

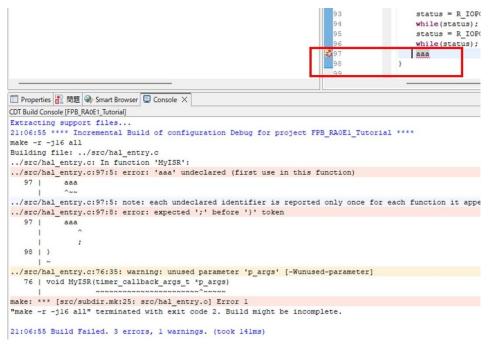


Figure 3-55 Build



RA0E1 Group

4. How to debug

This chapter explains the settings required to run the program.

4.1 Debug settings and startup

After the build is complete, write the program to the MCU on the board. For the first time only, check the settings for writing.

Connect the PC and FPB board with a USB cable.

1. From the project properties, select Debug \rightarrow Debug Configurations.

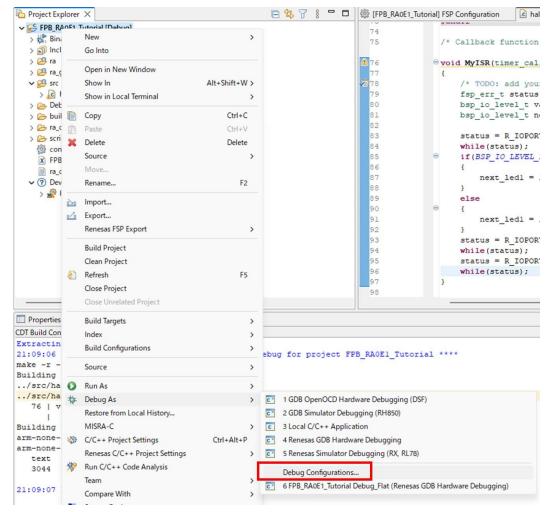


Figure 4-1 Debug settings and startup



RA0E1 Group

2. The configuration screen will be displayed. Select Renesas GDB from the tree on the left. Select your project name under Hardware Debugging.

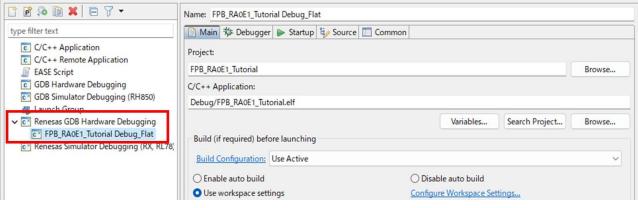


Figure 4-2 Debug settings and startup

 Select the Debugger tab and please verify the following settings: Debug hardware = "J-link ARM" Target Device = "R7FA0E107"

Press the "Debug" button to start writing the program to the microcontroller.

Debug Configurations		— 🗆 X
Create, manage, and run configurations		TO-
Image: Second State Sta	Name: FPB_RAOE1_Tutorial Debug_Flat Ms n Startup Source Common Debug hardware: J-Link ARM Target Device: R7FA0E107 GDB Settings Connection Settings Debug Tool Settings GDB Connection Settings Host name or IP address: localhost Ocnnect to remote GDB server GDB port number: 61234 Connect to remote GDB server GDB port number: 61234 GDB GDB GDB Step Mode	Browse Variables
Filter matched 9 of 11 items		Revert Apply
?		Debug Close

Figure 4-3 Debug settings and startup

4. After flashing is complete a pop-up will appear to ask if you would like to switch perspective to the "Debug" perspective.

This operation optimizes the debug workflow and for this tutorial you should click "Switch".

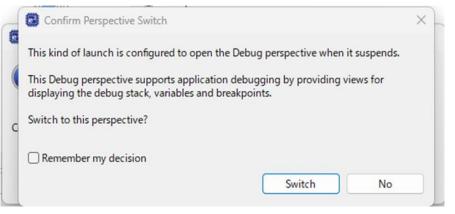


Figure 4-4 Debug settings and startup

*Even if you press "No", you can switch the screen later by pressing the "Debug" button at the top right of e² studio.

🔍 🕴 💼 C/C++ 👼 FSP Configuration 🔯 デバック								
(x)= Vari	💁 Bre	Pro	€** Ex	e Eve >	< 🔀 Per 🔳 IC) 🗆 🗖		
			X <i>X</i>	💥 🖬 🕅	PC: 0/4 OA: 0/2	8		
Type ☐ ௺ Trace Start ☐ 🞽 Trace Stop			Add	ress	Data			
	Trace Red							
and the second s	Event Bro	the second se						
	· Timer Sto	op						

Figure 4-5 Debug settings and startup

5. When the program finishes writing, it pauses at the SystemInit () function in startup.c.

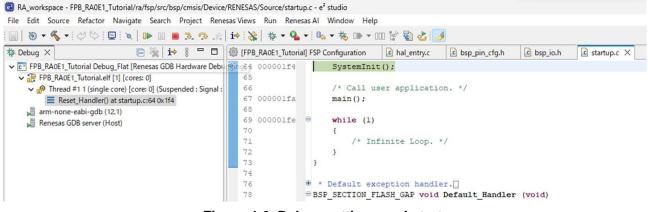


Figure 4-6 Debug settings and startup



4.2 Execution

In this state, the MCU has been reset and the program is not yet running.

You can confirm that neither LED1 nor LED2 on the board are lit.

1. Run the program by pressing the resume button in the red frame or the F8 key on your keyboard.

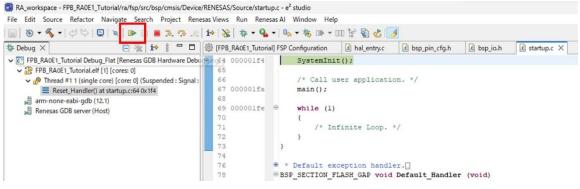
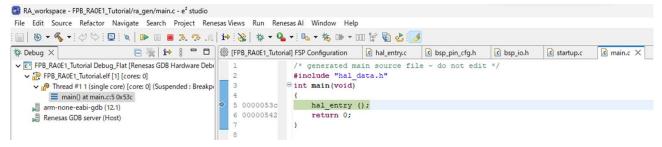


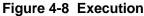
Figure 4-7 Execution

The program pauses at the beginning of the main function . (This is because the e^2 studio project default is set to pause at the main function.)

In this state, SystemInit () has been completed and the initial settings have been completed. If you check the board, you will see that LED1 is lit.

2. Press the resume button again to continue the program.







The execution status will be displayed at the bottom left of e² studio. When "Running " is displayed, the program is running.

3. If you check the board, you can see that LED1 and LED2 are lit alternately every 500ms.

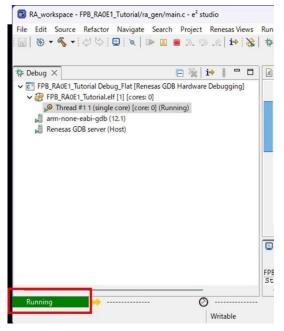


Figure 4-9 Execution



4.3 Quit debugging and restart

1. If you want to end debugging, press the "Terminate" button.

<u>File</u> <u>E</u> dit	Source	Refactor	Navigate	Search	Project	Renesas View
- 🛞 🔋	% - i	00:	📮 i 🔍 i		3. 7	

Figure 4-10 Quit debugging

2. The "Project Explorer" window is not displayed in the specified position because we are in the "Debug" perspective.

To return to the C/C++ Perspective and navigate the project, click "C/C++" on the top right of e2 studio.



Figure 4-11 Quit debugging

If you debug again, your debug settings are remembered.
 You can start debugging by [Right clicking] the project → "Debug As" → "6 Project Name".

脊	Debug As	>	C×	1 GDB OpenOCD Hardware Debugging (DSF)
	Restore from Local History		C×	2 GDB Simulator Debugging (RH850)
	MISRA-C	>	C	3 Local C/C++ Application
10	C/C++ Project Settings	Ctrl+Alt+P	C×	4 Renesas GDB Hardware Debugging
	Renesas C/C++ Project Settings	>	C×	5 Renesas Simulator Debugging (RX, RL78)
×	Run C/C++ Code Analysis			Debug Configurations
	Team	>		6 FPB_RA0E1_Tutorial Debug_Flat (Renesas GDB Hardware Debugging)
	Compare Mith		C	6 FPB_NAUE1_IULUNIAI DEDUG_FIAL (Reflesas GDB Hardware Debugging)

Figure 4-12 Quit debugging

Alternatively, you can start debugging by clicking the icon below.

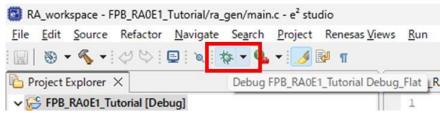


Figure 4-13



Revision History

		Description		
Rev.	Date	page	Summary	
1.00	2 024.03.27	-	First edition issued	



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

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

1. Precaution against Electrostatic Discharge (ESD)

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

2. Processing at power-on

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

3. Input of signal during power-off state

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

4. Handling of unused pins

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

5. Clock signals

6.

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. Voltage application waveform at input pin

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

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Corporate Headquarters

TOYOSU FORESIA, 3-2-24 Toyosu, Koto-ku, Tokyo 135-0061, Japan www.renesas.com

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